Report to the Congress on Ocean Dumping and Other Man-Induced Changes to Ocean Ecosystems

OCTOBER 1972 through DECEMBER 1973

Public Law 92-532, Title II

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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Report to the Congress on Ocean Dumping and Other Man-Induced Changes to Ocean Ecosystems

OCTOBER 1972 through DECEMBER 1973

Submitted in compliance with
Title II of the Marine Protection, Research, and Sanctuaries Act of 1972
(Public Law 92-532)

March 1974

UNITED STATES
DEPARTMENT OF COMMERCE
Frederick B. Dent, Secretary

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION
Robert M. White, Administrator

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THE SECRETARY OF COMMERCE
Washington, D.C. 20230

President of the Senate
Speaker of the House of Representatives

Sirs:

It is my privilege to submit to the Congress this first annual report of the Department of Commerce on the administration of the comprehensive ocean research provisions of the Marine Protection, Research, and Sanctuaries Act of 1972.

The Congress, in framing this legislation, addressed itself to some of our most basic concerns regarding the ocean environment. For example, the Act reflects official recognition of the fact that measures taken to protect our lakes and rivers should be complemented with similar controls over and research on ocean waters. Also, the Congress, fully aware that the Nation's relentless search for new sources of energy, food and raw materials will lead us increasingly to the oceans, has established as national policy that development of the oceans is to be carried out within a framework that takes into account the physical and biological limits of marine ecosystems. Especially in regard to the current imbalance between energy supply and demand, the comprehensive marine research authorized by the Congress is particularly appropriate and timely.

Title II of the Act assigns to the Department of Commerce responsibility for initiating programs of research and monitoring of the effects of ocean pollution and other man-induced changes to the marine environment. This program is being carried out by the National Oceanic and Atmospheric Administration. The research and monitoring program on short-term ecological effects of ocean dumping is intended to build the necessary data base to help government agencies make wiser decisions regarding the practice and control of ocean dumping. Looking beyond these immediate concerns, the Act also authorizes a comprehensive and continuing research program with respect to the long-range effects of pollution, overfishing and other man-induced changes to ocean ecosystems.

The successful application of this farsighted concept would provide the Nation an early warning system that would allow us to anticipate and head off serious ocean problems before they reach the crisis stage or become unmanageable.

In this first report we have presented a sense of the importance with which we view the legislation, something about the initial priorities, and also what is being planned now for the years ahead. The present research and monitoring programs consist of some projects already in progress when the law was passed, as well as some new ones just now getting under way. For example, NOAA's Marine Ecosystems Analysis Program (MESA) was initiated in FY 1973. Nevertheless, MESA, along with other earlier programs, has been provided added impetus and direction by P.L. 92-532.

This report describes programs carried out in response to Sections 201 and 202. It does not cover activities under Section 203, which authorizes the Secretary to assist and promote the coordination of research and other activities for the purpose of determining means for minimizing or ending all dumping within five years of the effective date of the Act. The Department of Commerce has not yet initiated a program of activities under this section. However, development of alternatives to ocean dumping is being addressed by investigations at the Federal and State levels and by educational and private research organizations. The results of these and similar studies are expected to provide the kinds of information and data required to ascertain the feasibility of minimizing or terminating ocean dumping by late 1977.

This report does not deal extensively with the problems of the Great Lakes. The international character of the Great Lakes system poses special problems of program integration which will be addressed more fully in subsequent annual reports, after evaluation of the results of the International Field Year for the Great Lakes (IFYGL) and related programs.

The Act assigns responsibility to the Secretary of Commerce for a comprehensive ocean research program to be coordinated with other appropriate Federal departments and agencies. Compliance with this mandate requires the Department of Commerce through NOAA to evaluate research activities relating to the health of the oceans and, as appropriate, to recommend, provide for, or conduct the research necessary to help solve the problems caused by ocean dumping and other activities of man. This requires a level of interagency coordination that has heretofore not existed for addressing these problems. Indeed, this lack of agency coordination was a central concern of the Congress in passing the legislation. The Department of Commerce with the cooperation of other concerned agencies, has begun to confront this problem. As indicated in this report, a start has been made, but considerable work remains to be done.

It is not possible to adequately discharge the Department of Commerce's responsibility to report on progress in this area without describing the relevant activities of other departments and agencies. The descriptions provided of these other Federal programs are by no means all-inclusive or exhaustive, but, taken collectively, they do give a sense of where we are and where we ought to go in marine research.

It has been a short time since the law was enacted and much of our initial response has been directed toward marking out an overall effort that will produce the most results for the amounts expended. We look forward to building on the present base of programs in meeting our new responsibilities.

Respectfully,

Secretary of Commerce

PREFACE

The Marine Protection, Research, and Sanctuaries Act (P.L. 92-532), enacted on October 23, 1972, provides for the regulation of ocean dumping, research on ocean dumping and other man-induced changes to ocean ecosystems, and the designation, acquisition, and administration of marine sanctuaries.

Section 201 of the Act requires the Secretary of Commerce to initiate a comprehensive and continuing program of monitoring and research regarding the effects of ocean dumping and to report from time to time, not less frequently than annually, his findings (including an evaluation of the short-term ecological effects and the social and economic factors involved) to the Congress. With regard to long-range effects of pollution, overfishing, and man-induced changes of ocean ecosystems, Section 202 of the Act states that the Secretary shall report to the Congress in January of each year on the results of activities undertaken during the previous year.

This first report is submitted to the Congress in response to these requirements. It presents a perception of the problem of ocean dumping as well as an overview of the more complex, longer-term problems of man's effects on the world's oceans. Included are relevant activities from enactment of this Act through the end of calender year 1973.

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OVERVIEW OF OCEAN RESOURCES, USES AND CONFLICTS, AND THE LEGISLATION DESIGNED TO RESOLVE THEM

INTRODUCTION

There is increasing concern that the cumulative effects of man's activities are working undesirable and possibly irreversible changes in some ocean ecosystems. With the emergence of the environmental movement in the 1960's, the concerns of a few scientists became reflected in a public awareness that the oceans were neither an inexhaustible source of food nor immune to man's environmental insults. Public support encouraged new legislation authorizing an expanded role for the Federal Government in the overall effort to understand and protect the marine environment.

The provisions of the Marine Protection, Research, and Sanctuaries Act of 1972 reflect the concern and public awareness that coastal and ocean resources important to man can be threatened by unregulated ocean dumping. Clean seawater, beaches, and shorelines are valuable resources, as are bountiful and disease-free finfish and shellfish stocks, and the natural areas that support them. Other truly unique areas that will be designated as marine sanctuaries under other provisions of this Act have also been formally recognized as resources of recreational, scientific, and aesthetic values.

Equally valuable to man, however, are the nonliving resources in or beneath the coastal and offshore ocean: oil, gas, sand, gravel, hard minerals, thermal gradients, powerful ocean currents, and cold nutrient-rich water. Moreover, as land and water-based resources become fully developed or scarce, there is increasing need to develop and use alternative resources, both living and non-living, found in the ocean.

Increased use of ocean resources is already evident in fisheries, siting of offshore nuclear powerplants and superport oil and LNG terminals, recreational boating, marine transport, coastal zone development, and dumping and disposal of wastes. And in the near future, we can expect attempts to develop and use heretofore untapped resources such as unfamiliar but abundant fish species, offshore sand and gravel, deep water manganese deposits, thermal gradients and currents to produce electric energy, and artificially induced upwelling.

Multiple use of resources inevitably leads to conflicts between competing uses that can threaten the uses and even in some cases, the resources themselves. The Coastal Zone Management Act of 1972 provides a framework and Federal encouragement to the States to formulate objectives and management tools designed to minimize such conflicts and maximize benefits that coastal resources can supply. Other legislation such as the National Environmental Policy Act of 1969, the Fish and Wildlife Coordination Act, the Federal Water Pollution Control Act, as amended, and the Marine Mammal Protection Act, also work in the same direction by requiring coordination between Federal agencies that are responsible for regulating the use of natural resources.

The Marine Protection, Research, and Sanctuaries Act of 1972 addresses the potential conflicts between the impacts of man-induced changes in the ocean ecosystem, and certain nonconsumptive uses as well as the integrity of primary resources themselves. The Act directly controls dumping by requiring, prior to issuing permits, the Environmental Protection Agency (EPA), and the Corps of Engineers in the case of dredged spoils, to formally and publicly consider the effects of such dumping on human health and welfare, including economic, aesthetic and recreational values, fisheries resources, wildlife, shorelines and beaches, marine ecosystems, and on nonliving resource exploitation, etc., and to weigh these effects against the need for and benefits to be derived from ocean dumping and its alternatives. The Act also directs the Department of Commerce to work with the Coast Guard and to initiate a comprehensive and continuing program of monitoring and research regarding the effects of ocean dumping, and, in consultation with other agencies, to initiate a comprehensive and continuing research program with respect to possible long-range effects of pollution, overfishing, and man-induced changes of ocean ecosystems. A major purpose of these research and monitoring activities is clearly intended to provide scientific findings, evaluations, and conclusions that are relevant to defining use conflicts that could influence the decisions to grant or deny dumping permits. In requiring annual reports to Congress, the Act provides a convenient and timely mechanism for documenting our efforts.

RESOURCE USE PERSPECTIVES

Oil and Gas Development

The United States has an extensive Continental Shelf region off its coastal borders. Measured to the 200-meter depth contour, the Continental Shelf is 545,000 square nautical miles, or approximately the same area as the State of Alaska.[1] The Continental Shelf is not a uniform feature, but varies in width, with nearly 70 percent of the U.S. Continental Shelf area lying off the Alaskan coast.

Excluding coastal lands under State jurisdiction, almost 10 million acres of Outer Continental Shelf lands have been leased for petroleum production; about one-half of this leased acreage is current, with approximately 11,500 producing wells situated on a total of about 1,944 platforms (as of October 1973). Currently, some 18 percent (about 660 million barrels annually) of our crude oil production and 15 percent of our gas production come from offshore areas. As of March 1973, proven reserves of oil and gas in the Outer Continental Shelf region were 10.1 billion barrels of oil and 39.9 trillion cubic feet of natural gas, excluding Prudhoe Bay. Economically recoverable oil and gas from U.S. offshore and outer Continental Shelf regions may be 20 times that great. According to the U.S. Geological Survey (USGS), 5 billion barrels would supply the nation's oil requirements for a little less than 1-1/2 years.

Because of the constantly growing demand for oil and gas and the advisability of decreasing our dependence upon imported fuel, the Administration has moved to triple the acreage leased on the outer Continental Shelf by the end of this decade. This accelerated leasing rate could by 1985 increase annual energy production by an estimated 1.5 billion barrels of oil (approximately 16 percent of our projected oil requirements for that year), and 5 trillion cubic feet of natural gas (approximately 20 percent of expected demand for natural gas that year).

When we add to this the future transshipment of Alaskan North Slope oil from Port Valdez to west coast terminals, it is clear that our offshore areas will be the focus of very intense activity beginning in the mid-1970's.

Some petroleum spokesmen believe that the technology now exists to carry on all necessary operations in water depths to 600 feet almost anywhere except in the Arctic Ocean. During this decade the petroleum industry expects to have the capability to drill and produce in depths approaching 1000 feet. Experimental drilling has been successfully carried out in ocean depths as great as 11,700 feet.

Minerals From the Sea

Recovery of minerals from the sea, other than petroleum, is presently accomplished using four methods: extraction from seawater, tunneling under the seabed, dredging unconsolidated deposits on the Continental Shelf, and harvesting of precipitates (nodules) lying on the deep ocean floor.

In the extraction method, salt compounds such as calcium, sodium, bromine and magnesium are precipitated and then separated from seawater. All of these elements have many metallurgical and industrial applications. The commercial value of the minerals extracted from seawater was around $150 million in the United States in 1969. This represents a slight increase over the previous year; the value has shown an upward trend each year, reflecting a generally stable but solid demand.

The nearshore tunnel mining of coal, and to a lesser extent, iron, is carried out in the United Kingdom, Japan, Canada, Finland, and Taiwan, where this method represents an important supplemental source of minerals. As our demand for energy increases, interest in this mining method will accelerate. In several European countries (notably Great Britain), sand and gravel of commercial value are obtained by dredging on the Continental Shelf.

The fourth method of obtaining minerals from the ocean is the harvesting of the deposits of precipitates (nodules) lying on the seafloor in water depths often exceeding 4,000 meters, especially in the North Central Pacific Ocean. The precipitate of most commercial interest at present is the manganese nodule containing relatively high concentrations of manganese, nickel, copper, and cobalt.

The recovery of minerals from the seafloor and seabed is expected to cause changes in the marine environment. The extent to which these changes may be harmful is unknown at the present time. A better understanding of the marine environment and the effects of marine mining is needed if it is to be performed in an environmentally acceptable manner.

Recreation

Larger incomes and shorter working hours make it possible for Americans to enjoy a variety of leisure time activities. The coastal zone has received much of the impact of the recreation boom. Sport fishing in saltwater has doubled in number of participants and tripled in revenues since 1955. Census figures show that marine anglers numbered over 9 million in 1970 and spent about $1.4 billion. Boating is another major coastal recreational activity. The proliferation of marinas, and other facilities catering to pleasure boaters and fishermen, can be observed in many coastal communities. Fishing and boating, however, are not mutually exclusive activities, because many pleasure boaters also fish. A third category of coastal recreational interest includes water contact activities -- swimming, surfing, water skiing, and scuba diving. Another large group of coastal visitors includes those who go to the seashore to picnic, camp, hike, take photographs, and enjoy the surroundings.

There are many potential conflicting interests in coastal regions. One of the major problems in coastal zone management lies in the need to balance the recreational needs of the population with the desires of private investors regarding economic development of the shoreline and inshore waters. Is it better to develop a given bay or estuary as a commercial harbor, or as a recreational harbor, or should it be left in its natural state? Should a given species of fish be allocated to sport or to commercial fishermen or should it be divided in some manner between them? Is such offshore development as the extraction of oil and gas and other marine mining activities compatible with recreational uses of the same area? If they are incompatible, how can the conflict be reconciled? Problems of this nature are facing us now and they will most certainly increase in the years ahead.

Food From the Sea

Since the turn of the century, there has been a rapid increase in the utilization of living resources of the oceans, and during the past 72 years the catch of marine fishes has increased fifteen-fold. The world catch is approximately 70 million metric tons annually. The current U.S. catch is about 3 million metric tons. The biological limit of production of traditional fishes from the oceans is now estimated to be approximately 100 to 150 million metric tons. It has been estimated that the upper limits of sustainable yield will be reached well before the year 2000. It is well to remember, however, that these are renewable resources, which, if properly protected and managed, can assure the world a continuous and substantial supply of valuable animal protein. Although the importance of marine fish to most other countries is generally recognized, there is a tendency to underrate their importance to the United States. About 9 percent of the total world fish production is consumed in this country. For human consumption, the U.S. demand is selective with a strong predilection for relatively high-priced fish and shellfish. For example, shrimp, salmon, and tuna alone account for nearly 50 percent of the total landed value of the U.S. fisheries. Including fish used for oil, animal feeds, and other industrial purposes, the U.S. per capita use of fishery products (56 pounds in 1971) is a third greater than the world average.[2]

Most of the world catch of marine fish comes from waters over continental shelves at depths less than 200 fathoms. It has been estimated that about 90 percent of the world harvest is taken from the approximate 8 percent of the ocean defined as shelf waters.[3] With the important exception of our distant-water tuna fishery, nearly all of the U.S. annual harvest comes from estuarine or coastal waters. In this regard, it is important to differentiate between the highly productive nearshore waters and the much less productive waters of the open ocean. Because of this, it is not simply a matter of our fishermen operating farther from shore as the nearshore areas may become closed to them due to pollution; they have no economically viable alternative.

Marine plants are valuable sources of chemicals and other substances useful to man. Few Americans are aware of their everyday use of red and brown algae derivatives which are important sources of carageenan and algin, respectively. These two colloids are used in instant milk mixes, evaporated milk, fruit juices, lipstick, gelatin, candies, toothpastes, ink, cosmetics, and many pharmaceutical products. The U.S. seaweed industry has established harvesting and collecting points in various parts of the world to obtain a sufficient quantity of algae. Some interesting preliminary research indicates that one specie of brown algae contains significant amounts of fats that could be converted into vegetable oils. A particular green seaweed is high in vegetable protein and appears to have high yield potential. Another intriguing and underexplored area is the use of marine plants and animals as sources of pharmaceutical substances such as antibiotics and drugs. The presence of antitumor and antimicrobial agents has been identified in such common marine organisms as clams and oysters. It has been estimated that less than one percent of all the sea organisms known to contain biologically active materials has been studied.

ENVIRONMENTAL IMPLICATIONS

The oceans cover about 70 percent of the earth's surface -- 140 million square miles. They are critical to maintaining the world's environment, and providing the base for the world's hydrologic systems. Oceans are economically valuable to man, providing, among other necessities, food and minerals. However, we now realize that the oceans are not an infinite sink for wastes, nor are they an inexhaustible source of fish and shellfish. Neither can we regard the mineral and fuel resources, the waterways, and the coastal areas as available for indiscriminate use and development. Man is beginning to recognize the oceans for what they truly are -- dynamic and major components of the earth ecosystem from which he can reap infinite benefits providing he manages wisely.

There are three significant aspects to modern man's intervention into the marine environment: 1) the vastly shortened time scale of environmental changes he can bring about which makes it difficult or impossible for plants and animals to adapt to such changes through evolution; 2) the fact that carefully designed modifications of marine environments need not bring about serious environmental deterioration and destruction; and 3) that through this knowledge marine environments can be enhanced to provide important benefits. There are many examples for the first two points, but we are only beginning to recognize the possibility of positive results from marine environmental modification. Thermal effluents, when properly distributed, can have beneficial effects in increasing fish and oyster production and by extending the use and enjoyment of bathing beaches. Water diversions or alteration of coastal currents and upwellings can benefit marine areas in a variety of ways; for example, enhancing fisheries, recreation, ocean shipping, and possibly climate.

As we become more aware of the environmental implications of man's interaction with marine ecosystems, it is well to recognize that natural events and processes also can introduce substances or bring about conditions which create undesirable conditions or impair man's use of the marine environment. Floods bring excessive quantities of freshwater, silt, sand, and organic material into estuaries. Droughts allow the ocean to invade the brackish and freshwater zones, altering fertility and productivity, and the composition of species. Warm weather and intense stratification of the water may bring about depletion of dissolved oxygen sufficient to cause catastrophic mortalities of fish and shellfish. Disease epidemics may produce severe mortalities among marine organisms. Severe storms, earthquakes, and volcanic eruptions may also cause widespread damage and sometimes permanent alteration of coastal environments and their resident communities of marine organisms.

Ocean Pollution

Ocean pollution may be defined as the unfavorable alteration of the marine environment, wholly or largely as a by-product of man's actions, through direct or indirect effects of changes in energy patterns, radiation levels, chemical and physical constitution, and distribution, abundance, and quality of organisms. These changes may affect man directly or indirectly through his supplies of food and other products, his physical objects or possessions, and his opportunities for recreation and appreciation of nature.

There are four major avenues by which oceans become polluted: 1) runoff from land, 2) contaminants from the atmosphere, 3) deliberate discharges through ocean outfalls and dumpings, and 4) through accidents. The assimilative capacity of the ocean to accommodate wastes is great but not unlimited. Coastal environments have a limited capacity to receive wastes, a capacity that has already been exceeded in many areas. Gradually we are beginning to recognize the undesirable consequences of food chain amplification of DDT and other chlorinated hydrocarbons, heavy metals, radioisotopes, and other industrial wastes. Some of these substances already occur in substantially greater concentrations in the upper layer of the ocean than in the total ocean. Thus, calculations of the capacity of the ocean to assimilate wastes need to consider the very slow mixing process between the upper and deeper layers.

To better predict future effects of ocean pollution on living resources, we should document how specific populations of marine organisms are now being affected by chronic levels of pollution. We have evidence of genetic changes and adaptations among some organisms from certain pesticides; there is increasingly strong association of deformities, cancer, and other diseases among marine organisms in polluted waters; it has been observed that the presence of certain nutrients in excess can result in an increase in undesirable algae. Beyond this we can only speculate. The need, then, is for research on the acute and chronic toxicological effects of pollutants on a broad spectrum of biological and ecological systems.

Major Offshore Construction

Man's ability to undertake large-scale construction projects in the oceans has been well demonstrated. Offshore towers for oil and gas extraction, massive landfill operations for projects such as superports, and bridge and tunnel construction projects are tangible evidence of this technological competence. The Dutch have completed huge land reclamation projects. A dam across the Bering Straits may be within the present state-of-the-art; this was proposed by the Soviet scientist Borisov in 1967 as a way to induce greater influx of oceanic heat into the Arctic Basin. The British and French may soon see the dream of a tunnel under the English Channel come to fruition.

Some of the projects which have been proposed for U.S. coastal regions include: airports; superports; barge-mounted floating nuclear powerplants enclosed in protective breakwaters; and operation of oil and gas structures in the deeper waters of the Continental Shelf. In the category of the more ambitious schemes, which have been suggested over the years, are: harnessing the energy of major ocean currents, such as the Gulf Stream; and piping deep cold water to the surface in the tropics to increase nutrient availability, generate power, and precipitate atmospheric moisture.

In addition to biological, physical, and social impacts, aesthetics must be considered as an intangible, but appreciable factor in planning for offshore development. In some areas, structures may have to be architecturally designed to harmonize with their surroundings. In any event, the inevitable appearance of large construction projects, especially in nearshore waters, will create additional resource use conflicts.

Overfishing

It was noted in the discussion of "Food From the Sea" that an estimated 100 to 150 million metric tons of traditional fish resources are available annually from the oceans, of which about 70 million metric tons are presently being harvested. The assumption is generally made that these are renewable resources that will be continually available to man, providing they are properly managed and protected and the environment preserved.

Increased utilization of the living resources of the sea means, however, that more marine populations are being fully utilized, and increasingly large amounts of fish biomass are being removed from the oceans. Because there is usually close coupling among different populations of marine organisms, it is necessary to develop a more sophisticated understanding of the relationships among them, i.e., the exploited stocks, unexploited populations, available food as well as the environmental factors affecting the abundance and

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distribution of these various groups. At some time in the future, to maintain a proper ecological balance, it may be necessary to engage in harvesting not only desired species, but also some degree of selective fishing of other species having less economic value.

Where fishing involves a multispecies resource such as in the North Atlantic, the need to manage the fishery in terms of the entire complex is necessary to assure the maximum sustainable yields.

Beyond these considerations is the need to assure that man's predation will not permanently alter the ecosystem, or that other groups such as marine mammals, or other interests such as the sport fishermen, are properly considered.

MEETING THE CHALLENGE

Although threats to the ocean are increasing, as previously described, and man's demands on the ocean for various kinds of uses are increasing, so has the capability to manage the ocean resource rationally been improving.

A number of studies in recent years have defined the use conflicts and threats to renewable ocean resources. Perhaps most influential in initiating direct Government action was the report in 1970 by the Council on Environmental Quality (CEQ) on ocean waste disposal,[4] which helped shape the Marine Protection, Research, and Sanctuaries Act of 1972. The reports of the Ash Council (1969)[5] and the Stratton Commission (1969)[6] laid the groundwork for the creation in 1970 of the Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration.[7] These reorganizations did much to reduce the previously fragmented division of responsibilities for environmental concerns and marine affairs within the Federal Government.

Legislation

The early 1970's have been active years insofar as environmental legislation is concerned. In addition to the 1970 reorganization establishing NOAA and EPA, the Congress and the Administration in that same period made substantial progress in creating the necessary statutory framework for preserving and enhancing the air and water environments.

National Environmental Policy Act. In the late 1960's there was mounting concern that environmental considerations were not being given adequate recognition by mission-oriented Federal agencies and departments. Large construction projects were being approved and executed. Possible environmental side effects were seldom included in the decision process.

A second major difficulty during the period was the lack of an articulated national policy with respect to environmental quality, as well as a mechanism, at a high level, to exercise an overall coordinating and advisory function with respect to all Federal programs related to environmental quality.

In response to these deficiencies, Congress passed the National Environmental Policy Act of 1969 (NEPA).[8] This landmark legislation set forth a clear statement of national policy on environmental quality, and created the Council on Environmental Quality (CEQ) within the Executive Office of the President. It also required, for the first time, a statement of environmental impact for every proposed Federal project and all proposed legislation significantly affecting the quality of the human environment, and formal coordination between Federal agencies for major actions undertaken.

Federal Water Pollution Control Act. Another important law related to the problems of ocean pollution and the environmental aspects of coastal zone management is the Federal Water Pollution Control Act Amendments of 1972.[9] The statute, administered by EPA, sets into effect a massive effort to clean up the Nation's waters. Some of the important provisions of the law include: major financial assistance for construction of municipal waste treatment works; grants to encourage regional waste treatment projects; streamlined enforcement procedures; a strengthened capability to deal with spills of oil and hazardous materials; and a permit program calling for stringent control of all effluent discharges.

Provisions of the FWPCA specifically related to the marine environment include: a water quality surveillance system for monitoring the quality of navigable waters including the contiguous zone (Sec. 104(a)(5)); coordinated research efforts on pollution problems of the estuarine zone (Sec. 104n); an annual water quality assessment and an inventory of all point sources of discharge of pollutants into all navigable waters, including those of the contiguous zone (Sec. 305); and limitation on discharges into the navigable waters and a national contingency plan for removal of oil and other hazardous substances (Sec. 311).

Coastal Zone Management Act. The Coastal Zone Management Act of 1972 is another outstanding example of basic legislation relating to the problems of the marine environment.[10] In this law, Congress has declared a national policy to preserve, protect, develop and, wherever possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations. In passing the Coastal Zone Management Act, the Congress has recognized the special nature of the coastal areas and the unusually great pressures now being exerted on them.

The objectives of the Act are: (1) to encourage and assist the States to develop and implement coastal zone management programs; (2) to foster Federal-State cooperation and joint participation in effectuating the purposes of the Act; and (3) to promote broad participation in the development of State coastal zone management programs. The law authorizes funds for both the development and implementation phases of the State coastal management programs. It also authorizes the Secretary of Commerce to make available to a coastal State grants of up to 50 percent of the costs of acquisition, development, and operation of estuarine sanctuaries for the purpose of studying the phenomena occurring within the estuaries of the coastal zone. The Act is administered by the Department of Commerce.

Marine Mammal Protection Act. This legislation places strict limits on the taking of marine mammals on the high seas.[11] The Act generally prohibits the taking or importation of such mammals and their products by U.S. citizens. The Secretary of Commerce or the Secretary of the Interior, depending on the species, may waive this prohibition only if he receives scientific evidence that the waiver would not endanger the species to be taken. The legislation is unique in that it is the first wildlife protection law that has for its primary purpose the preservation of the health and stability of an ecosystem. The Act also created the Marine Mammal Commission whose responsibility is to undertake a continuing review of the condition of the stocks of marine mammals and other related matters and to make recommendations to appropriate departments to further the purposes of the legislation.

Endangered Species Act. The Endangered Species Act of 1973 places severe limits on the importation, taking, or possession of species of fish or wildlife or plants in the United States or on the high seas by U.S. citizens, which are determined by the Secretary of the Interior or the Secretary of Commerce, depending on the species, to be in danger of or threatened with extinction.[12] The Secretary of the Interior is directed to publish in the *Federal Register* lists of species that he or the Secretary of Commerce determines to be threatened or endangered. Exception to this prohibition may be made only by way of permits for scientific purposes or to enhance the propagation or survival of the affected species, or in cases of undue economic hardship. The Act also calls for international cooperation and for the review of State programs, and provides for Federal funding to States which have programs carried out in accordance with the Act.

International Efforts

Concern over the quality of the environment has become a matter of priority in many nations. Because resource use conflicts and environmental degradation are not necessarily contained within a given set of political boundaries, there is the need to establish bilateral and multilateral agreements. The international community has already taken a number of important steps to accomplish this in recent years.

United Nations. Foremost among these international efforts was the UN Conference on the Human Environment (June 5-16, 1972) which took place in Stockholm, Sweden, and was attended by representatives from 113 nations. The Conference generated 109 recommendations of which several dealt in a significant way with ocean pollution and other man-induced changes to the world's oceans.

The three components of the action plan adopted at the UN Conference on the Human Environment are: global monitoring and assessment (EARTHWATCH); environmental management; and supporting measures. EARTHWATCH, as a major component of the UN Environment Programme (UNEP), will assess the impact of pollutants upon the human environment and the environment upon man, provide the capability for early warning of potential hazards, and provide a continuing assessment of selected natural resources. EARTHWATCH will make use of the environmental data gathering and monitoring systems of the Global Investigation of Pollution in the Marine Environment (GIPME), and

Integrated Global Ocean Station System (IGOSS) of the Intergovernmental Oceanographic Commission (IOC).

The most significant institutional innovation approved by the Conference participants, and subsequently by the parent body, was the creation of a new permanent organization within the UN structure to coordinate international environmental activities. This new body, the UN Environment Programme (UNEP), will coordinate the environmental activities of the UN specialized agencies, initiate action when it is needed, and develop and implement a comprehensive plan for global environmental protection. Created at the same time was the UN Environment Fund which will support the work under UNEP; this is a voluntary fund with a target total of $100 million for the first 5 years.

One of the initiatives begun in the preparations for the 1972 UN Conference was the drafting of a text of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. This Convention was completed in November 1972 at London and is now open for ratification. It prohibits ocean dumping of specific materials and requires a permit system for the dumping of other material. In essence, it is similar in purpose on an international level to the regulatory provisions (Title I) of the Marine Protection, Research, and Sanctuaries Act (P.L. 92-532).

Legislation is pending in Congress to amend P.L. 92-532 in order to make it fully consistent with the provisions of the international convention. This legislation deals principally with extending United States regulations on ocean dumping to United States flagships anywhere in the world.

United States-Canada Great Lakes Water Quality Agreement. In April 1972 Canada and the United States concluded the Great Lakes Water Quality Agreement, calling for cooperative efforts in abating pollution in the Great Lakes and in the connecting channels. The agreement was developed in response to a growing concern on the part of both countries over the heavily polluted condition of some sections of the lower Great Lakes, their connecting channels, and the St. Lawrence River. The accord commits both countries to achieve a number of general and specific water quality objectives and requires that a series of pollution abatement measures and programs be either completed or initiated by the end of 1975. Priority attention is given to the reduction of phosphate loadings, phosphorus having been identified as the limiting nutrient for phytoplankton production and thus a main contributor to eutrophication in the Great Lakes. The International Joint Commission (IJC), a body created by the Boundary Waters Treaty of 1909, has been assigned the lead role in coordinating the activities and programs carried out by the two countries under the 1972 agreement. The IJC has established a Great Lakes Water Quality Board and a Research Advisory Board to assist it in implementing the accord. The IJC issued its first annual report relating to the agreement in September 1973.

The United States and Canada are also currently working on the Joint Canada-United States Marine Pollution Contingency Plan for Spills of Oil and Other Noxious Substances. The Plan follows the provisions of the Great Lakes Water Quality Agreement but emcompasses boundary waters of the Atlantic and Pacific Oceans as well as the Great Lakes. The objectives of the Plan are:

(a) to develop the appropriate measures of preparedness and systems for the discovery and reporting of a pollution incident within the areas covered by the various Annexes to the Plan; (b) to institute prompt measures to restrict the further spread of oil or other noxious substances; and (c) to provide adequate resources to respond to a pollution incident.

International Decade of Ocean Exploration. In March 1968, the President of the United States proposed, "An historic and unprecedented adventure...an International Decade of Ocean Exploration (IDOE) for the 1970's." Shortly after, the Office of IDOE at the National Science Foundation was established to provide, inter alia, a basis for assessing the impact of man's activities on various levels of marine life. The U.S. IDOE program is discussed further in Chapter VI.

Law of the Sea Conference. Another major international negotiating effort now in progress is the forthcoming UN Conference on the Law of the Sea. The UN General Assembly in 1970 called for such a conference to establish definitive rules governing national rights and responsibilities in the oceans and to move forward with an international agreement which will include fisheries, mineral exploration and exploitation of the deep seabeds, and marine pollution.

Preparatory meetings on marine pollution issues began in 1973. As a result of those discussions, proposed texts will be presented to the Conference regarding marine pollution from land-based sources, vessels, and seabed economic activities. The United States supports a general obligation not to pollute the marine environment, and compliance with minimum international standards for marine-based sources of marine pollution, with international standards for vessel-source pollution established by the Inter-Governmental Maritime Consultative Organization. Higher standards could be set by coastal states with respect to seabed economic activity within their jurisdiction, by port states with respect to vessels entering their ports, and by flag states with respect to their own flag vessels.

The outcome of the Conference on the Law of the Sea will have important economic and political implications for all nations. The Conference began with an organizational session in New York in late 1973; substantive negotiations are scheduled to begin in Caracas, Venezuela in June of 1974.

IMCO Conference. The Inter-Governmental Maritime Consultative Organization (IMCO), a specialized agency of the United Nations, has devoted considerable effort to the problem of oil pollution in the oceans. As early as the London Conference in 1962, held for the purpose of amending the 1954 Convention on the Prevention of Pollution of the Seas by Oil (conducted under IMCO auspices), the international community set an ultimate goal of eliminating all intentional discharges of oil into the oceans. In 1970, the United States proposed that intentional discharges of oil be eliminated by 1975. However, the NATO Committee on Challenges of Modern Society (NATO/CCMS), at a meeting in Brussels in November 1970, adopted a resolution that fell short of the U.S. position, but called for work to start at once to achieve by 1975, if possible, but not later than the end of the decade, the elimination of intentional discharges of oil and oily wastes.

This NATO/CCMS resolution was adopted as the goal of the IMCO-sponsored International Conference on Marine Pollution that was held in London in October 1973. The IMCO Conference concluded a new International Convention for the Prevention of Pollution From Ships, 1973, which, when it enters into force, will supersede the International Convention for the Prevention of Pollution of the Sea by Oil, 1954, as amended in 1962, 1969, and 1971.

The new Convention contains provisions aimed at eliminating pollution of the sea by oil and other noxious substances which may be discharged operationally, and at minimizing the amount of oil which would be accidentally released in such mishaps as collisions and groundings. It requires that new tankers of 70,000 DWT and above and those contracted to be built after 1975 be fitted with segregated ballast tanks sufficient in capacity to obviate the need to carry water in cargo oil tanks. It tightens the oil discharge criteria of 1969; the maximum permissible quantity of oil which may be discharged in a ballast voyage is reduced from 1/15,000 to 1/30,000 of the oil carried during its last cargo voyage for new oil tankers. The Convention places special handling requirements on the ocean transport of some 400 noxious liquid substances. It also designates semi-enclosed areas where oil discharge is completely prohibited, such as the Mediterranean, Black, Baltic, and Red Seas and "Gulf areas" (Persian Gulf). The 1973 Convention will enter into force 12 months after it has been ratified by 15 States which should constitute at least 50 percent of the world's merchant shipping.

<u>1969 Brussels Legal Conventions.</u> In order to deal with the legal problems associated with pollution control and regulations adequately and effectively, the IMCO established a Legal Committee and charged it with the mandate to study and recommend action on all the legal problems brought to light by the *Torrey Canyon* disaster.

As a result of this work carried out by the Legal Committee, an International Legal Conference was convened by IMCO and met in Brussels in 1969. This Conference adopted and opened for signature two International Conventions. These were:

- The International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties.

- The International Convention on Civil Liability for Oil Pollution Damage.

Neither is yet in force. The President has submitted both Conventions to the Senate for its consent and the implementing legislation to the full Congress for enactment.

CHAPTER II

OCEAN DUMPING

This chapter considers research and monitoring aspects of ocean dumping as required under Section 201 of the Marine Protection, Research, and Sanctuaries Act. It defines the current problems of ocean waste disposal and reviews the status of research, monitoring, and coordination for dealing with these problems.

Regulatory aspects of ocean dumping are assigned to the Environmental Protection Agency (EPA), the Coast Guard, and the Corps of Engineers under Title I of the Act. A report on that subject was prepared and submitted by EPA to the Congress in October 1973.

In April 1970, in response to a Presidential request, the Council on Environmental Quality (CEQ) initiated a comprehensive study of the ocean dumping problem. In its report issued October 1970, *Ocean Dumping - A National Policy*, the Council provided the first synoptic view of the ocean dumping problem and made significant recommendations toward establishing a comprehensive national policy with respect to the problem. Many of the Council's recommendations were incorporated in the Marine Protection, Research, and Sanctuaries Act of 1972.

In its study, the Council was able to draw upon many completed and ongoing investigations.[13] One of the most comprehensive and detailed studies on ocean dumping was then currently under way by the Dillingham Corporation of La Jolla, Calif., initially under contract to the Department of Health, Education, and Welfare and later (after December 1970) under contract to the Solid Waste Management Office of EPA.[14,15]

This EPA-sponsored study provided a thorough review of current ocean disposal practices, types and amounts of materials dumped, environmental effects, regulatory monitoring, and institutional aspects of ocean dumping. Preliminary data from the study were made available to the CEQ for its 1970 report. The report of the Dillingham Corporation, issued in 1971, revealed that the total amount of material disposed of in U.S. coastal waters in 1968 was 62 million tons.

Another EPA-sponsored investigation on ocean dumping was recently completed by the Interstate Electronics Corporation of Anaheim, Calif.[16] That study focused on six U.S. coastal areas in detail for the purpose of establishing a data base to be used by EPA in developing regulatory criteria for ocean waste disposal.

The CEQ report and the two EPA-sponsored studies together provide the best available data and information on the subject of ocean waste disposal. While there is no attempt to repeat in this report the detailed information contained in these studies, some data and information are drawn from them in order to characterize the nature and magnitude of the ocean disposal problem.

A REVIEW OF OCEAN WASTE DISPOSAL

In the context of this report, ocean dumping means the disposal in ocean waters of waste materials transported from U.S. coastal ports aboard barges or ships. The types of waste materials include (but are not limited to): dredge spoil, solid waste, incinerator residue, garbage, sewage sludge, chemical wastes, discarded military equipment and munitions, excavation debris, and other industrial, municipal and agricultural wastes. It does not include: oil within the meaning of Section 311 of the Federal Water Pollution Control Act as amended (P.L. 92-500); sewage from vessels within the meaning of Section 312 of that Act; or the discharge of effluent from any outfall structure to the extent that such disposal is regulated under the provisions of P.L. 92-500 and other applicable laws.

A 1971 National Academy of Sciences study reported that "the mobilization of matter from the continents to the marine environment by man is quantitatively rivaling the movements of materials by weathering processes."[17] In the natural environment, matter is transported to the oceans by rivers, runoff, wind, or glaciers. Man has created two additional paths -- ships and waste outfalls. Although we do not as yet have accurate figures on mass emission rates of the various sources of ocean pollution, there is no question that the amount of waste matter dumped in U.S. coastal waters each year constitutes a significant fraction of the total national contribution to ocean pollution from all sources.

With respect to natural sediment discharge from rivers, a 1969 report concluded that no U.S. river on the Atlantic coast has a natural sediment load approaching the mass of solids dumped into the ocean annually by the New York metropolitan region. According to the study, the waste solids from the New York area exceed the sediment discharge of all rivers emptying into the Atlantic Ocean between the U.S.-Canadian border and Chesapeake Bay.[18]

While there are useful quantitative and qualitative estimates that have been thus far developed on ocean waste disposal, it must be stressed that we do not as yet have anything approaching a precise fix on the types and quantities of materials now being dumped in our coastal waters. Much of the problem results from nonstandard requirements on vessel reporting and record-keeping, and inadequate monitoring and enforcement. The recently instituted regulatory program of EPA and the Coast Guard is now developing the data and information required to correct these deficiencies.

Table 1 summarizes types and amounts of wastes dumped in U.S. coastal waters during 1968. Not included in the table are those wastes piped to sea, including approximately 1.0 billion gallons per day (BGD) of primary treated sewage effluent and digested sewage sludge discharged to 1 to 5 miles offshore of the southern California coast.[19] In addition, because of considerable differences in characteristics of waste materials, tonnage dumped is not necessarily an accurate measure of the capacity of the materials to inflict damage on the receiving waters.

Although the 1973 study done for EPA contains no compilation of national totals on ocean dumping, the associated field survey determined that the

Table 1.--Summary of type and amount of wastes disposed of in U.S. coastal waters for the year 1968[14]

Waste type	Pacific Coast annual tonnage	Atlantic Coast annual tonnage	Gulf Coast annual tonnage	Total annual tonnage	Percent of total annual tonnage*
Dredging spoils	8,320,000	30,880,000	13,000,000	52,200,000	84
Industrial wastes					
Bulk	981,000	3,011,000	690,000	4,682,000	8
Cont.	300	2,200	6,000	8,500	
Refuse, garbage	26,000			26,000	
Sewage† sludge		4,447,000		4,447,000	7
Miscellaneous	200			200	
Construction debris		574,000		574,000	1
Explosives		15,200		15,200	
Total††	9,327,500	38,959,400	13,696,000	61,982,900	100

* All waste types and geographic areas.

†Tonnage on wet basis. Assuming 4.5 percent dry solids, this is equivalent to approximately 200,000 tons dry solids per year.

††Radioactive wastes omitted. There were no dumps in 1968.

disposal of dredge spoils on the Gulf Coast had increased to 40 million tons by 1972, compared with 13 million tons in 1968.[20] Likewise, this report noted that dumping of industrial chemical wastes off the Gulf Coast had doubled since the 1964-68 period to a total of 1.2 million tons in 1972. Using these data for the Gulf Coast, and hypothesizing an annual 6 percent increase for all other waste categories (an assumption based in part on the analysis of ocean dumping trends by the CEQ),[21] an extrapolated total of 102 million tons is arrived at for 1972. This indicates an increase of some 40 million tons over the reported 1968 level.

Dredge Spoil

Dredge spoil consists of materials dredged to improve and maintain navigation channels. These spoils contain various concentrations of sand, silt, clay, detritus, rocks, and municipal or industrial waste sludges. Most dredging operations are conducted by the Corps of Engineers and its contractors using hydraulic pipeline dredges and clam-shell dredges. Dredged materials generally are disposed of in open coastal waters less than 100 feet deep. In Table 1 dredge spoils represent the largest category of ocean-dumped waste material, accounting for 84 percent of the total in 1968. In view of the accelerated dredging activities reported for the Gulf Coast, the current share of the total may be closer to 90 percent. In addition to the massive volumes involved (52.2 million tons in 1968), the Corps estimates that, on the average, about one-third of the dredged material is polluted.[22] The CEQ estimates that, in the long run, water pollution abatement programs will reduce the percentage of polluted spoils; however, as the Council pointed out, the expanding needs of marine commerce will cause an increase in dredging and, hence, in the volume of dredge spoils.[23]

Although there is a current lack of knowledge regarding the fate of dredged materials within disposal sites due to the lack of comparative data on conditions existing prior to and after disposal operations began, several extensive monitoring programs have been undertaken to ascertain the impact of dredged material on a disposal site.[24,25] There is also a lack of knowledge regarding the environmental effects of spoil disposal. Though there have been piecemeal studies of the impact of many dredging operations, an overall investigation of the dredge spoil problem was begun only recently.

The Corps of Engineers, under authority of the River and Harbor Act of 1970, initiated a comprehensive, nationwide study of the problem, including a consideration of related environmental factors. This program is described more fully in the section, Recent Research and Monitoring Programs.

Industrial Wastes

Industrial wastes, although far less than dredging spoils in terms of tonnage, were the second largest category of wastes dumped in the ocean in 1968. These wastes accounted for 4.7 million tons or 8 percent of the total, up from 2.2 million tons in 1959. New York City alone disposed of 2.7 million tons at sea, of which 90 percent was some form of acid waste. Included in this category are: waste acids (58%), refinery wastes (12%), pesticides (7%), paper mill wastes (3%), and a variety of other industrial wastes in relatively low quantities such as oil drilling wastes, pharmaceutical wastes, and others (20%). Highly toxic wastes usually are packed in drums and dumped at locations well offshore and in deeper waters.

The 1973 EPA study presented evidence that the volume of industrial wastes disposed in the ocean is decreasing. Reasons given were: new methods of recycling waste material, higher costs of barge disposal; increasingly stringent Federal and State water pollution control regulations; new industrial processes that produce lower volumes of waste but containing higher concentrations of toxic materials; and increasing use by industry of municipal waste treatment facilities.

Sewage Sludge

Sewage sludge is the third largest category of wastes disposed of at sea, accounting for 7 percent of the total in 1968. In that year almost 4.0 million tons of sewage sludge were dumped in the New York Bight. Another 0.5 million tons were disposed of by the City of Philadelphia at a dumpsite off Cape May, N.J. Although there are no current total figures on ocean disposal of sewage sludge from the New York-New Jersey metropolitan area, EPA Region II reports that dumping of sludge in the New York Bight has increased significantly since 1968. EPA is now compiling this information and expects to publish it later this year.

Sewage sludge is a major by-product of wastewater treatment facilities. Undigested sewage sludge contains only 2.0 to 7.0 percent solid matter. These solids can be further treated by anaerobic digestion which reduces the sludge volume by as much as half, while also reducing odors and bacterial counts. Most sewage sludge produced in this country is disposed of on land, or is incinerated. As of early 1974, the only offshore areas being used for sludge dumping operations were the New York Bight and areas off Cape May. However, comparable quantities of sludge solids are being discharged from the Los Angeles-San Diego area from submarine pipes 1 to 5 miles offshore. Partially treated sewage is also discharged directly to the ocean from a number of other U.S. communities.

Since stringent pollution laws require higher levels of wastewater treatment, the production of sewage sludge is expected to increase in the future. This, coupled with the tendency of industrial plant managers to meet their new obligations under the law by piping their liquid wastes into municipal treatment facilities, will make sludge disposal a major enviromental problem. This situation holds special significance for the New York-New Jersey metropolitan area which is expected to produce a sharp increase in the amount of sludge for disposal in the New York Bight.

Other Materials

There are additional classes of waste material which are disposed of at sea, but they are not significant in terms of volume, representing only about

1 percent of the total. This group includes solid wastes, military explosives, construction and demolition debris, and radioactive wastes.

Solid Waste. The dumping at sea of refuse and garbage has been reduced to an insignificant level in this country. The only recent disposal operation of this type occurred off the California coast in the Long Beach-San Pedro area. The materials disposed of included garbage and trash collected from commercial vessels that call at those cities. This disposal operation has been suspended. Likewise a sizeable dumping operation involving cannery wastes in the San Francisco area was recently terminated.[26]

With regard to municipal garbage and trash in general, the amounts of pollutants they contain are very low compared with sewage sludge. However, they do contain nutrients, oxygen-demanding substances, and heavy metals. A substantial portion of the wasteload consists of floatable materials that can be carried shoreward, creating potential esthetic problems. One approach to solving this problem by baling is discussed in the section on Recent Research and Monitoring Programs.

Military Wastes. This class includes unserviceable or obsolete ammunition such as shells, mines, solid rocket fuels, propellants, and chemcial agents. Until 1964, the primary method of disposal was from barges and ships. Subsequently, stripped-down World War II Liberty ships were loaded with munitions and scuttled in water depths greater than 4,000 feet. Since 1970 all ocean disposal of unserviceable munitions has ceased. Environmental effects of these earlier ocean disposals of war materials were the subject of a detailed survey carried out by the Oceanographer of the Navy in 1971-72. Details of this survey are discussed in a later section of this chapter, Recent Research and Monitoring Programs.

Construction and Demolition Debris. This is a minor fraction of the wastes disposed of in the ocean. According to the 1971 Dillingham Corporation study, only the City of New York carries out this type of dumping activity. The principal reason is lack of available landfill space. These wastes are usually inert, consisting typically of stone, tile, brick, concrete, masonry material, pipe, wood, and dirt. In 1968, 574,000 tons were disposed of in the New York Bight, however, yearly quantities vary considerably depending on construction activity.

Radioactive Wastes. No significant quantities of these wastes from U.S. sources have been dumped in the sea since 1962. These materials are stored at several sites operated or regulated by the Atomic Energy Commission or at sites regulated by the States. The principal concerns with respect to radioactive wastes are the expected increase in the use of nuclear energy and the consequent increased opportunities for unintentional release of radionuclides into the air and water environments.

RESEARCH AND MONITORING REQUIREMENTS

A program of research and monitoring is an integral part of a comprehensive effort to assess and control the effects of ocean dumping on human health and welfare. This section describes research and monitoring needs.

Effects of Pollutants on Marine Life

Matter that has been dumped into the sea can affect marine life directly through toxicity, oxygen depletion, biostimulation, and habitat changes. Research on toxicity and other pollution stresses has been concentrated on acute effects which are usually measured by ascertaining the dose required to kill 50 percent of the test organisms following short-term exposure. This rather basic approach does not take into account the equally important effects of long-term, sublethal concentrations on behavior, survival, reproduction, and community structure. Substantial additional work is required not only on acute effects, but on chronic or sublethal toxicity as well, particularly for industrial wastes disposed of at sea. In addition, means of relating laboratory bioassay results to actual conditions in the environment are urgently needed.

Another important aspect of evaluating the effects of a chemical pollutant on marine organisms is the impact of the pollutant through the food chain. We know that certain noxious substances, for example DDT, can be passed through the food chain and concentrated in the larger fishes without apparent harm to them, but with potentially serious effects on organisms higher up in the food chain. This is an area of critically needed research which is now being addressed by NOAA, EPA, the National Science Foundation, and other Government agencies.

Oxygen depletion at a dumpsite can kill off the less motile organisms and can render the water column in the vicinity of the site uninhabitable. Biostimulation is the result of nutrients from polluted materials stimulating plankton growth over and above natural levels. Biostimulation can have beneficial as well as harmful effects on the marine environment as we know from natural upwelling and the high productivity of estuaries. Habitat changes can also result from dumped material on the seafloor, changing the nature of the substrate.

Dispersal and Transport of Pollutants

Our understanding of how wastes mix and disperse after discharge at sea is rudimentary. The transport of pollutants introduced into a particular ecosystem is effected by water mass movements and by migration of marine organisms. Evaluation of the transport process thus requires information on the mass movements of the water and the organisms, and knowledge of the pollutant concentrations within each.

In the case of dumped materials, we are dealing with a large mass of matter, either in solution, suspension, or settled on the seafloor. Dispersion of dumped materials is determined by the action of bottom currents, gravity, movements of bottom sediments, and other phenomena, including density and thermal barriers. Most, if not all, of these variables and their effects need to be known if we are to have the capability of predicting with some degree of confidence the fate of waste material once it is discharged to the marine environment.

Chemical Nature of Pollutants

Biochemically, the materials dumped at sea can be classified into two categories -- nondegradable and degradable matter.

The nondegradable substances include trace metals, inorganic nutrients, solid minerals associated with dredge material, various inorganic chemicals, and long-lived radionuclides. The ultimate fate of these substances is best ascertained by an approach involving estimates of input, determination of concentrations, evaluation of rates of movement, and geochemical reactivity. Research is required, for example, to determine how these inorganics react in the marine environment with other substances to form biologically active compounds that can interfere with life processes. An example is the transformation of inorganic mercury to organic mercury (methylation).

Degradable substances are those materials that will degrade through biological or chemical action to simpler, harmless materials within a short time period. The largest single category of degradable matter to be dealt with in ocean dumping is the organic fraction of sewage sludge. Another significant source is the organic component of dredge material. The assessment of the effects of degradable organics on a particular marine ecosystem involve application of a large body of experience and measuring techniques from the field of sanitary engineering, largely developed for use in fresh water, to the more complex marine environment. Evaluation of the impact and fate of many synthetic organic substances, such as chlorinated hydrocarbons and their decomposition products, may be even more difficult.

Fate of Pathogens

Sewage sludge and polluted dredge spoils are potential carriers of bacterial and viral pathogens from human and other animal intestinal tracts. Viruses of human origin have been isolated from estuary waters receiving primary treated sewage effluents and from shellfish inhabiting these waters. About one-fifth of the 10 million acres of U.S. shellfish-producing waters have been closed because of sewage pollution.

Present methods for isolating pathogens are costly and time-consuming. For this reason, microorganisms such as coliform bacteria are used as indicators of the possible presence of pathogens. A problem with indicator organisms is that a direct relationship between their presence and the actual presence of pathogens does not always exist. For example, the coliforms found in a given water sample may have been of nonhuman origin, thus having no relationship to human pathogens.

While techniques are emerging for direct measurement of viruses in the marine environment, they are still not available for use as tools in quantitative studies of the fate of pathogens discharged in dumped materials. Nonetheless, transmission of infectious hepatitis virus has occurred through consumption of shellfish, either raw or improperly cooked, and large areas of coastal waters polluted with sewage have been placed off limits for certain public uses.

Public health studies are needed to determine the incidence, duration, and number of virus types in our coastal waters. In order to do this, new standard assay methods must be developed for detecting, isolating, and enumerating viruses in very low concentrations from marine and estuarine waters.

Some studies have related the disease known as fin-rot that occurs in bottom-dwelling finfish to the presence of pathogenic bacteria. Further research will be required to establish the connection, if any, between fin-rot disease and pathogens.

Baseline Environmental Data

Proper evaluation of the effects of introducing any given pollutant into a marine environment requires an understanding of the natural state and fluctuations of the system. It is important to develop the capability through research of differentiating between normal variations and those resulting from the introduction of a pollutant. Baseline studies carried out prior to discharging wastes are a means of obtaining reference data for use as a standard in measuring the effects of introduction of wastes. In the case of an existing dumpsite, a control study area established near the site can assist in providing the required information. In both cases, multidisciplinary research efforts are required. The subject of environmental baseline studies is discussed in more detail in Chapter VI.

Development of a Systematic Program of Dumpsite Monitoring

It is necessary to develop a program for systematically measuring the extent of damage at various sites at which wastes are dumped using the best available techniques. The basic objective of environmental monitoring is to determine the short- and long-term effects of waste disposal practices. A monitoring program can guide regulatory activities and can also serve to maintain an awareness of trends and thereby provide an early warning capability. Monitoring data are essential for developing water quality criteria applicable to ocean dumping, for assessing trends and changes, and for identifying problem areas that require the attention of the appropriate research and regulatory agencies. NOAA is currently working with the other agencies concerned to delineate a cooperative site evaluation and monitoring program.

Environmental monitoring involves periodic field observation and sampling, supported by laboratory testing and analysis. Monitoring programs by their very nature require data collection on a long-term basis. Furthermore, because of the equipment required for marine monitoring, e.g., vessels, and the large expanses of water involved, it is much more costly than land-based environmental monitoring. This means that a marine monitoring program must be carefully planned and well coordinated. Economy can be gained from an element of flexibility in a monitoring program. For instance, initial sampling should determine what variables are significant and which, if any, can be safely ignored, or measured less frequently.

Improved and Standardized Research Methods and Measurements

There is a critical need to develop better equipment and techniques with which to carry out the research and monitoring requirements discussed above. In the effort to mount a coordinated and comprehensive marine research program, it has become apparent that there are some research tools that are missing or that are lacking in some important aspect. Inadequacies center around: 1) sampling design and equipment; 2) standardization of analytical procedures; 3) calibration of instruments; and 4) data usability and dissemination to users.

The biological and physical processes in the ocean present a more complex problem to the marine scientist with respect to sampling than does land-oriented research. The design of a statistically adequate sampling program is also time-consuming and expensive. A great deal of effort is required merely to determine how many samples must be taken at a given time and place in order to describe, within acceptable confidence limits, cause and effect relationships. Perhaps the most perplexing problem facing the marine scientist is that some of the very tools which he uses to obtain the sample material introduce measurement variations sufficiently large as to mask completely at times the changes or relationships that he seeks to determine.

Standardization of data and analytical procedures is another problem that must be confronted. The need is to assure that a result obtained at one laboratory is comparable to one obtained on the same item in another laboratory. This requires a system of calibration and standardization of techniques that does not now exist for measuring all materials being dumped.

At the present time, only a few of the problems mentioned in the foregoing paragraphs appear to be moving toward resolution. Complete standardization of research and monitoring procedures and data still is some time off. Better sampling equipment and procedures are not beyond our technological competence, yet the fact remains, we do not have them today. The interagency coordination provided for in the Marine Protection, Research, and Sanctuaries Act is an important mechanism for addressing these needs.

RECENT RESEARCH AND MONITORING PROGRAMS

New York Bight Dumpsite Investigations

Studies on the effects of ocean dumping at existing dumpsites are of critical importance in developing information that will guide future regulatory decisions.

The New York Bight has been a principal focus for recent and current studies of the effects of ocean dumping. The New York Bight is the coastal area from Montauk Point, Long Island to Cape May, N.J., extending seaward to the edge of the Continental Shelf, an area of approximately 15,000 square miles. Adjacent to the heavily populated and industrialized New York - New Jersey metropolitan area with its associated vessel traffic, waste disposal

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operations, commercial fishing, shoreline construction and other activities, the New York Bight is the Nation's most complex and intensively used coastal area. The Nation's most significant ocean dumping operations also occur in the Bight.

The Corps of Engineers' Coastal Engineering Research Center (CERC) initiated in 1967 a series of studies in the New York Bight in order to acquire data the Corps needed to assess the impact of ocean waste disposal on the Bight. The investigations were ordered pursuant to the Corps' responsibilities under the Refuse Act of 1899 and in consultation with EPA's predecessor agency, the Federal Water Pollution Control Administration. The Smithsonian Institution, under contract to CERC, developed a research plan and identified institutions qualified to carry out the proposed studies. Participants in the Corps of Engineers study were: Sandy Hook Laboratory of the National Marine Fisheries Service (then the Bureau of Commercial Fisheries), the Marine Sciences Research Center of the State University of New York at Stony Brook (SUNY), the Woods Hole Oceanographic Institution, and the Sperry Rand Company. The studies were completed in 1972 and the Smithsonian Institution submitted an analysis of the work carried out by Sandy Hook Laboratory and SUNY that same year.[27]

In 1973 CERC issued a report that summarized the results of the New York Bight research project.[28] The studies supported by CERC produced useful data related to the disposal of sewage sludge, dredge spoils, and acid-iron wastes in the Bight. They provide an important base upon which current studies of the Bight can build. Among the conclusions of the report were:

- The data gathered to date suggest that the large volume of wastes being dumped in the Bight and the frequency of the dumping has changed the marine environment of the dumping grounds and adjacent areas;

- There is a need to acquire sufficient data in order to be able to differentiate between the areal extent and magnitude of change caused by dumping and that caused by other sources of pollution; and

- The basic mechanisms by which ecological changes occur in the marine environment of the New York Bight remain essentially unknown due to the limited scope and funding of research carried out to date, the long history of waste disposal, and the absence of baseline data.

In addition, in an extensive 1970 Department of the Interior report on the effects of dumping in the Bight, the following four points specifically related to ocean dumping were emphasized:[29]

> "There will be increased pressure for more ocean disposal of sewage sludge and dredge materials in the New York Bight. This will raise to a potentially critical level the threat of pollution to land and surrounding ocean."
>
> "Accumulation by fish and shellfish of heavy metals and other persistent toxic compounds is another potential

health hazard in the New York Bight. This threat appears to be most serious from the sludge disposal areas."

"Ocean disposal of sludge and dredge spoil materials, along with pollution from other sources, offer a potential threat to local fish populations."

"The present ocean disposal of sewage sludge and dredge fill may be a serious threat to the sanitary quality of local populations of ocean quahogs and surf clams (4-10 mile radius)."

Marine Ecosystems Analysis (MESA)

While the contributions of earlier investigations are indeed relevant, the fact remains that existing information falls far short of that required by EPA and the Corps of Engineers for establishing the regulatory criteria called for in Section 102 of the Marine Protection, Research, and Sanctuaries Act. The need for better information on the effects of ocean dumping, as well as on other environmental problems in the New York Bight, led to the initiation of a major NOAA investigation of the Bight in 1973, the Marine Ecosystems Analysis (MESA) New York Bight Project. The MESA Project involves a number of NOAA organizational elements and contractors in an integrated study of ocean waste disposal and also a number of other resource management problems confronting that coastal region. In conducting the MESA New York Bight Project, NOAA is cooperating with other Federal, State and local agencies.

Specifically, the MESA Project is directing its efforts to help answer the following questions regarding dumping practices in the Bight:

- o What is the environmental impact of present dumping activities?
- o What are the projected consequences of continued and accelerated dumping at present disposal locations?
- o Are there alternative sites where continued and accelerated dumping can be carried out with less adverse impact than at sites currently being used?

To provide some answers to these as well as other questions, the MESA program is presently undertaking an extensive, long-term (1973-79), interdisciplinary investigation of the Bight. Existing information that bears on the problem is being examined, summarized, and published. An extensive field program is underway covering physical, geological, chemical, and biological oceanography activities directed at understanding the Bight's ecosystem and the effects of ocean dumping on that ecosystem. A conceptual model of the Bight will be completed in early FY 1975. The conceptual model will be used to develop and direct future modeling efforts relating to waste disposal in the Bight.

The MESA Project began preliminary field studies of the area in which the sludge dumping is occurring in July 1972 and full-scale efforts commenced in September 1973. To date, field activities have accomplished the following tasks:

a) The depth of the seafloor and associated microrelief showing small-scale features in seafloor geometry and roughness have been mapped for the entire sludge dumpsite and surrounding area. Charts will be developed showing the extent and thickness of the main body of the sludge beds, and will be available in late 1974.

b) More than 450 bottom sediment samples have been obtained, and 40 cores have been collected for deeper penetration into the sediment. Chemical analyses of these materials are under way. These analyses should provide at least partial answers as to the age, decomposition rate, and extent of the sludge.

c) The seafloor and associated sediments are being examined quarterly at 50 selected sites in the dump area and environs in order to detect changes in thickness and lateral extent of the sludge and any recent movements.

d) Current meter arrays have been deployed at various intervals for up to a month's duration to determine direction and velocity of current flow in areas affected by the dumping.

e) Stations have been sampled repeatedly at periodic intervals for chemical analyses of water and suspended materials.

These measurements show that at the sewage sludge dumpsite, the seafloor consists of a black paste, which is a mixture of natural fine sediment and sewage sludge. An appreciable amount of sludge extends beyond the dumpsite in all directions, but primarily to the north towards the Long Island shore.

Because of the presence of naturally occurring dark, organic rich muds in parts of the bottom, precise definition of the boundaries of the sludge bed extension is difficult and depends on chemical characteristics. For example, sewage sludge has high concentrations of heavy metals, such as lead and zinc, and of organic carbon. Waters overlying sewage sludge are typically low in dissolved oxygen concentration. Therefore, low oxygen values in waters over and north of the dumpsite may be taken as presumptive evidence for northward migration of sewage sludge. However, low oxygen values over areas of naturally deposited organic-rich muds may not.

Chemical analysis of the MESA samples collected in 1973 is still under way. However, analyses of bottom sediment samples completed to date show evidence of sludge within 3.5 miles of Long Island with some evidence suggestive of sludge as close as 2 miles.

Information available to date shows that the sludge bed is a dynamic entity. Throughout the quiet summer months more sludge accumulates than is oxidized by the ecosystem, or washed away, and the sludge bed expands. During the winter, southwestward flow, punctuated by intense storm currents, flushes sludge seaward and southward away from the coast. Sludge is also worked into the bottom sediments during this period. Because of the variability of this seasonal cycle and problems in defining the boundary of the sludge area, it is not possible to reach conclusions about net large movement of the sludge bed on the basis of only a few observations. Instead, the area must be monitored at least on a quarterly basis to see if more sludge accumulates each summer than is washed away in the winter. The MESA investigation is continuing and there are plans to produce a comprehensive status report on the New York Bight sludge problem in FY 1975.

EPA's Pacific Northwest Environmental Research Laboratory (PNERL) at Corvallis, Oregon, through its National Coastal Pollution Research Program (NCPRP) is working in close coordination with MESA to investigate ocean dumping in the Bight. Since 1972 the staff of the NCPRP have provided overall direction and technical support to a series of interrelated studies of an experimental sewage sludge dumpsite in the Bight. For experimental purposes, a site located about 12 miles south of Fire Island is being used for the study. This location has been selected to receive a predetermined amount and type of digested sewage sludge under closely controlled conditions, and its movement and effects on the local ecosystem determined. Results of this study will provide information for waste management in the New York Bight.

Deepwater Dumping Investigations

Section 102 of the Marine Protection, Research, and Sanctuaries Act provides that in designating recommended dumping sites EPA shall utilize where feasible locations beyond the edge of the Continental Shelf. Investigations of the impact of dumping in this complex and little understood deepwater environment are, therefore, of prime importance.

EPA-NOAA Study. Continued population growth, coupled with the new and higher standards of municipal wastewater treatment, will sharply increase the amount of sewage sludge produced in the years ahead. In the New York-New Jersey and Philadelphia areas, where land disposal sites are scarce, these factors forecast a marked increase in the volume of sludge destined for offshore disposal.

An important policy question that must be addressed by public officials in response to Section 102 of the Act is whether or not wastes from these metropolitan areas should continue to be dumped in increasing amounts at or near present dumpsites; whether they should be dumped at deepwater sites at the edge of the Continental Shelf and thus take advantage of the greater dilution capacity at such depths; or whether other waste disposal alternatives such as incineration, use as landfill, or chemical or biological recycling should be pursued. Furthermore, it is not yet clear whether or not dumping various wastes into deep water is a feasible alternative over the long run, either economically or environmentally.

To assess the possible environmental effects of the deepwater dump alternative, EPA and NOAA have initiated a joint investigation of the physical and biological characteristics of a deepwater site at the edge of the

Continental Shelf. Research activities include a review of the historical data base on the physical, geological, chemical, and biological characteristics of the outer shelf region by researchers of the University of North Carolina. These analyses are intended to provide a detailed scientific description of the Continental Slope and Rise from Cape Cod to Cape Hatteras. In addition, gaps in information will be identified and recommendations for future surveys and site monitoring requirements will be developed.

In May 1974, following completion of the data base analysis, a field survey of a deepwater dumpsite at a depth of 6,000 feet at the outer edge of the New York Bight will commence.

An important feature of this joint study will be the use of the manned underseas capability of NOAA. Personnel of the Manned Undersea Science Technology Program (MUS&T), using the research submersible *Alvin*, will participate in the deepwater dumpsite investigation. The submersible will be used to obtain in situ measurements of physical, chemical, and biological baseline information at the site. Migrations and structures of the deep scattering layer will be observed to determine if this daily vertical migration of plankton would be subject to the degraded waters of the proposed dumpsite. Species distribution patterns will be related to the chemical and physical properties of the water column. Observations will be made in submarine canyons and their associated fans to determine the stability of the seafloor sediment and the distribution of organisms and their relationship to bottom topography and sediment type.

Since the *Alvin* now has a depth capability of 10,000 feet, it will be possible to observe for the first time a deeply flowing contour current that flows parallel to the bottom in a southerly direction off the east coast of the United States. More specific knowledge of the location and strength of this current is needed in order to determine how widely any waste material reaching it would be distributed in the abyssal waters.

U.S. Navy Activities. During its Deep Water Dump (DWD) Program (1964-71), the Navy disposed of unserviceable or obsolete ordnance by loading it on Liberty ships and sinking them in depths greater than 4,000 feet. During the program, 19 dump operations were carried out, of which 15 involved conventional munitions and 4 involved Army chemical ordnance wastes.

In 1971, the Navy began a comprehensive survey to assess the environmental impact of the 15 Liberty ships, laden with conventional munitions, which were scuttled during the DWD Program. Two representative DWD sites were selected for investigation: one site containing five hulks which detonated during scuttling and sinking, and one site containing an intact, undetonated hulk.

Data were collected at the selected sites to characterize the water column, currents, biota, and water chemistry. Samples from control and survey sites were analyzed for explosive residues and compared with standard seawater samples. Exhaustive sea-bottom photography, sonar searches, and magnetometer searches were also employed in the survey.

The findings of the survey were published in April 1972 as the Department of the Navy's *Environmental Condition Report for Numbered Deep Water Munitions Dump Sites.*[30] Conclusions of the report with respect to both detonated and intact hulk sites were that, aside from sea floor litter, no contamination of the marine environment was detected and there appears to be no significant, irreversible damage to the deep ocean environment by the deep water disposal of conventional munitions.

The Navy has also investigated environmental conditions at sites where nerve gas and other chemical warfare agents were dumped during the DWD Program. Between June 1967 and June 1970, four surplus World War II ships were scuttled in the Atlantic Ocean at a location called Deep Water Dump Area A, about 152 nautical miles east-southeast of New York City. Two of these ships carried cargoes of unserviceable chemical nerve agent munitions of the U.S. Army in addition to obsolete conventional ordnance. The Navy, responding to public concern over possible ecological effects of chemical munition dump sites, initiated investigations in 1972 to ascertain the environmental conditions at DWD Area A. The hulks of greatest interest were the two loaded with chemical munitions. Those hulks were sent to the bottom intact and are resting in 7,000 feet of water on the Continental Slope.

The purposes of the survey, which was carried out April - July 1972,[31] were: a) to locate the hulks and to ascertain their conditions; b) to assess the extent of possible contamination in the surrounding waters; c) to determine whether any evident damage to bottom life had occurred as a result of the disposal; and d) to determine physical characteristics, including vertical mixing, bottom currents, and sediments.

The Navy concluded from the survey that: a) the two hulks of interest did not break up upon hitting the bottom, and they rest intact in an upright position in DWD Area A with their cargo; b) no leakage of chemical agents from the intact hulks was detected; c) if leakage did or does occur, the released material would not reach the ocean surface because of the horizontal layering of the water; and d) extensive marine biology studies disclosed no visible effects on the ecology.

No further monitoring activity of the DWD sites is planned by the Navy.

<u>California Borderlands Survey</u>. In mid-1972, a series of submersible dives off the southern California coast were conducted to investigate environmental and seafloor conditions of dumpsites containing low-level radioactive waste material, chemical and industrial wastes, and ship garbage, respectively. The sites were located in the San Pedro Basin at depths ranging from 2,400 to 6,300 feet. At the dumpsite for chemical and industrial wastes, the ocean floor was found to be nearly devoid of live fish and bottom-dwelling organisms, which was to be expected because of the known natural lack of oxygen at those depths.

At none of the sites did the divers find more than a relatively small amount of wastes on the bottom. It was concluded that the wastes were not being dumped in the areas designated or that they were scattered over a much larger area than expected.

Dredging Operations Research

The material produced from dredging operations accounts for as much as 90 percent of the tonnage of wastes disposed of in U.S. coastal waters. Annual production of dredge spoil is currently averaging about 360 million tons from maintenance dredging and about 96 million tons from new work. Furthermore, the polluted nature of substantial quantities of dredged materials compounds the problem.

The most significant effects of ocean disposal of dredge spoils are sediment accumulations at the dumpsite and turbidity problems. Rapid local build-up of spoil sediment and movement over the bottom through gravity or bottom currents can suffocate benthic organisms, reduce food supplies, trap organic matter and thus induce anaerobic bottom conditions, and absorb organic matter, including oil. Turbidity caused by ocean disposal of dredge spoils can have a number of adverse effects on an ecosystem. These include: 1) reduced growth and decreased survival of larval stages of fish and shellfish; 2) reduction in light penetration resulting in reduced photosynthesis; 3) reduction of visibility to some feeding organisms; and 4) flocculation and consequent settling of phytoplankton.

U.S. Army Corps of Engineers. The Congress, in the 1970 River and Harbor Act,[32] authorized the Corps of Engineers to undertake a comprehensive, nationwide study of the dredge spoil disposal problem. This long-term investigation is known as the Dredged Material Research Program (DMRP) and is being conducted by the Waterways Experiment Station (WES) at Vicksburg, Miss. The general purpose of the study is to develop definitive information on the environmental impact of current dredging operations and spoil disposal and to develop new or improved disposal practices. The DRMP represents one of the most significant R&D programs ever undertaken by the Corps of Engineers.[33] The study has been divided into four phases:

Phase I - Review of Literature and Available Data

Phase II - Development of the Research Program

Phase III - Research Accomplishment

Phase IV - Prototype Tests

A final report on phases I and II was issued in November 1972.[34] The work identified and assessed specific problems connected with dredge spoil disposal, and mapped out a research program and task priorities. Phases III and IV of the study are presently underway. The required research effort draws upon the capabilities of the Corps and of other Federal agencies and research organizations. The Corps estimates that it will require at least 5 years (1978) to complete the study.

National Science Foundation. The National Science Foundation, through its Research Applied to National Needs (RANN) program, has sponsored a long-term research project at the Oregon State University on the effects of dredging in estuarine areas.

The work at Oregon State on dredge spoil distribution and estuarine effects has been supported by RANN since 1971. The investigation consists of two phases: exploratory studies and a long-term research project. The objectives of the exploratory studies were to: 1) develop and evaluate methods suitable for measuring and evaluating ecological changes due to estuarine dredging operations; 2) ascertain the long-term effects of past dredging activities; and 3) develop plans for a long-term research program.

With the preliminary studies completed, a major objective of the second phase is the development of a set of multiparameter indices which can provide meaningful information regarding the impact of dredging operations on estuarine benthic systems. These indices will be derived from field measurements, conceptual models of the benthic system, and mathematical simulation modeling techniques. Another research objective is the evaluation of the influence of dredging activities on water quality. Analysis will attempt to determine which water quality parameters best reflect quality deterioration resulting from dredging. Also, dredge site baseline information will be obtained in order to quantify recovery times and other system dynamics to assist in developing a prediction capability with respect to dredging effects.

International Joint Commission. The 1972 U.S.-Canada Great Lakes Water Quality Agreement established a joint program to abate and prevent pollution of the Great Lakes. A Great Lakes Water Quality Board was created to assist the International Joint Commission (IJC) in carrying out its responsibilities assigned by the Agreement. A current project of the Great Lakes Water Quality Board assigned to it by Annex 6 of the Water Quality Agreement is a review of existing dredging practices, programs, laws, and regulations. To carry out this review, an International Working Group on Abatement and Control of Dredging Activities was formed in November 1972. The purpose of the review is to develop criteria for the characterization of polluted dredge spoil and to provide recommendations for the environmentally compatible disposal of such material in open water.

Research on Baled Solid Waste

Ocean disposal has been considered as a possible solution to some of the urgent refuse disposal problems of some of the Nation's coastal cities.

NOAA and the University of New Hampshire are exploring the possibility of controlled dumping of compacted solid waste both as a means of waste disposal and as a means of encouraging the growth of new populations of lobsters and crabs. This program involves the chemical monitoring of the decomposition of baled waste submerged in Continental Shelf waters and an evaluation of the efficiency of such baled waste as artificial habitat for offshore lobsters.

In other work on baled solid wastes, the University of Rhode Island has done some studies for the New England Regional Commission on the feasibility of ocean disposal of baled solid wastes.[35] Closely related work has also been carried out for the Commission by the University of New Hampshire and the Woods Hole Oceanographic Institution. These investigations are designed to answer the question of the ecological costs of ocean disposal of compressed residential solid wastes.

Ocean Processes

A limited amount of current research concerns the interrelationship between basic ocean features and processes and dumped waste behavior.

Bahama Banks Seafloor Study. A joint EPA/NOAA/university seafloor study was conducted off Grand Bahama in January and February 1973. Scientists from EPA's National Coastal Pollution Research Program (NCPRP), Oregon State University, and NOAA's MUS&T Program collaborated in a 4-week research project at Lucaya, Grand Bahama, studying selected physical and biological characteristics of digested domestic sewage sludge similar to that being dumped in the New York Bight. The project included a 6-day in situ investigation of the exchange characteristics, degradation rates, and oxygen demand of the sludge, utilizing the NOAA Hydro-Lab undersea laboratory and NOAA's Undersea Instrument Chamber, a specially constructed underwater data recording package. The basic purpose of the project was to extend our understanding of what occurs when sewage sludge is deposited on the ocean floor.

The researchers resided for 6 days in Hydro-Lab which was positioned one-half mile offshore in 50 feet of water. The crew released the sludge in a marked zone on the ocean floor and sensors measured temperature, currents, pH, dissolved oxygen levels, and other water parameters. Water, sludge, and other bottom samples were taken for onshore analysis. The data obtained from these experiments provide a basis for describing short-term advection and diffusion characteristics of domestic sludges in marine bottom waters and will help to guide future planning for EPA and NOAA joint studies on the fate and effects of sewage sludge disposed of in ocean waters.

Hudson Canyon Survey. Scientists from NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML), Woods Hole Oceanographic Institution, and Lehigh University undertook two submersible dives in June 1972 in the Hudson Canyon, about 100 miles east of New York City. The purpose of the study was to assess whether submarine canyons serve as channels for the movement of sediment and associated pollutants from the Continental Shelf to the abyssal depths. Fine-grained sediment high in organic content was found to be moving across the Continental Shelf and being deposited in the Hudson Canyon. It now must be determined if the Canyon is a pathway for conveying such material to the deep seafloor and the significance of such movement.

Toxicological Studies

Many substances disposed of at sea exert acute and chronic toxicological effects on marine life, and can also have significant public health implications. Studies on toxicity are, therefore, an important and integral part of a balanced research effort directed at the practice of ocean dumping and its effects. Toxic constituents of dumped wastes, such as petroleum, heavy metals, and synthetic organics, usually have been studied as general marine pollutants, and not specifically with respect to their presence in dumped wastes. The major Federal programs involving toxicological studies of marine pollutants are described in Chapter III, Ocean Pollution.

IMPLEMENTATION OF OCEAN DUMPING PROGRAM

The national policy with respect to ocean dumping is expressed in Section 2(b) of the Marine Protection, Research, and Sanctuaries Act:

> "The Congress declares that it is the policy of the United States to regulate the dumping of all types of materials into ocean waters and to prevent or strictly limit the dumping into ocean waters of any material which would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems or economic potentialities."

The responsibility for implementing the Federal ocean dumping program pursuant to the above-stated policy is shared among four agencies: the Environmental Protection Agency, the Army Corps of Engineers, the Department of Transportation (Coast Guard), and the Department of Commerce (NOAA). In its basic form, the Federal program consists of:

1) development and promulgation of regulations and criteria to guide evaluation of permit applications (EPA, Corps of Engineers);

2) the implementation of the permit program (EPA, Corps of Engineers);

3) surveillance and enforcement of permit requirements (Coast Guard);

4) monitoring of the disposal sites and adjacent areas (NOAA);

5) research to support the regulatory program requirements (NOAA, EPA, Corps of Engineers); and

6) selection of disposal sites (EPA).

In this first year since the Act has been in force, significant progress toward resolution of ocean dumping can be reported.

Environmental Protection Agency

The Environmental Protection Agency promulgated, on April 15, 1973, interim regulations for the permit system. This was followed on May 16, 1973 by criteria for the evaluation of permit applications for ocean dumping.

On October 15, 1973, EPA published the final regulations and final criteria required by the legislation.[36] The final criteria also satisfy the requirement of Section 403(c) of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500), requiring that EPA promulgate guidelines for determining the degradation of the waters of the territorial sea, the contiguous zone, and the oceans.

With respect to ocean dumping research and monitoring, EPA initiated design of a national coastal water quality monitoring network. This concept addresses the problem of organizing the acquisition and dissemination of coastal zone monitoring data. The basic objectives include: the standardization of data inputs; the identification of data producers and data users; and the design of a computer-based information processing system for convenient and economical access to a comprehensive bank of coastal zone monitoring and research data.[37]

Additional EPA effort includes a study of ocean dumping operations in six geographic areas.[38] This study and some of the conclusions derived therefrom were cited earlier in this chapter.

Corps of Engineers

The U.S. Army Corps of Engineers will continue to issue permits for the disposal of dredge spoil, subject to concurrence by EPA that the material will not result in an unacceptably adverse impact on municipal water supplies, shellfish beds, wildlife, fisheries, or recreational areas. On May 10, 1973, the Corps published revised regulations for permits for the transportation of dredge spoil to be dumped in ocean waters.[39] The regulations also provide guidance with regard to the authorities and requirements of the Federal Water Pollution Control Act and the Marine Protection, Research, and Sanctuaries Act pertaining to dredging operations.

Coast Guard

The Coast Guard is taking steps to conduct surveillance and other appropriate enforcement activity to prevent unlawful transportation of material for dumping or unlawful dumping. The nature of Coast Guard action in each particular dumping operation depends on the type of materials to be dumped. In the case of toxic wastes, the dumping conveyance will usually be escorted to the dumpsite. Other materials are being monitored by the Coast Guard on a spot check basis. The Coast Guard presence, in port and at sea, is expected to provide a significant deterrent to would-be violators. An agreement between EPA and the Coast Guard has been reached whereby the Coast Guard District Commander may impose additional stipulations on any issued permit in order to facilitate the surveillance and enforcement activities.

The Coast Guard is also contributing to the overall effort by collecting information on the materials being dumped, the technical problems encountered in dumping, and by conducting analyses of these to determine ways by which the surveillance of ocean dumping can be improved.

National Oceanic and Atmospheric Administration

A major NOAA initiative with respect to the research and monitoring requirements of Section 201 of the Act is the New York Bight Marine Ecosystems Analysis (MESA) Project. The New York Bight is the coastal region with the Nation's most significant dumping problems. The MESA Project represents a major interdisciplinary attack on the problem. It is yielding information which will be of direct assistance in regulating ocean dumping in the Bight. The research findings also are expected to contribute to our basic understanding of the environmental effects of ocean dumping and should have wide-spread application elsewhere.

In addition, a start has been made towards addressing the very significant issue of waste dumping off the edge of the Outer Continental Shelf. A joint project assessing this problem has been initiated between EPA and NOAA. Detailed studies will be made of a deepwater site currently receiving industrial wastes from the New York Metropolitan Area, in an effort to assess the impacts of this practice.

Both of the above programs were described earlier in this chapter.

In addition to responsibilities detailed in Titles I and II of the Marine Protection, Research, and Sanctuaries Act, NOAA is also obligated to review applications for ocean dumping permits under the Fish and Wildlife Coordination Act.[40] This Act requires the Corps of Engineers and EPA Regional Administrators to consult with appropriate regional officials of the Departments of Commerce and Interior, and the agency exercising administrative jurisdiction over the fish and wildlife resources of the State in which dumping would occur. The Act states that wildlife conservation shall receive equal consideration and be coordinated with other features of water resource projects and environmental alterations, including permits for ocean dumping, which are undertaken either directly by a Federal agency or under a Federal permit or license.

Interagency Coordination

Coordination is an essential element of an effective national program to carry out the requirements of Section 201 and is reflected in the language of the Act. Coordination is necessary to assure that the nature of research and monitoring programs undertaken is relevant to the regulatory programs under Title I of the Act. It is also necessary to assure that the programs of the various agencies are complementary and mutually supportive. A significant start has been made towards this end since enactment of the legislation.

A permanent four-agency Ocean Disposal Program Coordinating Committee, chaired by EPA and with representatives from the Corps of Engineers, Coast Guard, and NOAA, was formed in April 1973. A representative of CEQ attends committee meetings as an observer. This committee has proved to be effective in facilitating the exchange of information on development of regulations and on the design and conduct of research projects.

In its first year, the Coordinating Committee has worked on joint research and monitoring strategies for planning of agency and multiagency research projects relating to ocean dumping. A major effort is currently underway to develop standarized methods and procedures for the characterization of disposal sites. In addition, a subcommittee has been established to begin development of specific research projects within the framework of the research strategy. One such project is the joint (EPA-NOAA) investigation of the desirability of disposing of wastes in deeper waters.

CHAPTER III

OCEAN POLLUTION

There are many sources of marine pollution. Industrial wastes and municipal sewage effluent reach the sea through streams and rivers. These wastes are also transported in barges to offshore disposal sites or discharged directly into coastal waters through outfalls. Rivers carry sediments and polluted material from agricultural operations and land-development activities to the sea. Pesticides, heavy metals, and other contaminants reach the ocean through surface runoff and the atmosphere.

The introduction of these contaminants into the marine environment has caused serious pollution problems in coastal areas and in entire seas (e.g., Mediterranean, North, and Baltic Seas). Coastal and regional pollution in recent years have become the subject of many studies and remedial programs, both at the national and international level. Generally, however, these problems have tended to be relatively localized or regionalized in nature. Examples of some of the more significant studies of regional marine pollution under way in the United States include: the Southern California Coastal Water Research Project; a study of sewage effluent loads in the Chesapeake Bay sponsored by the RANN Program of the National Science Foundation; and joint U.S.-Canadian investigations of pollution in the Great Lakes.

This report does not review individual coastal or regional problems in detail. Instead, the emphasis is on the broader aspects of ocean pollution, including the possible long-term changes in ocean ecosystems. There is a growing concern that buildup of certain materials in the oceans may be a problem in that they are suspected of showing up widely distributed in the marine environment. This chapter treats those classes of materials that are now generally recognized to be of global concern.

There have been various meetings of expert groups to examine the issue of which pollutants might represent a serious global threat to the oceans. Major workshops include: the Study of Critical Environmental Problems (SCEP) in July 1970, sponsored by the Massachusetts Institute of Technology; a workshop to examine the scientific problems related to marine environmental quality held in August 1971, organized by the National Academy of Sciences/ National Research Council Ocean Affairs Board; a conference to assess man's impact upon the marine environment as ascertained from scientific investigations, held in May 1972 under the sponsorship of the IDOE Office of the National Science Foundation; and a NOAA-sponsored workshop conducted in October 1972 to develop the strategies for a national program of marine pollution monitoring.

Basically, these conferences and workshops concluded that petroleum, metals, and synthetic organics are the principal pollutants of global significance. In addition to the above studies, the National Academy of

Sciences conducted a workshop at Woods Hole, Mass., in late 1973, the purpose of which was to identify materials that could be classified as potential pollutants of the marine environment.

However, despite broad general consensus about which contaminants represent the greatest threat of global pollution, knowledge of their full extent, their fate, and their impact on the ocean ecosystem is seriously lacking. These must be matters of increased research attention and concern if we are to devise effective means of assessing the health of the oceans.

OIL POLLUTION

Sources

Present estimates of the amount of oil spilled into the oceans, either deliberately or accidentally, vary widely but suggest a world input of at least 4 to 5 million metric tons annually.[41]

The oil introduced into the oceans as a result of man's activities is not evenly distributed over the ocean surface. It is more heavily concentrated in coastal areas (including estuaries) primarily because these regions are where land-originated petroleum wastes enter the marine environment and also where there is the most vessel traffic and most intensive offshore drilling operations. The coastal regions are also the areas of greatest biological activity, thus pollution by oil of these regions may result in more ecological damage than if the oil were more evenly distributed over the ocean.

While the introduction of 4 to 5 million metric tons of oil in the oceans each year is certainly significant, the participants of the 1970 SCEP workshop estimated that the added influx to the oceans from vaporization and subsequent washout of a wide range of petroleum products such as gasoline and other volatiles may approach 9 million metric tons per year.[42] This estimate is tentative and requires corroboration.

In the marine environment, hydrocarbons are derived from natural sources, such as organisms and from submarine seeps, as well as from man's use and transport of petroleum and petroleum products. Research shows that marked compositional differences exist between hydrocarbons from living organisms on one hand and oil from fossil fuels and natural seepages on the other. These differences can be detected by chemical analysis, which provides the basis for distinguishing among hydrocarbons from various sources. Natural seepage in the world's oceans has been estimated at less than 100,000 metric tons annually, or about one-fiftieth of the amount of hydrocarbons introduced directly into the marine environment through man's activities.

The primary source of marine oil pollution is from the extraction, transport, and use of hydrocarbons in the form of fossil fuel. Porricelli, et al., carried out a comprehensive, worldwide tanker casualty analysis of

1416 incidents which occurred during 1969 and 1970.[43] Based on events of those years, this group developed a detailed breakdown of direct (nonatmospheric) sources of marine oil pollution and their magnitudes. These results were further refined in a study in 1973 and the revised estimates are given in Table 2.[44]

The influx of oil into the oceans as a result of man's activities for the years 1969-70 was estimated to be about 4 million metric tons per year. This estimate in Table 2 does not include atmospheric fallout of hydrocarbons, recreational boats, or natural sources of hydrocarbon such as natural seepage and marine organisms. Furthermore, it may understate the contribution of automotive waste oil (1.0 million metric tons), an extremely difficult source to measure. Of the estimated 4 million metric ton annual input of oil into the oceans, about one-half enters the ocean directly from vessel operations, vessel accidents, and offshore activities. The other half reaches the ocean from nonmarine sources, such as refinery and petrochemical plant wastes, industrial machinery waste oil, and automobile crankcase waste oil.

The quantities cited thus far in this discussion are for the 1969-70 period. What about the future? World oil requirements are expected to increase sharply, possibly doubling, between the years 1970 and 1980. Also during the decade, offshore crude oil production is expected to triple, while the amount of oil transported by tanker may double.

Assuming a positive correlation between the amount of oil in use and the amount of oil introduced into the marine environment, this could mean that the 1980 levels of marine oil pollution could be double those of the 1970 period unless control programs to reduce various discharges of petroleum hydrocarbons are effective.

Control Programs

Many programs are currently under way to reduce oil losses from marine operations. These efforts center on improved tanker design and ballasting techniques for tankers and on improved operational procedures to minimize losses from offshore platforms.

At present 75 to 80 percent of tankers carrying oil use the recently developed load-on-top (LOT) ballasting technique. The LOT concept consists of collecting all tank washings and oil-contaminated ballast drainings in a slop tank. After the oil and water separate, the relatively clean water is pumped overboard until the oil-water interface is reached. The next oil cargo is then loaded on top of the residual oil-water mixture. The LOT technique achieves a significant reduction in the volume of oil discharged to the sea. There have been, however, problems in the use of the LOT system. For example, the technique is not always used even if the equipment exists; the equipment may be inadequate; control of discharges above the legal limits is dependent on visual observation by the tanker operation (human judgement); in heavy seas emulsions form and insufficient time may be available for separation of the emulsion, or the oil-water interface may

Table 2.--Estimated annual oil pollution of the oceans

		Metric tons	*Percent*
Tanker operations			
LOT* tank cleaning/ballasting		265,000	
Non-LOT tank cleaning/ballasting		455,708	
Product tankers using shore reception facilities		19,492	
Product tankers not using shore reception facilities		63,832	
Ore/bulk/oil carriers: cleaning and ballasting		119,543	
Additional cleaning and disposal prior to drydocking		91,895	
Tanker bilges		9,573	
Tanker barges		12,787	
Terminal operations		31,933	
	Total	1,069,763	28.1
Other ship operations			
Bunkers		9,055	
Bilges, cleaning, ballasting, etc.		292,481	
	Total	301,536	7.9
Vessel accidents			
Tankers		208,536	
Tank barges		39,606	
All other vessels		97,944	
	Total	346,086	9.1
Offshore activities			
Offshore drilling		118,126	
	Total	118,126	3.1
Nonmarine operations and accidents			
Refinery-Petrochemical plant waste oils		195,402	
Industrial machinery waste oil		718,468	
Automotive waste oil		1,034,588**	
Pipelines		25,574	
	Total	1,974,032	51.8
	Overall Total***	3,809,543	100.0

*LOT is an abbreviation of "Load-on-top."

**This value is a minimum. It could be 400,000 tons greater.

***The overall total does not include oil from recreational boats, natural seepage, or that added as hydrocarbon fallout.

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not be readily recognized; the operation is not feasible for short voyages; and it cannot be used for the carriage of refined products.[45, 46]

Losses during offshore petroleum extraction operations are primarily the result of human error or faulty equipment. A study at the University of Oklahoma (1973)[47] has identified the following problems: lack of proper training of people responsible for operations, slowness in applying new and safer methods of spill control, and inadequate equipment maintenance programs. Research and development efforts are now under way which address these problems. The U.S. Geological Survey is working with industry to solve these problems. New equipment is being developed that should reduce the possibility of human error.

Improved technology, while contributing to the reduction of oil loss to marine waters, will not eliminate this source of pollution completely. Techniques to control spilled oil must be improved and this capability must be readily available when and wherever required. Such rapid response to oil spills has been accomplished in the United States through the National Oil and Hazardous Substances Pollution Contingency Plan. This plan, published in the *Federal Register* of August 1973, has been developed in compliance with the Federal Water Pollution Control Act, as amended (P.L. 92-500). The purpose of this plan is to minimize damage from oil and hazardous substance discharges by providing the mechanism for efficient, coordinated, and effective actions within the Federal Government's departments and agencies.

Distribution and Fate of Contaminants

We are only beginning to understand the physical, chemical, and biological processes in the open ocean that act to disperse, degrade, and recycle petroleum and petroleum products. We do know that even the largest crude petroleum slicks disperse within a few weeks, and small ones within hours, by evaporation of the volatiles, spreading of the film, emulsification under wave action, absorption, and dissolution. The rate and relative importance of these physical processes depend not only on the chemical composition of the crude oil or refined product, but on the temperature, wind force, natural particulate concentration, sea state, and surface current velocities. Simultaneous with these physical actions, certain fractions of the petroleum undergo chemical and biological oxidation. Again, the rates depend on the temperature, intensity of sunlight, degree of emulsification, and number and species of hydrocarbon-utilizing bacteria at the particular spill site. Certain other residue-fractions form tar balls and waxy lumps, and others ultimately wash up onto shorelines where they continue to "weather." Recent evidence indicates the natural weathering of such residues is a slow process, requiring a period of years.[48]

Development of quantitative methods for evaluating the distribution of spilled oil in the ocean environment has been slow because of the difficulty in sampling and analyzing for the complex and changing chemical components of petroleum. Only in the past 2 years have analytical techniques been developed to detect marine hydrocarbons in their present natural concentration range in the open ocean.

For this reason, information on baseline levels of dissolved hydrocarbons in the world's oceans is quite limited. In the northwest Atlantic near Nova Scotia, the background dissolved hydrocarbon concentration ranges from 1 to 13 parts per billion (ppb).[48,49] In order to acquire additional data on the distribution of such hydrocarbons in the Atlantic, a sampling program jointly funded by the Maritime Administration and the Esso Research and Engineering Corporation was carried out during 1971-72. Water samples were collected at the surface and at a depth of about 10 meters by Exxon vessels along the well-travelled Gulf-East Coast and Caribbean-East Coast routes. These results also showed that dissolved and dispersed persistent hydrocarbons generally occur in concentrations from 1 to 12 ppb, except within 100 miles of major northeast ports where values were 10 to 100 times greater.[50] The survey did not include sampling and measurement of the lighter and less persistent hydrocarbons or the solid hydrocarbon residues and tar balls. The Esso study also found that the dispersed persistent hydrocarbon content of the ocean waters decreases with depth below the surface, and hydrocarbons near the surface are principally derived from petroleum rather than from biological sources.

Results of a second part of the Maritime Administration - Esso Research and Engineering survey, including samples analyzed from tanker tracks in the Mediterranean Sea and Persian Gulf, and from NSF-IDOE North and South Atlantic Ridge GEOSECS cruises, are expected to be published in the spring of 1974.

The National Marine Fisheries Service (NMFS), in fish surveys in the Pacific and Atlantic Oceans carried out in 1972 and 1973 as part of its Marine Resource Monitoring and Assessment Program (MARMAP), reported the widespread presence of oil clumps and plastic debris in over 700,000 square miles of the U.S. Atlantic coastal waters and the Caribbean Sea, from Cape Cod to South America.[51] Sea Grant-supported studies of pelagic tar collected by neuston nets in the Gulf of Mexico and Caribbean Sea have revealed that, of the samples collected, 37 percent of the tar mass was debris, rust, wheat grains, clay, silt, and other matter. These studies also found lower levels of petroleum pollution in open Gulf and Caribbean waters than those reported in the Atlantic, despite major oil production and poor surface circulation in parts of the Gulf.

A number of research programs are under way to study the distribution and fate of oil contaminants. Among these are the following.

<u>Baseline Distribution in the Pacific Ocean</u>. The Maritime Administration and NOAA, with the assistance of the National Bureau of Standards, are jointly sponsoring a study of oil pollution baselines in the Pacific Ocean. This project will assess the baseline level of hydrocarbon compounds along selected tanker routes in the Pacific Ocean, including transects along the marine leg of the proposed Trans-Alaska Pipeline System (TAPS). As in the earlier work in the Atlantic, Esso Research and Engineering is carrying out the hydrocarbon analyses. In FY 74 the project involves collection of samples from tankers and ships which are also participating in the National Science Foundation (IDOE) GEOSECS Program, as well as research on marine hydrocarbon sampling and analysis.

Puget Sound and Prince William Sound Studies. NOAA is currently conducting studies of baseline hydrocarbon concentrations in sediments and marine organisms in the two coastal areas affected by the marine leg of the proposed Trans-Alaska Pipeline System -- Prince William Sound, Alaska, and Puget Sound, Wash. The 2-year Prince William Sound study, with the cooperation of the National Bureau of Standards, will complement a recently completed study of Port Valdez by the University of Alaska (1973). The Puget Sound Study will assess hydrocarbon baseline concentrations in sediments and marine animals and will attempt to relate the hydrocarbon baseline work to sources and circulation patterns in the area.

Coast Guard Studies. The Coast Guard Research and Development Center in Groton, Conn., is conducting research on pollutant discharge identification. Less than catastrophic spillage is often undetected and yet can have a significant cumulative effect unless it is quickly identified and controlled. In project TIPS (Transportation Induced Pollution Surveillance), the Coast Guard is developing the techniques to detect, identify, and quantify oil and hazardous substance discharges and to predict discharge movement. For the latter, computer models are being developed to predict oil movement in selected harbors and estuaries so that cleanup efforts can be effected quickly.

In addition, studies of tar clump distribution in selected harbors and the ocean are being conducted by the U.S. Coast Guard. In harbors, collecting is accomplished through the mooring of specially designed sampling gear at selected locations within the harbor. At sea, gear designed specifically for collecting tar clumps is towed from the surface ship.

UNESCO/IOC Marine Pollution Monitoring Pilot Project. Under the framework of the Integrated Global Ocean Station System (IGOSS), the UNESCO Intergovernmental Oceanographic Commission (IOC) has established the Marine Pollution Monitoring Pilot Project to determine hydrocarbon distribution in the oceans. This project will examine the distribution of hydrocarbon forms such as oil slicks, tar clumps, and dissolved petroleum hydrocarbons in the water column. The project is designed to incorporate existing national and regional programs of participating member nations, with emphasis in the North Atlantic and adjacent seas. In support of this project, the U.S. Department of Commerce, through the National Bureau of Standards, NOAA, and the Maritime Administration, is hosting an IOC workshop in May 1974 to assess the status of current methodology for the measurement of petroleum and petroleum products in the marine environment. The results will be used to develop working guidelines for the IOC-sponsored project.

National Science Foundation Ocean Pollution Research. The NSF, under the U.S. International Decade of Ocean Exploration (IDOE) program, sponsors research on baseline levels and pollutant transfer processes, as well as on effects of pollutants on marine organisms and communities in conjunction with the Geochemical Ocean Sections Study (GEOSECS). Regional baseline data are being gathered in the Atlantic and Pacific Oceans, the Gulf of Mexico, and the Caribbean. Results have been obtained on the occurrence and distribution of petroleum, trace metals, and chlorinated hydrocarbons in water, marine life, and sediments. This study was followed by investigations on the contribution to oceanic pollution through various pathways -- atmospheric, riverine, geological, chemical, and biological. Research was initiated in 1973 on the effects that trace metals, petroleum, halogenated hydrocarbons, and other synthetic organic compounds have on marine organisms. This is a multiyear project providing global oceanographic data and involving geochemists from many nations.

Effects of Oil on Marine Environment

Little information is available on the effects of petroleum residues on fish populations. It appears, however, that contamination following a large spill of refined petroleum products in coastal waters can cause significant mortalities among both larval and adult stages of fish and shellfish. Moreover, the characteristic hydrocarbon residues persist in the nearshore sediments and muds, and in the lipid tissues of marine organisms. Investigations by the National Marine Fisheries Service have demonstrated lethal effects of refined oils on eggs, larvae, and adult salmon, striped bass, herring, anchovy, tanner crabs, and trout exposed to relatively high concentrations of petroleum residues in the laboratory. Detrimental sublethal effects have also been observed at the lower concentrations of petroleum extracts, including benzene, in ongoing research at the NMFS laboratory at Tiburon, Calif.

Other studies indicate that various oil dispersants caused as much or more toxic damage to marine fauna, including fish larvae, than did the initial oil spills. The most complete documentation of this effect is based on studies in the United Kingdom following the *Torrey Canyon* incident. These findings have been significant in guiding use of dispersants in oil spill cleanup operations.

Until recently, research on oil in the marine environment has focused on the short-term catastrophic effects, rather than the long-term or chronic effects. Such effects may have far greater implications for the marine environment over the long run because large numbers of organisms at all levels of the food web would be exposed over most of their life cycles.

At the present time, very little is known about the metabolic effects of crude oil on individual organisms. However, recent experiments on two species of mussels show that the presence of 1 part per million (ppm) of oil can reduce both feeding and assimilation while at the same time increasing respiration. This work, therefore, implies that even small amounts of oil can decrease the amount of energy available for maintenance, growth, and reproduction.[53]

The capacity of oil to interfere with the ability of a marine organism to locate food and to reproduce are two other sublethal effects under intensive investigation. It has been shown that certain oil fractions can block organs of chemoreception in marine shellfish. Since these animals use chemoreception as one means of locating food, the presence of oil could place an animal exposed to it at a competitive disadvantage. Petroleum fractions have been shown to interfere with reproduction of certain species. The female lobster, for example, emits chemicals called pheramones which are apparently necessary to stimulate copulation in that species. We need to know at what concentrations oil can mask the effects of these chemical stimuli in lobsters and in other marine organisms that may use this form of communication in reproductive activity. Finally, we need to know what levels of pollutants are sublethal for adult animals, but act to inhibit reproduction by diminishing the viability of the egg and sperm produced, or act as a lethal agent on a particularly sensitive early stage in the life cycle.

In addition to the effects of petroleum fractions on individual organisms, the effects on the total biotic community must be considered. Again, little knowledge is available on the effect of low levels of chronic oil pollution on biological communities. Community stability is directly related to community diversity and pollutants tend to reduce diversity. This is another area of needed research.

The subject of food chain transfer of petroleum is an important problem that merits an increased research effort. It has been demonstrated that the concentration of certain pollutants increases as they pass through successively higher levels in the food chain. A conclusion of the 1972 NSF/IDOE Baseline Conference[54] was that, in the case of petroleum hydrocarbons, there is not currently an adequate data base to assess the extent of bioaccumulation. This is a serious knowledge gap, because without definitive information on the dynamics of pollutant transfer through the various trophic levels, we will not be able to develop an ability to predict the consequences of petroleum pollution of the marine environment.

A number of research programs are underway to study the effects of oil on the marine environment. Among these are the following.

<u>EPA National Marine Water Quality Laboratory Research</u>. EPA's in-house research programs on the effects of oil in the marine environment are carried out at the National Marine Water Quality Laboratory at Narragansett, R.I. The Narragansett Laboratory, as part of its mission to develop the scientific basis for the establishment of water quality standards for marine and estuarine waters, is conducting toxicological studies on the acute and chronic effects of pollutants, including petroleum and heavy metals. The laboratory has developed acute toxicity bioassay procedures for oil and oil dispersants.

<u>Controlled Ecosystem Pollution Experiment (CEPEX)</u>. The National Science Foundation, as part of its IDOE program, has awarded grants to several institutions in Canada, Scotland, and the United States to begin a 6-year study of how pollutants affect plant and animal life in the world's oceans.

First steps are to obtain information on natural plankton populations, using cylindrical plastic containers at a depth of 30 meters. These are supported by moored floats and will trap plant and animal populations. Later experiments will collect specimens to depths of 120 meters.

Controlled amounts of chemical pollutants, heavy metals, petroleum products, and chlorinated hydrocarbons will later be added to containers in order to measure their effects on the plankton populations.

This experiment is particularly significant because it attempts to bridge the gap between laboratory findings and actual long-term behavior of pollutants in the marine environment.

Pollution Study of the North Sea and Baltic Sea. In order to answer questions about the extent and impact of pollution from the recent active petroleum and natural gas developments and other activities in the North Sea and Baltic Sea, the 18 member International Council for the Exploration of the Seas (ICES) has, under United Nations auspices, carried out several studies. Preliminary results of these studies have been encouraging. The general level of toxic substances found in fish and shellfish was low. If these results are confirmed, future research can be directed toward the standardization of techniques among various nations, and establishment of baselines and indicator organisms.

The United States joined in the ICES effort in 1973. It is anticipated that the National Science Foundation and the National Marine Fisheries Service of NOAA will provide the focal point of U.S. support to the program.

HEAVY METALS

Metals are found throughout the biosphere in greatly varying concentrations. Table 3 gives average background ocean concentrations of metals that could be considered toxic at high concentrations.

The natural levels of the metals given in Table 3 are being augmented by mining and other extractive and industrial processes. However, direct relationship between industrial production and increased total levels in the sea has not been established. The metals contributed by man's activities reach the sea by the same routes as other pollutants, that is, through industrial waste discharges, municipal sewage systems, runoff, ocean dumping, and atmospheric transport. Some metals in pesticides are organically bound and reach the marine environment in this highly toxic form.

The presence of metals in the marine environment was brought to worldwide attention in the 1960's when 111 people died or suffered serious neurological damage in Japan as a result of Minimata Disease caused by mercury poisoning. World production of mercury is currently about 9,000 metric tons per year; about 5,700 tons per year are released into the environment as a result of man's activities (Table 4). This artificial input has caused such problems as: elevated mercury levels in fish and water birds in Scandinavian countries; accumulation of mercury in eels from the Rhine River in Holland; and fish contamination in the Great Lakes. In the marine environment, metallic mercury and most mercury compounds can be biologically converted into toxic organic compounds such as methyl mercury that is concentrated by some food chains. This is important because in addition to the known

Table 3.--Inorganic chemicals considered as pollutants of the marine environment [54]

Element (1)	Natural concentration of seawater (2)	World production 1968 (3)	Routes of entry into the sea (4)	Pollution categories (5)
	μg/1	*Metric tons/year*		
Beryllium (Be)	0.001	250	U	IV c
Titanium (Ti)	2	1,000,000	A	IV b
Vanadium (V)	2	9,000	A	IV a
Chromium (Cr)	0.04	1,500,000	R(U)	IV c
Iron (Fe)	10	480,000,000	D,R	IV c
Copper (Cu)	1	5,000,000	D,R	IV c
Zinc (Zn)	2	5,000,000	D,R	III c
Cadmium (Cd)	0.02	15,000	A,R	IV c
Mercury (Hg)	0.1	9,000	A,R	I b
Selenium (Se)	0.45	1,000	U	III c
Lead (Pb)	0.02	3,000,000	A,R	I a
Phosphorus (P)	-	?	D	IV c
Arsenic (As)	2	60,000	D	II c
Antimony (Sb)	0.45	60,000	U	IV c
Bismuth (Bi)	0.02	3,800	U	IV c

(1) Listed in the order of groups in the extended form of the Periodic Table.

(2) These values are approximate, but are representative for low levels in unpolluted sea water. Concentrations are in micrograms per liter.

(3) From *Minerals Yearbook*, 1968.

(4) D, dumping; A, through atmospheric pollution; R, through rivers (runoff) or pipelines; U, unknown.

(5) I-IV probable order of decreasing menace; a - worldwide, b - regional, c - local (coastal, bays, estuaries, single dumpings).

Table 4.--Estimates of environmental mercury fluxes[55]

	Tons/year
Natural flows	
Continents to atmosphere (by degassing of the earth's crust	
Based on precipitation with rain	84,000
Based on atmospheric content	150,000
Based on content in Greenland Glacier	25,000
River transport to oceans	3,800
Range of totals 28,800 - 153,800	
Flows involving man	
World production (1968)	8,800
Entry to atmosphere from fossil fuel combustion	1,600
Entry to atmosphere during cement manufacture	100
Losses in industrial and agricultural usage	4,000
Totals 5,700	

toxicity of methyl mercury, there is evidence that it can also cause genetic effects.[56]

Lead is another important environmental contaminant. The progressive contamination of some remote areas by lead has been recorded by some investigators. However, these data cannot be taken as representative of worldwide circumstances.[57] In their isotopic analysis of lead in polar snows in Greenland, Patterson et al., calculated that concentrations of that metal have increased from less than 0.0005 micrograms per kilogram (ppb) of ice in 800 B.C. to 0.20 micrograms per kilogram (ppb) by 1965. This implies a hemisphere-wide atmospheric transport and dispersion of industrial lead over land and sea.[58] What happens to such lead in the sea is unknown. However, since worldwide lead production is increasing each year, we need to know more about how this lead is cycled.

An increase in surface concentrations of lead in some waters has been established by analysis of isotope ratios. Investigators have found that surface waters in the Pacific Ocean and the Mediterranean Sea contained 0.3 and 0.2 ppb of lead, respectively, compared to less than 0.1 ppb in deeper waters; however, no difference was noted in the Atlantic Ocean. These puzzling results further point up our ignorance on the natural recycling of lead.[59,60]

Furthermore, the investigators suggested that the widespread use of leaded gasoline is the principal source of industrial lead found in the atmosphere and in the surface waters of the oceans. Yet, to ascribe this lead specifically to manufactured tetraethyl lead, it would be necessary to know whether the isotopic composition of tetraethyl lead differs from that in all the other products of industry that contain lead and which also enter the marine environment by weathering, burning, and other routes.[61]

It is not known whether lead is being concentrated by marine organisms, nor what the effect of any accumulation might be. However, in contrast with mercury, lead is apparently not biotransformed. Inorganic lead is nonetheless toxic in excessive quantities and can accumulate in mammalian tissues.

The situation in regard to lead can be briefly summed up as follows: (1) industrial lead is entering the oceans via outfalls, dumping, and aerosols at increasing rates; (2) the natural accumulation rate and effects of oceanic lead have not been adequately investigated; (3) lead is toxic at low concentrations; and (4) there is no known adverse effects of lead at its present level in the oceans.

Other metals may be potentially more hazardous to man's health than mercury and lead. For instance, cadmium has been shown to accumulate in tissues and cause larval mortality in crabs and certain fishes (e.g., the tautog). Relationship to human disease is yet to be demonstrated, however. Silver, copper, zinc, and chromium are other metals which require further investigation. The only metal that has a presently effective FDA guideline, is mercury at 0.5 ppm. A number of Federal agencies are conducting research on the effects of toxic materials in the marine environment; in general, these programs were listed in the foregoing discussion of research on the effects of petroleum. In addition, the National Marine Fisheries Service's

Microconstituent Program is directed toward determining the occurrence and public health significance of various contaminants in fish and fishery products. A survey has been initiated to obtain baseline data and identify possible problems related to 15 metals in nearly 200 species of fish and shellfish. Additional work to determine levels of other inorganic trace elements and organic contaminants, such as pesticides and polychlorinated biphenyls is being conducted. To date, nearly 100 species have been shown to contain relatively low levels of mercury. Selected species have been extensively investigated to define mercury content in relation to size and location of catch. This study is being conducted as a basis for managing the mercury problem in these species. Nearly all species investigated to date have been shown to contain low levels of pesticides and PCBs, the subject of the next section.

SYNTHETIC ORGANICS

The major groups of synthetic organic chemicals that may have an impact on the marine environment are: chlorinated hydrocarbons such as DDT and PCBs, and volatile organic liquids and gases, such as Freon and dry cleaning solvent. These compounds are toxic; moreover, many resist chemical and biological degradation and thus persist and accumulate in the environment. Another characteristic of synthetic organics is that they are volatile and readily escape into the atmosphere ; and large quantities are transported to the oceans by wind currents.

Perhaps the best known synthetic hydrocarbon compound is DDT. Vast quantities of this pesticide were produced and applied in this country until it was banned in 1972. DDT itself has a very low solubility in water and tends to be adsorbed on soil and silt particles. The characteristics of its application and its volatility combine to make atmospheric transport a more significant pathway for DDT and DDT residuals than soil erosion and surface runoff. In soil and sediments, the half life of DDT has been estimated to be around 10 to 15 years.

DDT degrades in the presence of oxygen to DDE. It also can be metabolized in the absence of oxygen to other forms such as DDD. It is DDE that is the most persistent of the degraded forms of DDT. In fact, DDE appears to be the most abundant of the synthetic organic pollutants now in the oceans. DDT compounds have been detected in both snow and marine organisms in the Antarctic, strengthening the hypothesis that air transport and subsequent fallout is an important dispersal mechanism and pathway into the marine environment.

It is estimated that DDE usually comprises at least 80 percent of the DDT residuals found in marine organisms. Also, there is no known marine organism that metabolizes DDE, thus it tends to accumulate. DDT and its residues are known to accumulate in the fatty tissues of marine organisms, and its concentration increases as it moves through the food chain. The magnification is such that fish-eating birds (e.g., the herring gull) have been found to contain DDT concentrations which exceed the concentration found in the water by a factor of one million.[62]

It appears that there is considerable variation in the ability of different species to tolerate and concentrate chlorinated hydrocarbons. In 1969 a shipment of 28,000 pounds of coho salmon taken from Lake Michigan was embargoed because the fish contained 19 parts per million of DDT. However, other fish in the lake, such as herring and whitefish, have not been shown to carry high residues.[63]

Utilizing 20 years of plankton collections from intensive sea surveys of the California Current region, it has been shown that there has been a continual accumulation of DDT and its metabolites in planktonic fishes near Los Angeles from 1949 to 1970. The source of the pesticide was shown to be one chemical plant dumping DDT wastes into the Los Angeles sewer system; this dumping was stopped in 1970.

Polychlorinated biphenyls (PCBs) have been in use in the United States and elsewhere for over 40 years. Although its sole U.S. producer is the Monsanto Company, it also enters the United States from other manufacturers from abroad. Because of their superior insulating as well as fire and explosive resistant properties, PCBs are widely used in heat transfer systems and in electrical devices, particularly capacitors and transformers. PCBs have many other industrial applications,such as additives to plastics and paints and as coating compounds. As in the case of DDT and its residues, PCBs are highly persistent and ubiquitous. They are distributed in the marine environment in a manner that suggests that atmospheric transport and subsequent deposition on surface waters is an important pathway into the oceans.

The 1971 NAS study on marine environmental quality estimated that total cumulative world production of PCB was 1 million tons (1971). That study also estimated that about 25 percent of the annual world production of PCB leaks to the environment, 20 percent to the atmosphere (due to its high volatility) and 5 percent directly into sewers and rivers.[64]

Although little is known of the effects of PCB on marine organisms, there is some evidence that they can have adverse effects on human health.[65] As with organochlorine insecticides, PCBs are fat soluble and resist metabolic change. Thus, they tend to concentrate at succeedingly higher levels in the food chain. PCBs have been shown to accumulate in fish and aquatic invertebrates to levels 75,000 times those present in water.[66]

A considerable amount of information is now accumulating on the biological effects of various levels of PCBs on man and other animals. However, more research is needed to determine the magnitudes and the cycling mechanisms of PCBs in the marine environment and on the acute and chronic pathologic, mutagenic, physiologic, biochemical, and behavioral effects of PCBs on marine organisms.

The EPA and NOAA's National Marine Fisheries Service entered into arrangements beginning January 1974 to analyze pesticide residues in fish.

This interagency agreement was made in response to the Federal Environmental Pesticide Control Act of 1972 which requires EPA to conduct, in cooperation with other agencies, a nationwide pesticide monitoring program.[67] Under the terms of the agreement, NMFS furnishes fish samples from regularly scheduled cruises to EPA for the analysis of pesticide residues.

Other marine pollution studies of the National Marine Fisheries Service include mutagenic effects of pollutants in which larval marine forms are exposed to varying concentrations of a number of contaminants, including pesticides. Genetic tests are providing an especially sensitive means of measuring presence or absence of low dosage and long-term effects.

The National Marine Fisheries Service has also long had a program to study the pathological effects and mortalities that result from infectious disease. Important information is beginning to emerge as a result of this program which is now also being directed to the study of gross and subtle pathological effects of marine contaminants on aquatic organisms. Organ, tissue, and cell systems that are selective targets for certain contaminants found in the marine environment are used in the studies.

These studies seek to determine the distribution and chemical forms of contaminants in sediments, water, and biota of selected estuaries; determine turnover rates and food chain transport of these contaminants; and develop predictive models of the distribution and cycling of these contaminants in marine ecosystems.

Coastal transport is the subject of an NMFS study of chlorinated and petroleum hydrocarbons. The study objective is that of defining the processes influencing the dispersal of pollutants away from the coastal zone and the time required for these processes to operate.

The Environmental Protection Agency also conducts and supports research aimed at understanding the effects of contaminants on the marine environment. For example, the EPA Gulf Breeze Environmental Research Laboratory located near Pensacola Bay, Fla., specializes in research on pesticides and performs laboratory experiments on the effects of sublethal concentrations of chemical contaminants on estuarine organisms.

PLASTIC DEBRIS

The National Marine Fisheries Service, in fish surveys in the Pacific and Atlantic Oceans carried out in 1972 and 1973, reported the widespread presence of plastic debris floating near the surface and washed up on beaches. The field survey teams estimated that over 20,000 plastic items, including 12 tons of trawl web and perhaps 7,000 gillnet floats had washed up along 60 miles of beaches of Amchitka Island in the Aleutian Chain. Floating synthetic ropes and nets entangle in ships' propellers and derelict nets entrap fish, birds, seals and other marine animals. A similar situation was found in the Atlantic Ocean surveys in which oil clumps and plastic fragments were observed from Cape Cod to the northern coast of South America, an area encompassing over 700,000 square miles.[68]

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Plastic debris appear to be extensive in the ocean and current research efforts are directed toward ascertaining their biological significance, if any. Plastics have not been found in adult fish, indicating that these materials are not being ingested or they are passed through the digestive tract. Plastic material has been found in larval fish from Long Island Sound, however. Initial laboratory experiments show that the plastic does not appear to harm larvae and juveniles. In summary, based on limited studies to date, there is no evidence of biological harm to fish from plastic debris, but in view of the widespread distribution of these materials, continued study is warranted.

CHAPTER IV

OFFSHORE DEVELOPMENT AND THE OCEAN ENVIRONMENT

Today's new technological developments are making the offshore emplacement of large structures possible and are enhancing man's capability to extract minerals and fuels from the seafloor. Four major categories of offshore development are treated in this chapter: offshore terminals, nuclear power-plants, oil and gas structures, and ocean mining. The first three cited developments relate in some manner to the extraction, production, or transport of energy, and, as the Nation searches for additional sources of energy, each will involve the ocean to an increasing extent.

NOAA also is monitoring other developments that involve estuarine and Continental Shelf areas. These concepts are now generally of an experimental nature, but in the future could involve important alterations to the marine environment. These include aquaculture, piping of deep, cold, nutrient-rich waters to the surface (coastal upwelling research), harnessing tidal and Gulf Stream currents to obtain low-cost electrical energy, construction of reefs to improve fishing, construction of offshore islands, cities, and airports, and the modification of weather and related oceanic conditions. Much of the research in these developments is supported by NOAA and the National Science Foundation. These activities are not discussed in this report, but their potential effects and interactions with new developments described in this chapter must be taken into account.

OFFSHORE TERMINALS

The President has proposed legislation which would permit the Secretary of the Interior to issue licenses for construction of deepwater ports in the United States. More popularly known as "superports," these facilities could handle the offloading of oil from supertankers of the order of 300,000 dead-weight tons (DWT) and larger. As our energy needs increase, the transport of oil will require increasing numbers of such large tankers.

Ports having depths of about 40 to 50 feet were sufficient to accommodate virtually any ship up to 75,000 DWT. However, the largest tankers in use have increased in size from 60,000 DWT in 1956 to 326,000 DWT in 1971 and construction of a 477,000 DWT tanker is under way. The drafts of such vessels are greater (70 to 100 feet) than existing port facilities can accommodate, and require either deepening of existing ports or development of facilities in offshore deeper waters. In the latter case the facility may consist simply of a single-point mooring or a moored barge with pipeline connections. Proposals also have been made to construct more elaborate offshore structures including breakwaters, docking areas, and permanent buildings.

Several recent studies have focused on the environmental consequences of superports that might be constructed along various parts of the U.S. Atlantic and Gulf coastal areas. A recent report to the Council on Environmental

Quality by Arthur D. Little, Inc.[69] describes potential onshore impact of industrial development related to deepwater oil terminals. Potential sites were investigated for economic and environmental effects at five possible locations -- three Atlantic coast and two Gulf of Mexico sites. The report indicated that the further deepening of existing ports needs to be carefully analyzed from the economic and environmental points of view -- primarily because of the immense dredging requirements, the increased possibility of collisions and grounding caused by greater harbor congestion, and the impact of such activities on vulnerable coastal zone environments.

Marine-related environmental impact analyses on these superport locations were developed in 1973 for the Council on Environmental Quality by NOAA.[70] Studies of the three Atlantic coast and two Gulf of Mexico sites were sponsored under NOAA's Sea Grant program (at the Massachusetts Institute of Technology, State University of New York, University of Delaware, Louisiana State University, and Texas A&M University).

NOAA's analysis in the areas studied pointed out that environmental damage through dredging operations and oil spills could be serious and will necessitate careful safeguards. Habitats for bottom dwelling populations may be damaged where dredging occurs; suspended sediments in the water could be carried elsewhere and result in unwanted deposition patterns; and increased turbidity may decrease photosynthesis in surface layers and interfere with the development of some larvae. In some locations disruption of bottom sediments may cause additional pollution of the water column by hydrocarbons, trace metals, or other undesired chemicals contained in bottom deposits.

In some cases, dredging of deep channels could alter flow patterns or permit increased intrusion of saline water and have an influence on various fish and shellfish populations. Extensive deep dredging also could cause entry of saltwater into freshwater aquifiers, and affect the domestic water supply of coastal communities. Where a sizeable island structure is to be erected within confined waters, changes in tidal currents must be considered.

Environmentally, the impact of spilled oil remains a major concern. The areas examined in the studies included some of the major estuarine systems in the country. Coastal areas are biologically very productive, have resident as well as migratory populations, and are generally of a depth (relatively shallow) that spilled oil could become distributed throughout their extent. Oil discharges from terminals located farther seaward would probably be less damaging because of their greater distance from biologically sensitive areas; thus, pollutants would be diffused and possibly less toxic should they reach inshore waters.

Both the Corps of Engineers and the Maritime Administration have issued reports on various aspects of superport construction. The Corps of Engineers study addressed the probable impact of secondary onshore developments attendant to superport construction and operation.[71] The Maritime Administration study stressed environmental concerns.[72] Both investigations used specific port sites as examples.

More studies are required to gauge the probable effect of oil contamination in specific regions. It is necessary, further, to consider the cumulative effects of hydrocarbons on environmentally sensitive areas resulting from chronic releases from nonspill causes, e.g., transport of oil and barge traffic, pipeline leakage, etc. While it is possible that efficient safeguards can keep spillage to a minimum, it is essential that our programs and studies carefully examine potential adverse effects under all conditions, including those of large accidental spills. Furthermore, ecological relationships in the areas must be understood so that time comparisons can be made and baseline and predictive models constructed. In this regard, NOAA's work in the New York Bight area, and related information from studies in Puget Sound and Prince William Sound, will provide an important data and information base toward a comprehensive assessment of the possible effects of superport construction and operation on the marine environment. These assessments will be essential for decisions to be made on site locations, environmental safeguards, and monitoring requirements.

OFFSHORE POWERPLANTS

The growing scarcity of available land sites and concern about potential threats to ecological balances in coastal land areas, associated with the expected increase in the number of nuclear power generating facilities, have led to consideration of offshore sites for these plants. Utilities have previously located many of their power stations along inland rivers and lakes, and more recently in estuarine areas, due to easy availability of condenser cooling waters. Over 30 percent of the nuclear power stations planned or operating in the United States now use saline or brackish water for cooling.[73]

The offshore concept of powerplant siting takes advantage of the great heat-assimilation capacity of the ocean. There are also esthetic advantages over traditional land-based siting. An offshore station at 3 miles distance from the beach would have an apparent size comparable to a large ship.

The design concept presently being considered consists of a barge-mounted floating facility enclosed by a massive protecting breakwater 30 to 60 feet in height above the water surface. Transmission lines buried in the seafloor would connect the facility to the shore some 2 to 3 miles away. A gently sloping bottom is necessary, as opposed to steep inclines, with the breakwater emplaced in about 45 feet of water. Many potential sites exist off the Atlantic coast and in the Gulf of Mexico that meet the locational criteria; conversely, few are found off the Pacific coast, where the continental margin is relatively steep.

Westinghouse Corporation and Tenneco have designed a plan to construct a shipyard facility near Jacksonville, Fla., to produce the plants on a production line basis through a joint subsidiary, Offshore Power Systems. If approved, the proposed Atlantic Generating Station off Little Egg Harbor, N.J., to be operated by the Public Service Electric and Gas Company, would be the first such plant installed and operated; this is in the 1980 time frame. The Atomic Energy Commission is presently studying the engineering report on the procedures for construction of the barges in Jacksonville prior to approval of a manufacturing license. Additionally, AEC is preparing an environmental impact statement on the application by Public Service Electric and Gas Company for the Atlantic Generating Station.

Design concepts of the offshore plants hold that the breakwater will provide a calm basin for protection, with the plant being able to remain in operation during the severest weather conditions (or being safely shut down as necessary). The breakwater also will protect the plant from possible ship collision.

Many environmental concerns are inherent in the offshore powerplant concept. Near the facility, siltation and ship and barge traffic may affect marine life and, depending on the specific location selected, care will be needed to insure against disruption of spawning, migration of fish, and destruction of clam and other shellfish harvesting areas. The generation of large quantities of heated water in the vicinity of the plants may have an impact upon fish and shellfish populations in either the adult or larval stages. When plant operation is shut down for one reason or another, the subsequent cooling of adjacent waters could cause a shock effect sufficient to kill fish. While nuclear powerplants have a history of safe operations, possible accidents which would release sufficient radioactivity to affect mammals, birds, fish, and shellfish must be taken into account. As the life of these structures is anticipated to be no more than about 40 years, possible removal of the breakwater may be a source of further disruption in the immediate vicinity. In the surrounding area, currents may carry the suspended material caused by construction to beach areas many miles away and sediment deposition patterns may be altered causing beach erosion. Possible secondary effects of related construction,such as support facilities in onshore areas,are also an environmental concern.

The economics of offshore construction may lend itself to building powerplants in clusters. This poses difficult analytical problems with respect to the determination of environmental impact, since the effects of several plants are not necessarily the multiple of the effects of a single unit. The clustering of many plants in one general area may have severe local impact upon both shore and marine life, local recreation, transportation, etc. While every plant constructed would require impact analysis, the cumulative effects of the construction and operation of many plants must be considered.

The Council on Environmental Quality is coordinating a comprehensive investigation of the overall effects of offshore powerplants, with participation by NOAA, Federal Power Commission, Atomic Energy Commission, Environmental Protection Agency, Corps of Engineers, Department of the Interior, and others. This study will identify environmental and other issues in the offshore siting of powerplants. A part of the CEQ study will highlight the environmental conditions now found along major U.S. coastlines and the expected impact of powerplants in four representative regions on the Atlantic coast: (1) from Portsmouth, N.H. to the northern Maine border; (2) the New York area to Atlantic City, N.J.; (3) Chincoteague, Va., to Cape Charles, Va.;

and (4) Cape Canaveral, Fla. to the Florida Keys. These data will provide preliminary baseline information to assist in planning and site selection. NOAA inputs to this study focus upon physical and ecological processes in the selected coastal marine environments and include an evaluation of the representative impact of construction, operation, possible accidents, and decommissioning of offshore powerplants on marine ecosystems.

The Atomic Energy Commission is studying the general environmental effects of operating offshore nuclear powerplants in order to develop a set of guidelines for industry planners. In conjunction with the environmental assessments developed by CEQ, the AEC-sponsored analyses will allow preliminary site evaluations to be conducted.

An AEC workshop involving participants from government, industry, and universities was held in Rockville, Md., in October 1973 to investigate further research requirements associated with offshore powerplant development. The major problem areas identified include: thermal plume behavior under different environmental conditions; air-water interface dispersal of pollutants; and the possible resonance of the protecting breakwater caused by wave action, which might result in structural damage to the barge-mounted plants.

A continuing NOAA role is foreseen in providing environmental data and discrete data-related evaluations affecting offshore powerplant sitings and operation. For example, NOAA is presently delineating storm surge conditions in low-lying areas along the Atlantic coast in order to predict tidal variations that may affect both offshore powerplants and onshore support facilities.

OIL AND GAS DEVELOPMENT

Oil rig structures in this country are presently found in greatest numbers in the Gulf of Mexico, and recent Bureau of Land Management actions will lead to an increase in oil and gas extraction facilities in the eastern Gulf area west of central and northern Florida. However, exploration data indicate a large potential reserve on the Continental Shelf in areas off the Atlantic coast. This region, as well as the Gulf of Alaska, may soon be opened for oil and gas extraction. As the technology improves to allow drilling for oil and gas in deeper waters off the Continental Shelf, assessment of the potential environmental impact of drilling platforms and submerged pipelines becomes more complex.

As indicated in Chapter III, the impact of oil discharges on the coastal environment is largely unknown. It can be expected, however, that the greatest areas of concern are the estuaries and coastal embayments where dispersion is restricted and where many species that make up the biota undergo early development and may be particularly vulnerable. Oil on a beach may: (1) cause biological damage; (2) be esthetically unpleasant; and (3) disrupt recreational activities.

During construction of an oil rig or submerged pipeline, the local biota will undoubtedly undergo disruption. The relative significance of this effect in most areas is considered to be of little consequence because of the small area involved and the short duration of the activity. On the other hand, in eastern and central portions of coastal Louisiana, the effect of pipeline construction has been relatively severe because permanent flotation canals through the unconsolidated marsh substrate were dredged for pipeline laying operations. In addition to pipelines, other activities related to oil and gas production, such as transportation, storage, and refinery operations, will have some effect on the coastal environment and local and regional economics. The impact of all these effects on a cumulative basis is unknown.

Environmental studies are required to fill many existing gaps in our knowledge of the potential environmental consequences of offshore oil and gas development. In particular, studies are needed to:

- develop techniques and methodologies to detect adverse effects of offshore development;
- provide information about natural conditions and environmental fluctuations in order to recognize unnatural perturbations;
- develop a capability for predicting consequences of development activities; and
- provide the information necessary to take effective preventive and mitigatory action.

Since the full environmental consequences of offshore oil and gas development are unclear, investigations of potential effects and continued monitoring of conditions during the construction and operation of facilities are critical for averting major environmental damage.

NOAA is presently participating with other Federal agencies -- including the Bureau of Land Management -- in a CEQ-sponsored study of the potential effects of oil and gas development on the Atlantic and Alaskan outer Continental Shelf areas. This report, due in spring 1974, will address many of the environmental issues previously discussed.

OCEAN MINING

Deep Ocean Mining

The only presently known hard minerals of potential economic importance on the deep ocean floors beyond the Continental Shelf are manganese nodules and crusts. While nodules occur in some freshwater lakes and in some shelf areas, the highest quality nodules found to date are in the North Pacific Ocean at depths of 5,000 to 6,000 meters. These seafloor nodules have been known since at least 1875, when they were found at many stations during the *Challenger* Expedition.

Four U.S. firms are actively developing equipment to mine nodules and the metallurgical processing of the nodules has reportedly been worked out by several companies. Industry spokesmen have stated that it will be technologically possible and economically practicable to begin mining as early as 1976, but investment uncertainties and complex international legal problems may delay the actual date of commercial mining.

Three mining systems are proposed: hydraulic pumping, air-lift pumping, and continuous-line bucket (CLB). In the first two types, vertical transport is accomplished by hydraulic or air-lift pumping and the nodules and sediments as well as bottom water are forced to the surface through a pipe lowered from the mining ship to the seafloor. The nodules are then separated from the entrained sediment and bottom water, which can be discharged either at the surface or at some intermediary level in the water column (such as a platform rigidly suspended beneath the mining ship).

The CLB dredge system consists of a continuous line or belt which travels from the bow of the ship down to the bottom, along the bottom, and up to the stern of the ship. Large, open mesh buckets are attached to this line at regular intervals. As the rope is circulated, the buckets descend, scrape the ocean bottom, and then ascend to the ship where they are unloaded and lowered again. This system is designed to bring only nodules to the surface, but in practice some benthos and sediment also are transported and washed out throughout the water system.

Continental Shelf Mining

Because of the decreasing availability of economically suitable land deposits of sand and gravel, offshore deposits are an attractive potential for ocean mining on the Continental Shelf. Technology is available and the economics appears promising. A significant barrier to development of large-scale sand and gravel mining has been uncertainty over the possible deleterious environmental side effects of such activities. The result has been an actual and de facto moratorium on this kind of mining operation at the Federal and State levels. This general moratorium situation continues; however, the draft rules and regulations for the mining of hard minerals on the outer Continental Shelf have recently been proposed by the Department of the Interior. Commercial offshore sand and gravel mining could begin in 1 or 2 years.

The United Kingdom has developed a substantial sand and gravel industry off its coast in recent years. Experiences in the United Kingdom indicate that sand and gravel can be successfully mined by clam-shell barge, bucket-ladder dredge, suction dredge, and, steam shovel barge. The clam-shell technique is being gradually phased out (because it is uneconomical) except in certain deepwater glacial lakes, such as those in Switzerland.

The United Kingdom marine mining fleet is principally composed of suction hopper dredges with cargo capacities in the range of 500 to 10,000 tons. Recovery of sand and gravel is done by use of high-capacity pumps which suck up the materials from the seafloor (up to about 100 feet beneath the ocean surface) through a large pipe. The slurry, about 10 percent solids, is fed to a hopper where most of the solids remain. The excess water weirs overboard, along with the fine particles trapped in suspension.

Environmental Effects

Deep ocean mining operations are expected to disrupt local benthic communities, stir up sedimentary material, mix bottom water and sediment into the upper water column, and change the chemistry of surface waters.

Some damage to benthic organisms and their habitats will undoubtedly take place; the extent of this damage and the capacity for benthic organisms to reestablish themselves will, of course, vary with the area and the mining technique employed. In addition, the stirring up of bottom sediments may clog or smother benthic organisms over a much wider area than that which is actually mined.

The introduction of bottom water and material into the upper water column can have complex results and the effect is uncertain. The impact would be most severe in the case of a hydraulic system which would discharge large volumes of bottom water at or just below the surface, and increase turbidity in the euphotic zone. Of special interest is the introduction of nutrient-rich bottom waters and sediments into the euphotic zone and the resultant increased growth of phytoplankton. The type and extent of impact on phytoplankton productivity would appear to depend upon:

1) the rate and volume of discharge;

2) the nitrate concentration of the effluent;

3) the turbidity of the effluent and the depth to which it spreads;

4) the rate of dilution by mixing; and

5) the rate of nutrient uptake by the phytoplankton.

The most important factor in determining the effects of mining effluents on plankton communities will be the rate at which the effluent is diluted by mixing with surface water. If the initial dilution ratio is less than one percent, as research indicates, the impact of deep-sea mining on biological processes in the euphotic zone will probably be minimal. However, this observation remains to be documented during an actual mining operation.

Mining on the Continental Shelf can affect the environment in a variety of ways because of the excavation of the seafloor. Sand and gravel mining will remove bottom sediments to an average depth of about 3 meters, cratering the seafloor and altering the character of the bottom habitat. The possible destruction of predator and prey species and removal of plant materials can be expected to significantly affect the marine ecosystem in the immediate area of the dredge site.

Knowledge is most lacking with respect to the turbidity plume, the resultant blanket of fine sediments, and the effects of both on marine organisms. During mining, large amounts of silt will be released in the overflow from the dredge. For each cubic meter of sand and gravel extracted, approximately 10 cubic meters of water will be withdrawn. The water will flow through the barge and discharge -- along with fine material in suspension. The plume formed by this turbid discharge as well as sediment redeposition on the seafloor will be heaviest in the immediate vicinity of the barge. However, a significant degree of blanketing may extend over the bottom surface some tens of kilometers from the barge.

The biological impact of the silt plume on the Continental Shelf can only be predicted in a general way at present. Extensive literature exists pertaining to the response of estuarine organisms to high levels of suspended materials. However, extrapolating these findings to the coastal area is not valid because marine organisms have evolved in response to an environment different from that of estuaries.

While many species would no doubt be driven from the excavation area and the region of suspended silt, there are certain fishes which are known to be attracted to this kind of disturbance,including several which are of particular economic significance. Cod fishermen in regions of New England keep in close touch with mechanical clam digging operators, as the cod is known to be attracted to disturbances of the bottom. Winter flounder exhibit a similar behavior, as do sea robin and sculpin. These fishes possibly are attracted to the large numbers of benthic invertebrate organisms stirred up into the water column by the disturbance. Just how long these organisms would remain in the region, in the face of mechanical or chemical irritation resulting from the suspended solids, is uncertain.

Physiological responses to abnormally high levels of suspended materials have been observed to include depression of oxygen transfer across gill tissues and reduction in tissue glycogen levels. These effects, if persistent, can result in increased mortality and impairment of reproductive ability.

Another important consideration is the possibility of accelerated net photosynthetic production associated with the introduction of nutrients into the waters where they were previously present only in limiting quantities. Some workers believe that in coastal waters, phytoplankton production is essentially nigrogen-limited for the greater part of the year, and especially during the spring diatom increase. Therefore, resuspension of nitgrogen-rich bottom sediments could encourage plant growth.

Research Needs and Current Programs

The prospect of extensive deep ocean mining requires serious consideration of the environmental impact of these activities. Such mining will affect the benthic and pelagic environments within the general mining area, but the significance of these alterations is unknown. It is essential, therefore, that the environmental impact of manganese nodule mining be defined and its implication understood. The overall objectives of an environmental impact study of deep ocean mining should include:

(a) the establishment of physical, chemical, and biological baseline environmental conditions in potential mining areas;

(b) the documentation of changes induced in benthic and pelagic ecosystems by deep-sea mining;

(c) the formulation of guidelines for future mining operations which will minimize environmental effects; and

(d) the determination of the properties which should be monitored during deep-sea mining to provide the information needed to evaluate the environmental impact of specific mining methods and to devise mitigating measures, if necessary.

A NOAA contract (FY 1974) with the City University of New York, involves a baseline study of an area located in the siliceous ooze province of the North Pacific Ocean. One or two 30-day cruises at a typical mining site will be conducted to establish baseline conditions for biological, chemical, and physical parameters. The study will include benthic observations, observation of the lower water column (within 500 meters of the bottom), and observations of the upper portion of the water column (the euphotic zone--surface to 500 meters). Some measurements and samples, however, will be routinely taken over the whole length of the water column, including those for current studies, and STD (salinity-temperature-depth) and turbidity profiles.

Present plans call for continuation of this deep ocean work to include the monitoring of mining tests and operations in order to ensure that such activities do not adversely affect the marine environment.

With regard to Continental Shelf mining, there are at least five very general areas of interest: offshore Boston; New York; Washington, D. C.; Los Angeles; and San Francisco. Eventually, baseline data may be required for each of the five areas, and for other areas as exploration reveals new resources and as new markets appear. In addition, as in the case of manganese nodules, an assessment must be made of all the environmental ramifications of the development of an offshore sand and gravel mining industry.

Project NOMES (New England Offshore Mining Environmental Study) was originally conceived in 1972 as a 4-year study led by NOAA to answer many of the environmental questions confronting decision makers. NOMES was a joint project involving NOAA, EPA, the Coast Guard, Corps of Engineers, Department of the Interior, and State agencies in Massachusetts. The project was terminated in July 1973 because a suitable disposal site could not be located for the test dredge spoils. Analyses are continuing on data gathered prior to termination of the project. These results should improve capabilities to predict the dispersion and settling characteristics of silt plumes. Other areas more suitable to disposal requirements will be considered for possible renewal of this effort. In this connection, the Corps of Engineers, in its Dredge Material Research Program (DMRP), is conducting studies that are directly relevant to nearshore sand and gravel mining.

CHAPTER V

OVERFISHING

Overfishing is man's excessive harvesting of a fish stock to a level below which the stock cannot produce optimum sustained yields. The effects of such declines may have serious economic and social implications, as we have seen in coastal fishing communities from New England to Alaska. However, declines in fish populations are by no means a recent trend, nor do they necessarily result from the mismanagement of fish stocks. For example, in 1714 and 1715, the inhabitants of entire villages along the Norwegian coast are reported to have starved because of the failure of the cod fishery; whereas codfish were plentiful in the years immediately before and after.[74] Thus, even without the influence of man, animal populations can fluctuate quite drastically. There are many classic examples of how such fluctuations can produce dramatic chain reactions within terrestrial communities; however, such consequences in marine ecosystems have not been well documented. Scientists cannot yet fully explain the reasons for such fluctuations among marine animals. Occasionally, a major environmental disturbance can cause such a phenomenon. In 1882, a submarine disturbance occurred off the mid-Atlantic coast which killed most of the tilefish over a period of several weeks.[75] It was thirty years before the tilefish population recovered sufficiently to again become commercially important. Within this century we have seen natural fluctuations of other Atlantic coast species, especially weakfish, bluefish, and striped bass; similar fluctuations have occurred along all our coasts. The present drastic decline in Bristol Bay salmon is attributed, to a very large degree, to excessively cold water temperatures in the spawning streams since 1969. This situation will continue to cause severe shortages of canned salmon in the marketplace for the next few years, at least.

Man's influence at such times can accelerate changes in population structure through continued heavy fishing. For example, we are concerned that high-seas fishing for the Bristol Bay salmon, even though sanctioned by treaty, can have further serious effects on this resource. There is now ample evidence that the Pacific sardine was replaced by the less desirable California anchovy through a combination of natural conditions unfavorable for successful sardine spawning and heavy fishing pressure. There have been proposals to increase fishing pressure on anchovies to permit the Pacific sardine to recover, but this is being resisted by those who fear that such measures would not bring about the increase in Pacific sardines and, thus, the valuable sport fish resources of the area would be left with insufficient forage. Excessive overfishing by itself can also threaten commercial fisheries, as occurred with the yellowfin sole in the Bering Sea and which is occurring with the groundfish stocks in the northwest Atlantic, the yellowfin tuna fishery in the eastern tropical Pacific, and the Atlantic menhaden.[76]

POPULATION FLUCTUATIONS AND ECOSYSTEM IMPACT

Fishery scientists often have been able to document the increase or decline of fish populations due to combinations of environmental factors and overfishing, or because of overfishing only. However, they have not been able to document the full impact within an ecosystem that can follow the decline of a predominant species. Possibly the most dramatic example of ecosystem impact from the decline of a predominant species is the effect that cyclic fluctuations of Peruvian anchoveta have on the marine birds which depend on them for their food. In 1965, particularly, the decline in anchoveta caused a catastrophic mortality of these birds, to the extent that their numbers are still substantially below pre-1965 levels even though the anchoveta subsequently recovered. Here, too, the impact of the anchoveta fluctuations has had major economic and social effects. The decline in the bird population has seriously reduced fertilizer production from the guano. The current decline in the anchoveta fishery, following the record catch of 12.3 million metric tons in 1970, has been a matter of great concern to Peru, which depends heavily on its exports of fish meal for foreign exchange earnings.[77] The Peruvian government imposed strict limitations during the 1973 fishing season, and there is evidence that the resource is beginning to recover. However, the scarcity of fish meal has been felt throughout the world, including the United States, where this has been a further factor in the increasing costs of pork and poultry, which are fed fish meal to assure rapid growth and high-quality meat.

OVERFISHING AND ITS LONG-TERM EFFECTS

There are clear indications that overfishing or, perhaps, even moderately heavy fishing may exert serious long-term effects on marine communities, especially when coupled with natural fluctuations that are still little understood. It is with these "chain-reaction" events that scientists are now becoming more concerned, especially since a third major factor, man-induced environmental changes, is becoming increasingly important as another possible cause of population fluctuations. To understand these more subtle and perhaps more drastic impacts on marine ecosystems requires much more basic ecological information about the total system.

The factors responsible for drastic fluctuations in fish populations may be grouped into three broad categories: (1) natural fluctuations, i.e., disease, predation, lack of food, marine catastrophies such as earthquakes and hurricanes, and climatic changes that cause shifts in ocean currents or changes in salinity, or alter temperatures during critical life history stages; (2) overfishing by man; and (3) environmental stresses produced by man from pollution and other alterations to the marine habitat. The latter is a more recent factor that will have increasing impact and importance.

How many of these factors interact to cause population fluctuations is highly complex, little understood, and, indeed, may vary from year to year. Until recently, studies on the effects of overfishing on entire marine ecosystems received little emphasis or support as research efforts were largely species-oriented. Likewise until recently, the impact of natural events and pollution on individual stocks had been given little attention. We have learned that certain fishing activities can sustain a marketable level of fish or, conversely, cause declines in yields that necessitate more fishing pressure to attempt to achieve former harvest levels. We have determined that increases in the abundance of so-called industrial fish that are undesirable for marketing can result from overfishing of marketable fish. There is similar evidence, from efforts to manage lake fisheries, supporting the general conclusion that when the stock of desirable fish declines it will be replaced by one or more species that are less desirable.

Concern about the larger impact of overfishing on total ocean ecosystems is a real one. We are at this time, however, unable to predict specific effects such as, for example, the long-range implications of annually removing 1 million or more metric tons of fish out of a given ecosystem, such as the North Atlantic, the eastern Bering Sea, the Gulf of Mexico; and the longer term effects of intense overfishing on a given species or groups of species upon other life forms. Some of the present research programs in overfishing contribute to knowledge about these larger effects on the ocean ecosystem. But efforts specifically devoted to the effects of overfishing on total ecosystems are limited.

The fishing grounds of the United States have witnessed major changes during the past decade. Our best documentation for overfishing is in the northwest Atlantic--the traditional fishing grounds of New England fishermen. North Atlantic stocks have contributed to the U.S. economy from earliest colonial days. Before 1960, almost all the fishing off New England was done by U.S. vessels.[78] This fleet was developed on the basis of a coastal or nearshore fisheries and comprised vessels under 300 tons. Since 1960, the fleets of the U.S.S.R., Poland, Federal Republic of Germany, and Japan, and other countries, have entered this area. These fleets are primarily composed of larger and highly mobile vessels (240 to 5,000 tons) and have steadily increased both in number and total tonnage, while the U.S. fleet has gradually declined. In terms of standardized units, effective fishing effort has increased four to six times since 1960. This tremendous increase in fishing capacity has resulted in enlarging the scope of the fishery which previously had concentrated on selected groundfish species. As a result, all the major species of fish in many areas are heavily fished now. The Research and Statistics Committee of the International Commission for the Northwest Atlantic Fisheries (ICNAF), which evaluates the effects of fishing on stocks in this area (almost exclusively based on U.S. research), has from time to time advised the Commission that certain stocks were demonstrably overfished. The Commission has set quotas on some species, but often only after the stock size has been severely reduced to the point of adversely affecting production. It is possible that such depletions have already caused changes in species composition that may be difficult to reverse. An example is the apparent increase in abundance of cod and sculpin at the expense of haddock in the northwest Atlantic. Such changes, however, have been demonstrated most conclusively in experimental tanks and relatively small bodies of water. Changes in the oceans need to be monitored for a number of years to determine the effects of fishing on the total ecosystem.

Assessment Studies of Fishing Levels

Fishery management has used single species assessment studies as a major tool to determine the effects of various levels of fishing. In New England, thorough assessments have been made for haddock, yellowtail flounder, and herring. All three species have been fished beyond the level of maximum sustainable yield. Preliminary assessments have been made for numerous other species such as mackerel, scallop, and silver hake. These studies will continue because they provide critical components of the information necessary for fisheries management.

It is doubtful, however, that management based on assessing the status of each stock is capable of producing a management regime that will result in a sustainable yield at or near the maximum for the total biomass; rather, it results in a strong tendency to overfish the system. This is not only because scientists are unable to collect the necessary data and make the required assessments in a short period of time. It also reflects the mixed nature of the fisheries which take many species not sought and not adequately recorded in assessments. Further, it does not take account of species interactions, such as competition for food and space from a species that is increasing to the detriment of one that is declining because of overfishing.

Recognizing the difficulties involved in obtaining annual assessments of each of the species subjected to intensive fishing pressures, the United States took a more direct approach to marine fishery management. The Northeast Fisheries Center of the National Marine Fisheries Service at Woods Hole documented the impact of foreign fishing pressures on the total finfish biomass off the New England coast. Based on this analysis, the United States recommended that the total catch in the internationally managed ICNAF area be reduced from over 1 million metric tons annually to 950,000 metric tons in 1974, and further reduced to 800,000 metric tons in 1975 and 1976 to allow the heavily overfished stocks to recover to former abundance levels. ICNAF member nations accepted this historic approach at a special 1973 meeting in Ottawa. The importance of this management decision cannot be overemphasized, for it is the first time that man has attempted to conserve fish stocks by limiting the catch of the total finfish biomass constituting some 30 species.

The decision could not have been reached had not NMFS been making groundfish surveys in the ICNAF areas for the past two decades. These groundfish surveys, combined with an analysis of commercial catches, provided fishery data that showed conclusively that the stocks were in a dramatic and continuing decline since 1960.

Ecological System Studies

Comprehensive ecological investigations have been formulated by NOAA to acquire a basic understanding of the manner in which natural biotic and abiotic factors control the production of marine fishes. Such an understanding is essential in order to have any reasonable chance of distinguishing between the usually subtle long-term natural changes and those caused by fishing or pollution, and to establish a sound basis for both short and long-term predictions of potential yields and stability of fishery resources. Only modest parts of the programs have been implemented so far. In the North Pacific this broad total ecosystem approach is being used in studies to understand the relation of fur seals to North Pacific fish stocks, and vice versa. Questions being asked are why the Pribilof Island seal herd is not increasing since the number annually harvested has been reduced; is the increased foreign fishing competing with the seals for the groundfish resource? We need specific data to develop models that can give us answers to such questions.

Of importance to overall ecosystem effect are modeling studies of the various population processes driving the system, as well as prototype models of the ecosystem as a whole. Such studies are essential for providing the mathematical framework for meaningful analysis and interpretation of such a complex system, and especially for developing of fishery management models which take into account the total productive capacity of the ecosystem and its dynamic characteristics. Consequently, modeling studies should be an integral part of the development of an ecosystem research program from the beginning.

It is emphasized that modeling on an individual species approach by itself is inadequate. We are now seeing global competition for the dwindling stocks of fish, and it seems quite likely that there is sufficient fishing power in the combined world fleets to overfish all the major grounds far below their capacity to produce finfish on a sustained yield basis.

The demand for protein is so great that we can no longer afford to depend upon a relatively few preferred species, but must begin looking at the total productive capacity of the system in relation to various harvesting strategies. Consequently, more emphasis must be given to measures of total fish biomass. And here is where studies on overfishing and its possible impact on the ecosystem provide empirical first approximations to the total productive capacity.[79] Ultimately, we must acquire a basic understanding of the population processes controlling production in the marine ecosystem, in order to develop truly long-range predictions of the effects. Assessment scientists must work closely with ecologists on the development of dynamic fishery production models that take these processes into account.

Marine Resources Monitoring, Assessment, and Prediction (MARMAP) Program

In response to pressing national needs, NMFS launched the MARMAP program. The continued development of the program is aimed at correcting discrepancies of the past as pointed out in earlier reports to Congress on our marine program needs.[80]

MARMAP is being implemented to satisfy marine assessment needs at a time when it is important to understand the consequences of continued use and abuse of the oceans. It is important now to better define, rapidly survey, assess, and manage fish populations that are all too often overfished

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and, in some instances, damaged beyond repair. For the first time, the professional talent and resources of the hitherto fragmented fishery assessment tasks of NMFS are being combined into a national and international network of related studies of fish populations and their environments. MARMAP now serves as the source for information on fish stock assessments that support the United States position in six international fisheries commissions, for eight bilateral agreements (U.S.S.R., Mexico, Poland, Canada, Korea, and Japan), and for domestic State/Federal fishery development and management initiatives.

The MARMAP Program provides the basic information on the composition, location, and condition of the fishery resources near the United States. This is needed to protect those being heavily fished, to encourage fishing on those that are underutilized, and to allocate them fairly among fishermen.

MARMAP obtains information from two major elements--fishery catch statistics and surveys. Comprehensive analyses of the effects of fishing are supplemented by surveys of stocks that are fished. Surveys are the primary source of information in the case of populations which are not fished or which are fished at a very low level. Actuarial information (age, growth, fecundity, mortality, and recruitment) is obtained for each of the stocks concerned to support international and domestic management programs.

In addition to the basic information on distribution and biomass of finfish required for assessment, these surveys provide a wide variety of biological information needed for ecological assessments, including baseline data contaminants in marine organisms. Furthermore, with only modest additions to cruise schedules, ichthyoplankton and hydrographic sampling can be made concurrently on cruises to provide a large-scale picture of plankton communities in relation to major water masses. Beginning in FY 1974, spring and fall bottom trawl surveys by the United States will provide synoptic coverage from central Nova Scotia to Cape Canaveral, using a standard MARMAP sampling design and data processing format which will facilitate pooling of data and central processing. In addition, other nations (U.S.S.R., Poland, West Germany, France, and Canada) are involved in a coordinated development of bottom trawl surveys from Cape Hatteras to Western Greenland, and standardized MARMAP sampling methods are being established. After initial processing, a significant portion of these data bases will then be available to scientists on the entire U.S. eastern seaboard who are engaged in assessment and ecosystem studies.

SUMMARY

The era of untapped living marine resources will end long before the close of this century. Only informed management decisions can forestall disaster for many species of finfish and shellfish and sustain the productivity of these resources indefinitely.

Overfishing is a classical result of lack of proper management; it has contributed substantially to reduced fish production and may have detrimental effects on the total ecosystem. Fishery scientists have long been concerned with the management of stocks and catch regulations--usually only in the capacity or advisers to legislative bodies. In the past these efforts by the scientists have been largely species oriented. These efforts must certainly continue, but they need to be expanded into multispecie assessments with the means of surveying and monitoring large oceanic areas. Important as these matters are, certain large issues now loom. These deal with possible irreversible trends from excessive removal of fish biomass affecting all ocean areas, the interaction and effects of fish stock depletions, and the possible relation of fishery resources to some warning system that pertains to the health of the oceans overall. MARMAP--the marine resources monitoring and assessment program--is one of the promising new activities that will provide timely sampling and reporting of marine resources and environmental conditions.

CHAPTER VI

UNDERSTANDING THE MARINE ENVIRONMENT

The preceding chapters addressed the specific issues of ocean dumping, ocean pollution, overfishing, and other changes in the marine environment due to man's activities. It was shown that many activities of man have not only acute, immediate effects on the marine environment, but may also have subtle, long-term implications. Although the short-term effects and more localized consequences of ocean pollution are sometimes apparent, as yet we really know surprisingly little about the longer term consequences.

This report has focused largely on specific ocean problems and programs addressed to those problems. Some examples of these problems are: the extensive use of the New York Bight as a waste disposal area, the possible dangers associated with the biological accumulation of toxic substances by marine organisms, the question of where to deposit dredge spoil, and the introduction of petroleum into ocean waters. These are very real and current problems. To some extent, their acute effects can either be demonstrated or predicted. Such assessments are carried out through problem-directed research, and a great deal of this kind of research and monitoring is taking place throughout the United States and in many other countries. This work is essential and must continue to be supported.

By the same token, we cannot properly do our part in protecting the oceans if we fail to give proper emphasis to those kinds of research efforts carried out primarily for the purpose of better defining the fundamental environmental processes against which man's impact must be assessed.

Marine investigators have the all too common experience that in pursuing a particular research objective, their efforts are hampered and the results are sometimes unnecessarily diminished in usefulness because fundamental information is lacking. In these relatively few years of accelerated marine research, it has become apparent that overall efforts in marine research and monitoring must consist of both problem-directed research and the acquisition of reference data and information.

In many situations we simply do not know enough to separate the real problems from the nonproblems. If we are successful in eliminating as problems certain issues that now concern us, we would then be able to channel our resources into those areas that have potentially serious implications for us or for the oceans. Another benefit is that we can expect a mutually reinforcing effect to take place between that research directed at specific environmental problems and that carried out for man's increased comprehension of marine processes.

Research activities carried out primarily for a better comprehension of the marine environment require the integration of multiple disciplines. It is not possible for any single discipline to sort out the intricacies of a marine ecosystem (or any other physical or biological system, for that matter). Another characteristic of this kind of research is that it is concerned in many instances with large-scale spatial and temporal processes in the oceans. The emphasis is on the workings of entire systems.

These large-scale and comprehensive research efforts can be expected to help us answer certain basic questions, such as:

1) How do man's activities affect the ocean, not only locally, but on a regional or even global scale?

2) How do various effects interact?

3) Are we putting into the ocean any substances that could cause unwanted and even irreversible long-term effects -- either on a regional or global basis?

It is difficult to understand these larger effects, yet it is extremely important that we do so. Gaps in our knowledge of the ocean will not be easy to fill. We are dealing with complex and long-term phenomena. Our scientists, for example, understand reasonably well the acute toxic effects of many contaminants on marine organisms. They know much less about low-level chronic effects, which through alterations in spawning, migration, or other behavior, may take their toll over several generations.

A few years ago, for example, there was great concern over the proliferation of the Crown-of-Thorns starfish, which were destroying extensive areas of coral reefs. Some environmentalists thought that this destruction may have resulted from man's interference with the ecosystem. It is now generally accepted that this was a natural condition. There is evidence that this phenomenon has happened in the past, although we do not know why. We now believe man-made causes were not involved. It is clear that we must do a better job of understanding the marine environment if we are to safeguard and utilize it over the long run.

RESEARCH REQUIREMENTS

In the quest for a better understanding of the marine environment, a wide range of research tasks will have to be undertaken. Moreover, the magnitude of the total effort required is beyond the capacities of any single nation. The international programs related to marine research that have been developed in recent years are an essential feature in this endeavor. Some of the more significant of these national and international programs are described later.

Research needs can be grouped under the following headings:

- Baseline Surveys and Monitoring
- Comprehensive Ecosystem Studies
- Research on Basic Ocean Processes

Baseline Surveys and Monitoring

The acquisition of baseline environmental data is the process of determining so-called natural states or natural fluctuations within particular time frames. It involves measuring the parameters under which physical, chemical, and biological systems operate either individually or together. The information obtained represents a baseline or benchmark against which long-term natural changes and man-induced changes can be identified, separated, and measured quantitatively and qualitatively. Baseline surveys are a fundamental requirement in any broad-scale investigation of hydrologic systems. The ideal situation is to obtain baseline data on systems while they are still relatively unaffected by the activities of man; however, baseline data may also be used to quantify the effects of existing pollution.

Unfortunately, there are still many unresolved difficulties in obtaining adequate baseline data. In particular, wide natural fluctuations occur in ocean systems, both spatially and temporally. We must be aware of these variations and take them into account when designing statistically adequate baseline programs. However, statistical adequacy implies repetition, which in turn costs more in time and dollars. We are thus hoping to concentrate on parameters that are the most meaningful for each problem at hand, but still keeping the approach broad enough so that the survey results can be considered a sufficient baseline.

In addition, a great deal of existing data have not previously been evaluated for this purpose. There are data on decades of North Pacific oceanic fishery investigations, for example, that have been analyzed and processed to provide information only for fishery managers and negotiators. Such data might prove valuable if reprocessed for baseline purposes.

Research to sort out the man-induced from the naturally occurring phenomena requires a comprehensive system of regional, national, and international monitoring capable of making observations of requisite variables at appropriate frequencies. Comparing the data derived from a well-conceived and efficiently operated monitoring system against the previously measured baseline data will provide early warning of any changes occurring in a given marine environment. The system would also provide a means by which to measure the efficacy of any remedial actions taken. The elements of such a monitoring system might include:

1) Physical and Chemical Monitoring - to obtain time series measurements of key physical and chemical properties, including contaminants, in a given water column and its underlying sediments;

2) Biological Monitoring - to obtain periodic quantitative and qualitative information of a given biota, including the concentrations of contaminants in organisms; and,

3) Economic and Statistical Monitoring - to gather periodic data concerning industrial, agricultural, and energy-producing activities.

As an example of a monitoring activity, UN Environment Programme (UNEP) has proposed the establishment of a global monitoring system as part of the EARTHWATCH concept fostered at the 1972 UN Conference on the Human Environment. The United States expects to participate in this important international endeavor by integrating national monitoring programs into EARTHWATCH.[81]

Comprehensive Ecosystem Studies

The aim of comprehensive ecosystem studies is to understand the interactions between living organisms and their environment. This involves obtaining a baseline biological and environmental understanding of the area under study and determining cause-effect relationships among components as various changes occur in the ecosystem. It is also necessary to determine the nature of these ecological interactions and their magnitude. For example, we are interested in what happens to the flow of energy within the ecosystem with respect to both natural events and those induced by man. To interpret ecosystem interactions, there must be a thorough comprehension of the physical, chemical, and geological nature of the environment and the distribution, abundance, and physiological condition of the organisms.

Research on Basic Ocean Processes

These studies focus on the physical, chemical, and geological systems of the ocean. They are concerned with understanding the dynamics of ocean currents, wave action, storm surges, upwelling, tsunamis, the air-water interface, the water-sediment interface, and similar phenomena. In this area of research we are interested in large-scale spatial and temporal processes. Studies of basic ocean processes include analyses of physical properties and processes; diagnostic models; simulation models of currents, circulation, surface and internal waves; and so forth.

These investigations are by their very nature comprehensive, requiring considerable cooperation among specialists in many disciplines. Moreover, the expanses of ocean that are frequently involved and the magnitude of the tasks are factors that tend to encourage binational or international cooperation. This is a major reason that many of the present broad-scale investigations of basic ocean processes are planned and carried out under some form of bilateral or international agreement. Examples of this collaboration are the International Decade of Ocean Exploration (IDOE) and the joint United States/Canada field study of Lake Ontario.

CURRENT PROGRAMS

A number of programs now underway include elements of the above interrelated research approaches. Some examples of these efforts are described below:

International Decade of Ocean Exploration (IDOE)

IDOE is a long-term international, cooperative program to enhance use of the ocean and its resources for the benefit of mankind. IDOE was proposed in 1968 by the President of the United States.[82] In response to this U.S. initiative, the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) lent its support to the "concept of an expanded, accelerated, long-term, and sustained program of exploration of the oceans and their resources including international programs, planned and coordinated on a worldwide basis." In December 1968, the UN General Assembly formally endorsed the IDOE concept and invited member states to submit to IOC the proposals for national and international scientific programs.

After a joint study of U.S. marine research priorities by the National Academy of Sciences and the National Academy of Engineering,[83] the U.S. Government formally announced in 1969 the U.S. intention to participate in IDOE and assigned responsibility for planning, managing, and funding the U.S. program to the National Science Foundation (NSF).

Four priority areas were chosen for U.S. program attention: (1) environmental quality, (2) environmental forecasting, (3) seabed assessment, and (4) living resources. These program areas are briefly described.

Environmental Quality and Environmental Forecasting. One of three major studies in the Environmental Quality Program, the Geochemical Ocean Sections Study (GEOSECS) examines the concentration, injection, and transport of the chemical constituents of the ocean in surface and deep water. This multiyear project, designed to provide global baseline data and to promote understanding of physical oceanic processes, involves geochemists from 15 U.S. universities and participation from Canada, France, the Federal Republic of Germany, India, Italy, and Japan. Major portions of the U.S. program are based at the Woods Hole Oceanographic Institution and the Scripps Institution of Oceanography. The results from this effort will be relevant to some aspects of the Environmental Forecasting Program.

The GEOSECS research plan is to measure in detail selected oceanic constituents at certain depths along Arctic and Antarctic midocean sections in both the Atlantic and Pacific Oceans and to provide, for the first time, a set of more than 40 physical and chemical parameters determined from the same water samples. These data will not only provide input for quantitative studies of oceanic mixing but will serve as a baseline for the concentration levels of metals and fission products in the deep sea. In addition, the data will be relevant to some aspects of the Environmental Forecasting Program. Research based on the GEOSECS cruises will be carried out at many institutions throughout the world for several years.

Other aspects of the IDOE Environmental Quality Program are described in Chapter III.

Seabed Assessment. The Seabed Assessment Program supports studies of the continental margins, midoceanic ridges, and deep seabeds, which seek to identify new areas of natural resources, particularly petroleum and hard minerals, and to enhance understanding of the natural processes that produce these resources.

Scientists are studying the continental margins on both sides of the South Atlantic, and along the coasts of Peru and Chile. Field work for an extensive geophysical and geological survey of the East Atlantic Continental Margin was completed in 1973. Studies that complement the East Atlantic work are now underway off Brazil and Argentina. Tentative plans for new studies in East and Southeast Asia during FY 1975 are being considered.

Understanding the origin of metalliferous ores and metal-bearing sediments is the goal of projects on active spreading zones in the deep ocean, including the Mid-Atlantic Ridge and the East Pacific Rise. Complementary work on the Mid-Atlantic Ridge involves use of submersibles for direct observations of geological processes in the rift valley. Preliminary site surveys and initial dives by French submersibles were completed during the summer of 1973. French and United States scientists will have joint operations in 1974.

The location and cause of formation of economically valuable manganese nodules have been the focus of a major seabed assessment project. One product of the project is a series of maps showing the worldwide distribution and chemical composition of the nodules. These maps have been distributed, both nationally and internationally, to oceanographic institutions and to private industry. Other studies have been completed on the environmental conditions under which nodules grow, their rate of growth, and changes over time.

Living Resources. The objective of the Living Resources Program is to provide a scientific foundation for better management and use of the ocean's biological resources. The optimal use of renewable marine resources depends on knowledge of the natural productivity of the seas, regional differences, efficiencies of energy transfer from photosynthetic plants to harvestable species, and the population dynamics and maximum sustainable yield of different species.

The U.S. IDOE program has initiated a long-term research project called the Coastal Upwelling Ecosystems Analysis (CUEA). The primary objective of CUEA is to understand the coastal upwelling ecosystem so that responses of the system to change may be predicted from monitoring a few key biological, oceanographic, and/or meteorological variables. The CUEA project stresses the development of both biological and physical oceanography, with strong emphasis on systems modeling.

Upwelling phenomena are significant because an estimated 50 percent of the world's fish supply comes from upwelling areas. Upwelling usually occurs along continental west coasts at low to midlatitudes. When favorable winds blow toward the Equator, the Earth's rotation produces an offshore drift of the upper ocean layers along the coast. This drift, in turn, produces an upwelling of colder, deeper waters near the coast, often a narrow band 10 to 15 km wide. The rich nutrients of the upwelled deeper waters cause a rapid growth in the plankton population upon which prodigious numbers of fish feed and grow.

JOINT-I, one of the first large-scale international experiments on a marine ecosystem, will attempt to understand the upwelling phenomenon. At present, the Federal Republic of Germany, France, Spain, and the United States are the primary participants. Ghana, Ivory Coast, Mauritania, Morocco, and Senegal also plan to participate. At least six ships are expected to take part, including three from the United States and three from other countries. A JOINT-II has been proposed for 1976 in the Peruvian upwelling region.

MESA New York Bight Project

In addition to addressing the ocean dumping problem described in Chapter II, NOAA's MESA New York Bight Project is directing considerable attention to the study of total ecosystem processes to provide a basis for evaluating other important environmental issues in the Bight, such as siting and operation of offshore structures.

This project includes large-scale field studies of such ocean processes as physical circulation, sediment transport, and biological productivity. The project is also developing a conceptual model of the New York Bight ecosystem, its processes, and rates of change. In scope, the MESA Project is probably one of the most comprehensive environmental analyses of a major coastal area ever initiated.

The basic knowledge of the ecosystem being developed by the project is needed by those who decide how Bight waters are to be used and who need assistance in considering specific issues within the larger context of the total environment.

Global Investigation of Pollution of the Marine Environment (GIPME)

Another international interdisciplinary marine research program which is about to get underway is GIPME of the Intergovernmental Oceanographic Commission. It is a cooperative program of scientific research on ocean pollution, carried out primarily in the national laboratories of the cooperating nations. It will deal with sources and inputs of pollutants in the ocean; their transfer and transportation by physical, chemical, and biological processes; their effects on marine organisms; and their fate in the marine environment.

GIPME is to be directed toward studying pollution of the oceans on a regional basis and, where appropriate, on a global basis. GIPME will take into account the consequences of marine pollution, especially those related to human health, living resources and their use, climatic effects, and amenities, as well as more indirect ecological effects. GIPME also will define and provide the basis for a program of marine pollution monitoring. As yet, it is still in the planning stages and country participation is still undetermined.

The following objectives have been established:

- A GIPME comprehensive plan to provide an appropriate framework for promoting, coordinating, and guiding the scientific research essential to the solution of the complex problems of marine pollution will be developed;

- An adequate scientific basis for marine pollution assessment and monitoring will be achieved;

- Requirements of the various regions of the world for technical and material assistance, training, and organization will be identified, to enable countries to undertake regional marine pollution research and monitoring; and,

- Analytical methods will be standardized.

International Field Year for the Great Lakes (IFYGL)

IFYGL is an experimental program designed to improve knowledge of the limnology, hydrology, and meteorology of Lake Ontario and the Ontario Basin. The field operations for IFYGL were completed in 1973. The basic objective was to provide a scientific basis for improved management of Great Lakes water quantity and quality, and surrounding land use. Approximately 1,000 United States and Canadian participants from Federal, State, and provincial agencies, universities, and private institutions were involved.

The data collection program of IFYGL was the most comprehensive so far undertaken in the Great Lakes with regard to the sampling network intensity in space and time spanning the Lake and Basin, the numbers and types of data acquisition systems, and the use of advanced data acquisition systems.

SUMMARY

The marine environment is extremely complex, consisting of several interacting chemical, physical, and biological components and systems. Comprehensive understanding of the marine environment requires intensive long- and short-range studies, measurements, observations, and experiments of fragile marine ecosystems that are often delicately balanced against natural and man-made alterations. Some alterations can be acute, catastrophic, and readily detected. Others are more subtle and chronic; their manifestations may occur over generations or years, or may never be detected in our lifetime.

Because our understanding of the marine environment is woefully incomplete, further multidisciplinary research is essential. This research must extend beyond local or regional boundaries so as to involve oceanic, hemispheric, and global studies.

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APPENDIX B

Public Law 92-532
92nd Congress, H. R. 9727
October 23, 1972

An Act

86 STAT. 1052

To regulate the transportation for dumping, and the dumping, of material into ocean waters, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Marine Protection, Research, and Sanctuaries Act of 1972".

Marine Protection, Research, and Sanctuaries Act of 1972.

FINDING, POLICY, AND PURPOSE

SEC. 2. (a) Unregulated dumping of material into ocean waters endangers human health, welfare, and amenities, and the marine environment, ecological systems, and economic potentialities.

(b) The Congress declares that it is the policy of the United States to regulate the dumping of all types of materials into ocean waters and to prevent or strictly limit the dumping into ocean waters of any material which would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities.

To this end, it is the purpose of this Act to regulate the transportation of material from the United States for dumping into ocean waters, and the dumping of material, transported from outside the United States, if the dumping occurs in ocean waters over which the United States has jurisdiction or over which it may exercise control, under accepted principles of international law, in order to protect its territory or territorial sea.

DEFINITIONS

SEC. 3. For the purposes of this Act the term—

(a) "Administrator" means the Administrator of the Environmental Protection Agency.

(b) "Ocean waters" means those waters of the open seas lying seaward of the base line from which the territorial sea is measured, as provided for in the Convention on the Territorial Sea and the Contiguous Zone (15 UST 1606; TIAS 5639).

(c) "Material" means matter of any kind or description, including, but not limited to, dredged material, solid waste, incinerator residue, garbage, sewage, sewage sludge, munitions, radiological, chemical, and biological warfare agents, radioactive materials, chemicals, biological and laboratory waste, wreck or discarded equipment, rock, sand, excavation debris, and industrial, municipal, agricultural, and other waste; but such term does not mean oil within the meaning of section 11 of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1161) and does not mean sewage from vessels within the meaning of section 13 of such Act (33 U.S.C. 1163).

Ante, p. 816.

(d) "United States" includes the several States, the District of Columbia, the Commonwealth of Puerto Rico, the Canal Zone, the territories and possessions of the United States, and the Trust Territory of the Pacific Islands.

(e) "Person" means any private person or entity, or any officer, employee, agent, department, agency, or instrumentality of the Federal Government, of any State or local unit of government, or of any foreign government.

(f) "Dumping" means a disposition of material: *Provided,* That it does not mean a disposition of any effluent from any outfall structure to the extent that such disposition is regulated under the provisions of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1151–1175), under the provisions of section 13 of the Rivers and Harbors Act

30 Stat. 1152. 68 Stat. 921.

of 1899, as amended (33 U.S.C. 407), or under the provisions of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011, et seq.), nor does it mean a routine discharge of effluent incidental to the propulsion of, or operation of motor-driven equipment on, vessels: *Provided further*, That it does not mean the construction of any fixed structure or artificial island nor the intentional placement of any device in ocean waters or on or in the submerged land beneath such waters, for a purpose other than disposal, when such construction or such placement is otherwise regulated by Federal or State law or occurs pursuant to an authorized Federal or State program: *And provided further*, That it does not include the deposit of oyster shells, or other materials when such deposit is made for the purpose of developing, maintaining, or harvesting fisheries resources and is otherwise regulated by Federal or State law or occurs pursuant to an authorized Federal or State program.

(g) "District court of the United States" includes the District Court of Guam, the District Court of the Virgin Islands, the District Court of Puerto Rico, the District Court of the Canal Zone, and in the case of American Samoa and the Trust Territory of the Pacific Islands, the District Court of the United States for the District of Hawaii, which court shall have jurisdiction over actions arising therein.

(h) "Secretary" means the Secretary of the Army.

(i) "Dredged material" means any material excavated or dredged from the navigable waters of the United States.

(j) "High-level radioactive waste" means the aqueous waste resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated waste from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuels, or irradiated fuel from nuclear power reactors.

(k) "Transport" or "transportation" refers to the carriage and related handling of any material by a vessel, or by any other vehicle, including aircraft.

TITLE I—OCEAN DUMPING

PROHIBITED ACTS

SEC. 101. (a) No person shall transport from the United States any radiological, chemical, or biological warfare agent or any high-level radioactive waste, or except as may be authorized in a permit issued under this title, and subject to regulations issued under section 108 hereof by the Secretary of the Department in which the Coast Guard is operating, any other material for the purpose of dumping it into ocean waters.

(b) No person shall dump any radiological, chemical, or biological warfare agent or any high-level radioactive waste, or, except as may be authorized in a permit issued under this title, any other material, transported from any location outside the United States, (1) into the territorial sea of the United States, or (2) into a zone contiguous to the territorial sea of the United States, extending to a line twelve nautical miles seaward from the base line from which the breadth of the territorial sea is measured, to the extent that it may affect the territorial sea or the territory of the United States.

(c) No officer, employee, agent, department, agency, or instrumentality of the United States shall transport from any location outside the United States any radiological, chemical, or biological warfare agent or any high-level radioactive waste, or, except as may be authorized in a permit issued under this title, any other material for the purpose of dumping it into ocean waters.

ENVIRONMENTAL PROTECTION AGENCY PERMITS

SEC. 102. (a) Except in relation to dredged material, as provided for in section 103 of this title, and in relation to radiological, chemical, and biological warfare agents and high-level radioactive waste, as provided for in section 101 of this title, the Administrator may issue permits, after notice and opportunity for public hearings, for the transportation from the United States or, in the case of an agency or instrumentality of the United States, for the transportation from a location outside the United States, of material for the purpose of dumping it into ocean waters, or for the dumping of material into the waters described in section 101(b), where the Administrator determines that such dumping will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities. The Administrator shall establish and apply criteria for reviewing and evaluating such permit applications, and, in establishing or revising such criteria, shall consider, but not be limited in his consideration to, the following:

(A) The need for the proposed dumping.

(B) The effect of such dumping on human health and welfare, including economic, esthetic, and recreational values.

(C) The effect of such dumping on fisheries resources, plankton, fish, shellfish, wildlife, shore lines and beaches.

(D) The effect of such dumping on marine ecosystems, particularly with respect to—

(i) the transfer, concentration, and dispersion of such material and its byproducts through biological, physical, and chemical processes,

(ii) potential changes in marine ecosystem diversity, productivity, and stability, and

(iii) species and community population dynamics.

(E) The persistence and permanence of the effects of the dumping.

(F) The effect of dumping particular volumes and concentrations of such materials.

(G) Appropriate locations and methods of disposal or recycling, including land-based alternatives and the probable impact of requiring use of such alternate locations or methods upon considerations affecting the public interest.

(H) The effect on alternate uses of oceans, such as scientific study, fishing, and other living resource exploitation, and nonliving resource exploitation.

(I) In designating recommended sites, the Administrator shall utilize wherever feasible locations beyond the edge of the Continental Shelf.

In establishing or revising such criteria, the Administrator shall consult with Federal, State, and local officials, and interested members of the general public, as may appear appropriate to the Administrator. With respect to such criteria as may affect the civil works program of the Department of the Army, the Administrator shall also consult with the Secretary. In reviewing applications for permits, the Administrator shall make such provision for consultation with interested Federal and State agencies as he deems useful or necessary. No permit shall be issued for a dumping of material which will violate applicable water quality standards.

(b) The Administrator may establish and issue various categories of permits, including the general permits described in section 104(c).

(c) The Administrator may, considering the criteria established pursuant to subsection (a) of this section, designate recommended sites or times for dumping and, when he finds it necessary to protect critical areas, shall, after consultation with the Secretary, also designate sites or times within which certain materials may not be dumped.

(d) No permit is required under this title for the transportation for dumping or the dumping of fish wastes, except when deposited in harbors or other protected or enclosed coastal waters, or where the Administrator finds that such deposits could endanger health, the environment, or ecological systems in a specific location. Where the Administrator makes such a finding, such material may be deposited only as authorized by a permit issued by the Administrator under this section.

CORPS OF ENGINEERS PERMITS

SEC. 103. (a) Subject to the provisions of subsections (b), (c), and (d) of this section, the Secretary may issue permits, after notice and opportunity for public hearings, for the transportation of dredged material for the purpose of dumping it into ocean waters, where the Secretary determines that the dumping will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities.

(b) In making the determination required by subsection (a), the Secretary shall apply those criteria, established pursuant to section 102(a), relating to the effects of the dumping. Based upon an evaluation of the potential effect of a permit denial on navigation, economic and industrial development, and foreign and domestic commerce of the United States, the Secretary shall make an independent determination as to the need for the dumping. The Secretary shall also make an independent determination as to other possible methods of disposal and as to appropriate locations for the dumping. In considering appropriate locations, he shall, to the extent feasible, utilize the recommended sites designated by the Administrator pursuant to section 102(c).

(c) Prior to issuing any permit under this section, the Secretary shall first notify the Administrator of his intention to do so. In any case in which the Administrator disagrees with the determination of the Secretary as to compliance with the criteria established pursuant to section 102(a) relating to the effects of the dumping or with the restrictions established pursuant to section 102(c) relating to critical areas, the determination of the Administrator shall prevail. Unless the Administrator grants a waiver pursuant to subsection (d), the Secretary shall not issue a permit which does not comply with such criteria and with such restrictions.

Waiver.

(d) If, in any case, the Secretary finds that, in the disposition of dredged material, there is no economically feasible method or site available other than a dumping site the utilization of which would result in non-compliance with the criteria established pursuant to section 102(a) relating to the effects of dumping or with the restrictions established pursuant to section 102(c) relating to critical areas, he shall so certify and request a waiver from the Administrator of the specific requirements involved. Within thirty days of the receipt of the waiver request, unless the Administrator finds that the dumping of the material will result in an unacceptably adverse impact on municipal water supplies, shell-fish beds, wildlife, fisheries (including spawning and breeding areas), or recreational areas, he shall grant the waiver.

(e) In connection with Federal projects involving dredged material, the Secretary may, in lieu of the permit procedure, issue regulations which will require the application to such projects of the same criteria, other factors to be evaluated, the same procedures, and the same requirements which apply to the issuance of permits under subsections (a), (b), (c), and (d) of this section.

PERMIT CONDITIONS

SEC. 104. (a) Permits issued under this title shall designate and include (1) the type of material authorized to be transported for dumping or to be dumped; (2) the amount of material authorized to be transported for dumping or to be dumped; (3) the location where such transport for dumping will be terminated or where such dumping will occur; (4) the length of time for which the permits are valid and their expiration date; (5) any special provisions deemed necessary by the Administrator or the Secretary, as the case may be, after consultation with the Secretary of the Department in which the Coast Guard is operating, for the monitoring and surveillance of the transportation or dumping; and (6) such other matters as the Administrator or the Secretary, as the case may be, deems appropriate.

(b) The Administrator or the Secretary, as the case may be, may prescribe such processing fees for permits and such reporting requirements for actions taken pursuant to permits issued by him under this title as he deems appropriate.

(c) Consistent with the requirements of sections 102 and 103, but in lieu of a requirement for specific permits in such case, the Administrator or the Secretary, as the case may be, may issue general permits for the transportation for dumping, or dumping, or both, of specified materials or classes of materials for which he may issue permits, which he determines will have a minimal adverse environmental impact.

(d) Any permit issued under this title shall be reviewed periodically and, if appropriate, revised. The Administrator or the Secretary, as the case may be, may limit or deny the issuance of permits, or he may alter or revoke partially or entirely the terms of permits issued by him under this title, for the transportation for dumping, or for the dumping, or both, of specified materials or classes of materials, where he finds that such materials cannot be dumped consistently with the criteria and other factors required to be applied in evaluating the permit application. No action shall be taken under this subsection unless the affected person or permittee shall have been given notice and opportunity for a hearing on such action as proposed. Review.

(e) The Administrator or the Secretary, as the case may be, shall require an applicant for a permit under this title to provide such information as he may consider necessary to review and evaluate such application.

(f) Information received by the Administrator or the Secretary, as the case may be, as a part of any application or in connection with any permit granted under this title shall be available to the public as a matter of public record, at every stage of the proceeding. The final determination of the Administrator or the Secretary, as the case may be, shall be likewise available. Public information.

(g) A copy of any permit issued under this title shall be placed in a conspicuous place in the vessel which will be used for the transportation or dumping authorized by such permit, and an additional copy shall be furnished by the issuing official to the Secretary of the department in which the Coast Guard is operating, or its designee.

PENALTIES

SEC. 105. (a) Any person who violates any provision of this title, or of the regulations promulgated under this title, or a permit issued under this title shall be liable to a civil penalty of not more than $50,000 for each violation to be assessed by the Administrator. No penalty shall be assessed until the person charged shall have been given notice and an opportunity for a hearing of such violation. In determining the amount of the penalty, the gravity of the violation, prior violations, and the demonstrated good faith of the person charged in attempting to achieve rapid compliance after notification of a violation shall be considered by said Administrator. For good cause shown, the Administrator may remit or mitigate such penalty. Upon failure of the offending party to pay the penalty, the Administrator may request the Attorney General to commence an action in the appropriate district court of the United States for such relief as may be appropriate.

(b) In addition to any action which may be brought under subsection (a) of this section, a person who knowingly violates this title, regulations promulgated under this title, or a permit issued under this title shall be fined not more than $50,000, or imprisoned for not more than one year, or both.

(c) For the purpose of imposing civil penalties and criminal fines under this section, each day of a continuing violation shall constitute a separate offense as shall the dumping from each of several vessels, or other sources.

(d) The Attorney General or his delegate may bring actions for equitable relief to enjoin an imminent or continuing violation of this title, of regulations promulgated under this title, or of permits issued under this title, and the district courts of the United States shall have jurisdiction to grant such relief as the equities of the case may require.

Liability.

(e) A vessel, except a public vessel within the meaning of section 13 of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1163), used in a violation, shall be liable in rem for any civil penalty assessed or criminal fine imposed and may be proceeded against in any district court of the United States having jurisdiction thereof; but no vessel shall be liable unless it shall appear that one or more of the owners, or bareboat charterers, was at the time of the violation a consenting party or privy to such violation.

Ante, p. 816.

Ante, pp. 1054, 1055.

(f) If the provisions of any permit issued under section 102 or 103 are violated, the Administrator or the Secretary, as the case may be, may revoke the permit or may suspend the permit for a specified period of time. No permit shall be revoked or suspended unless the permittee shall have been given notice and opportunity for a hearing on such violation and proposed suspension or revocation.

(g)(1) Except as provided in paragraph (2) of this subsection any person may commence a civil suit on his own behalf to enjoin any person, including the United States and any other governmental instrumentality or agency (to the extent permitted by the eleventh amendment to the Constitution), who is alleged to be in violation of any prohibition, limitation, criterion, or permit established or issued by or under this title. The district courts shall have jurisdiction, without regard to the amount in controversy or the citizenship of the parties, to enforce such prohibition, limitation, criterion, or permit, as the case may be.

(2) No action may be commenced—

(A) prior to sixty days after notice of the violation has been given to the Administrator or to the Secretary, and to any alleged violator of the prohibition, limitation, criterion, or permit; or

(B) if the Attorney General has commenced and is diligently prosecuting a civil action in a court of the United States to require compliance with the prohibition, limitation, criterion, or permit; or

(C) if the Administrator has commenced action to impose a penalty pursuant to subsection (a) of this section, or if the Administrator, or the Secretary, has initiated permit revocation or suspension proceedings under subsection (f) of this section; or

(D) if the United States has commenced and is diligently prosecuting a criminal action in a court of the United States or a State to redress a violation of this title.

(3) (A) Any suit under this subsection may be brought in the judicial district in which the violation occurs.

(B) In any such suit under this subsection in which the United States is not a party, the Attorney General, at the request of the Administrator or Secretary, may intervene on behalf of the United States as a matter of right.

(4) The court, in issuing any final order in any suit brought pursuant to paragraph (1) of this subsection may award costs of litigation (including reasonable attorney and expert witness fees) to any party, whenever the court determines such award is appropriate.

(5) The injunctive relief provided by this subsection shall not restrict any right which any person (or class of persons) may have under any statute or common law to seek enforcement of any standard or limitation or to seek any other relief (including relief against the Administrator, the Secretary, or a State agency).

(h) No person shall be subject to a civil penalty or to a criminal fine or imprisonment for dumping materials from a vessel if such materials are dumped in an emergency to safeguard life at sea. Any such emergency dumping shall be reported to the Administrator under such conditions as he may prescribe. Exception.

RELATIONSHIP TO OTHER LAWS

SEC. 106. (a) After the effective date of this title, all licenses, permits, and authorizations other than those issued pursuant to this title shall be void and of no legal effect, to the extent that they purport to authorize any activity regulated by this title, and whether issued before or after the effective date of this title.

(b) The provisions of subsection (a) shall not apply to actions taken before the effective date of this title under the authority of the Rivers and Harbors Act of 1899 (30 Stat. 1151), as amended (33 U.S.C. 401 et. seq.).

(c) Prior to issuing any permit under this title, if it appears to the Administrator that the disposition of material, other than dredged material, may adversely affect navigation in the territorial sea of the United States, or in the approaches to any harbor of the United States, or may create an artificial island on the Outer Continental Shelf, the Administrator shall consult with the Secretary and no permit shall be issued if the Secretary determines that navigation will be unreasonably impaired.

(d) After the effective date of this title, no State shall adopt or enforce any rule or regulation relating to any activity regulated by this title. Any State may, however, propose to the Administrator criteria relating to the dumping of materials into ocean waters within its jurisdiction, or into other ocean waters to the extent that such dumping may affect waters within the jurisdiction of such State, and if the Administrator determines, after notice and opportunity for hearing, that the proposed criteria are not inconsistent with the purposes of this title, may adopt those criteria and may issue regulations to implement such criteria. Such determination shall be made by the Administrator within one hundred and twenty days of receipt of the proposed criteria. For the purposes of this subsection, the term "State" means any State, interstate or regional authority, Federal territory or Commonwealth or the District of Columbia.

"State."

(e) Nothing in this title shall be deemed to affect in any manner or to any extent any provision of the Fish and Wildlife Coordination Act as amended (16 U.S.C. 661–666c).

60 Stat. 1080; 72 Stat. 563.

ENFORCEMENT

SEC. 107. (a) The Administrator or the Secretary, as the case may be, may, whenever appropriate, utilize by agreement, the personnel, services and facilities of other Federal departments, agencies, and instrumentalities, or State agencies or instrumentalities, whether on a reimbursable or a nonreimbursable basis, in carrying out his responsibilities under this title.

(b) The Administrator or the Secretary may delegate responsibility and authority for reviewing and evaluating permit applications, including the decision as to whether a permit will be issued, to an officer of his agency, or he may delegate, by agreement, such responsibility and authority to the heads of other Federal departments or agencies, whether on a reimbursable or nonreimbursable basis.

(c) The Secretary of the department in which the Coast Guard is operating shall conduct surveillance and other appropriate enforcement activity to prevent unlawful transportation of material for dumping, or unlawful dumping. Such enforcement activity shall include, but not be limited to, enforcement of regulations issued by him pursuant to section 108, relating to safe transportation, handling, carriage, storage, and stowage. The Secretary of the Department in which the Coast Guard is operating shall supply to the Administrator and to the Attorney General, as appropriate, such information of enforcement activities and such evidentiary material assembled as they may require in carrying out their duties relative to penalty assessments, criminal prosecutions, or other actions involving litigation pursuant to the provisions of this title.

Infra.

REGULATIONS

SEC. 108. In carrying out the responsibilities and authority conferred by this title, the Administrator, the Secretary, and the Secretary of the department in which the Coast Guard is operating are authorized to issue such regulations as they may deem appropriate.

INTERNATIONAL COOPERATION

SEC. 109. The Secretary of State, in consultation with the Administrator, shall seek effective international action and cooperation to insure protection of the marine environment, and may, for this purpose, formulate, present, or support specific proposals in the United Nations and other competent international organizations for the development of appropriate international rules and regulations in support of the policy of this Act.

EFFECTIVE DATE AND SAVINGS PROVISIONS

SEC. 110. (a) This title shall take effect six months after the date of the enactment of this Act.

(b) No legal action begun, or right of action accrued, prior to the effective date of this title shall be affected by any provision of this title.

SEC. 111. There are hereby authorized to be appropriated not to exceed $3,600,000 for fiscal year 1973, and not to exceed $5,500,000 for fiscal year 1974, for the purposes and administration of this title, and for succeeding fiscal years only such sums as the Congress may authorize by law. Appropriation.

SEC. 112. The Administrator shall report annually, on or before June 30 of each year, with the first report to be made on or before June 30, 1973 to the Congress, on his administration of this title, including recommendations for additional legislation if deemed necessary. Annual report to Congress.

TITLE II—COMPREHENSIVE RESEARCH ON OCEAN DUMPING

SEC. 201. The Secretary of Commerce, in coordination with the Secretary of the Department in which the Coast Guard is operating and with the Administrator shall, within six months of the enactment of this Act, initiate a comprehensive and continuing program of monitoring and research regarding the effects of the dumping of material into ocean waters or other coastal waters where the tide ebbs and flows or into the Great Lakes or their connecting waters and shall report from time to time, not less frequently than annually, his findings (including an evaluation of the short-term ecological effects and the social and economic factors involved) to the Congress. Report to Congress.

SEC. 202. (a) The Secretary of Commerce, in consultation with other appropriate Federal departments, agencies, and instrumentalities shall, within six months of the enactment of this Act, initiate a comprehensive and continuing program of research with respect to the possible long-range effects of pollution, overfishing, and man-induced changes of ocean ecosystems. In carrying out such research, the Secretary of Commerce shall take into account such factors as existing and proposed international policies affecting oceanic problems, economic considerations involved in both the protection and the use of the oceans, possible alternatives to existing programs, and ways in which the health of the oceans may best be preserved for the benefit of succeeding generations of mankind.

(b) In carrying out his responsibilities under this section, the Secretary of Commerce, under the foreign policy guidance of the President and pursuant to international agreements and treaties made by

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the President with the advice and consent of the Senate, may act alone or in conjunction with any other nation or group of nations, and shall make known the results of his activities by such channels of communication as may appear appropriate.

Annual report to Congress.

(c) In January of each year, the Secretary of Commerce shall report to the Congress on the results of activities undertaken by him pursuant to this section during the previous fiscal year.

(d) Each department, agency, and independent instrumentality of the Federal Government is authorized and directed to cooperate with the Secretary of Commerce in carrying out the purposes of this section and, to the extent permitted by law, to furnish such information as may be requested.

Inter-agency agreements.

(e) The Secretary of Commerce, in carrying out his responsibilities under this section, shall, to the extent feasible utilize the personnel, services, and facilities of other Federal departments, agencies, and instrumentalities (including those of the Coast Guard for monitoring purposes), and is authorized to enter into appropriate inter-agency agreements to accomplish this action.

Federal-State cooperation.

SEC. 203. The Secretary of Commerce shall conduct and encourage, cooperate with, and render financial and other assistance to appropriate public (whether Federal, State, interstate, or local) authorities, agencies, and institutions, private agencies and institutions, and individuals in the conduct of, and to promote the coordination of, research, investigations, experiments, training, demonstrations, surveys, and studies for the purpose of determining means of minimizing or ending all dumping of materials within five years of the effective date of this Act.

Appropriation.

SEC. 204. There are authorized to be appropriated for the first fiscal year after this Act is enacted and for the next two fiscal years thereafter such sums as may be necessary to carry out this title, but the sums appropriated for any such fiscal year may not exceed $6,000,000.

TITLE III—MARINE SANCTUARIES

"Secretary."

SEC. 301. Notwithstanding the provisions of subsection (h) of section 3 of this Act, the term "Secretary", when used in this title, means Secretary of Commerce.

SEC. 302. (a) The Secretary, after consultation with the Secretaries of State, Defense, the Interior, and Transportation, the Administrator, and the heads of other interested Federal agencies, and with the approval of the President, may designate as marine sanctuaries those areas of the ocean waters, as far seaward as the outer edge of the Continental Shelf, as defined in the Convention of the Continental Shelf (15 U.S.T. 74; TIAS 5578), of other coastal waters where the tide ebbs and flows, or of the Great Lakes and their connecting waters, which he determines necessary for the purpose of preserving or restoring such areas for their conservation, recreational, ecological, or esthetic values. The consultation shall include an opportunity to review and comment on a specific proposed designation.

15 UST 471.

(b) Prior to designating a marine sanctuary which includes waters lying within the territorial limits of any State or superjacent to the subsoil and seabed within the seaward boundary of a coastal State, as that boundary is defined in section 2 of title I of the Act of May 22, 1953 (67 Stat. 29), the Secretary shall consult with, and give due consideration to the views of, the responsible officials of the State involved. As to such waters, a designation under this section shall become effec-

43 USC 1301.

tive sixty days after it is published, unless the Governor of any State involved shall, before the expiration of the sixty-day period, certify to the Secretary that the designation, or a specified portion thereof, is unacceptable to his State, in which case the designated sanctuary shall not include the area certified as unacceptable until such time as the Governor withdraws his certification of unacceptability.

(c) When a marine sanctuary is designated, pursuant to this section, which includes an area of ocean waters outside the territorial jurisdiction of the United States, the Secretary of State shall take such actions as may be appropriate to enter into negotiations with other Governments for the purpose of arriving at necessary agreements with those Governments, in order to protect such sanctuary and to promote the purposes for which it was established.

(d) The Secretary shall submit an annual report to the Congress, on or before November 1 of each year, setting forth a comprehensive review of his actions during the previous fiscal year undertaken pursuant to the authority of this section, together with appropriate recommendation for legislation considered necessary for the designation and protection of marine sanctuaries. Annual report to Congress.

(e) Before a marine sanctuary is designated under this section, the Secretary shall hold public hearings in the coastal areas which would be most directly affected by such designation, for the purpose of receiving and giving proper consideration to the views of any interested party. Such hearings shall be held no earlier than thirty days after the publication of a public notice thereof. Hearings.

(f) After a marine sanctuary has been designated under this section, the Secretary, after consultation with other interested Federal agencies, shall issue necessary and reasonable regulations to control any activities permitted within the designated marine sanctuary, and no permit, license, or other authorization issued pursuant to any other authority shall be valid unless the Secretary shall certify that the permitted activity is consistent with the purposes of this title and can be carried out within the regulations promulgated under this section. Regulations.

(g) The regulations issued pursuant to subsection (f) shall be applied in accordance with recognized principles of international law, including treaties, conventions, and other agreements to which the United States is signatory. Unless the application of the regulations is in accordance with such principles or is otherwise authorized by an agreement between the United States and the foreign State of which the affected person is a citizen or, in the case of the crew of a foreign vessel, between the United States and flag State of the vessel, no regulation applicable to ocean waters outside the territorial jurisdiction of the United States shall be applied to a person not a citizen of the United States.

SEC. 303. (a) Any person subject to the jurisdiction of the United States who violates any regulation issued pursuant to this title shall be liable to a civil penalty of not more than $50,000 for each such violation, to be assessed by the Secretary. Each day of a continuing violation shall constitute a separate violation. Penalties.

(b) No penalty shall be assessed under this section until the person charged has been given notice and an opportunity to be heard. Upon failure of the offending party to pay an assessed penalty, the Attorney General, at the request of the Secretary, shall commence action in the appropriate district court of the United States to collect the penalty and to seek such other relief as may be appropriate.

(c) A vessel used in the violation of a regulation issued pursuant to this title shall be liable in rem for any civil penalty assessed for such violation and may be proceeded against in any district court of the United States having jurisdiction thereof.

Jurisdiction. (d) The district courts of the United States shall have jurisdiction to restrain a violation of the regulations issued pursuant to this title, and to grant such other relief as may be appropriate. Actions shall be brought by the Attorney General in the name of the United States, either on his own initiative or at the request of the Secretary.

Appropriation. SEC. 304. There are authorized to be appropriated for the fiscal year in which this Act is enacted and for the next two fiscal years thereafter such sums as may be necessary to carry out the provisions of this title, including sums for the costs of acquisition, development, and operation of marine sanctuaries designated under this title, but the sums appropriated for any such fiscal year shall not exceed $10,000,000.

Approved October 23, 1972.

LEGISLATIVE HISTORY:

HOUSE REPORTS: No. 92-361 (Comm. on Merchant Marine and Fisheries) and No. 92-1546 (Comm. of Conference).
SENATE REPORT No. 92-451 (Comm. on Commerce).
CONGRESSIONAL RECORD:
Vol. 117 (1971): Sept. 8, 9, considered and passed House.
Nov. 24, considered and passed Senate, amended.
Vol. 118 (1972): Oct. 13, Senate and House agreed to conference report.
WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS:
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