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MESA

MARINE ECOSYSTEMS ANALYSIS PROGRAM

the

New York Bight Project - 1975;

Stony Brook,
Long Island,
New York

noaa

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION

Environmental
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NOAA Special Report

The New York Bight Project - 1975 Stony Brook, Long Island New York

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The New York Bight Project — 1975

Stony Brook, Long Island

New York

I. INTRODUCTION

A. The Marine EcoSystems Analysis (MESA) Program

From the earliest days of the Republic, America's economic and social developments have been closely linked to the coasts for transportation, fisheries, industry, and, more recently, for recreation and energy resources. Until lately, the impact of such activities on marine life has been little understood and largely ignored. However, it has become apparent that a limit exists as to the stress that can be placed upon the ecological balance in the coastal environment.

The concepts of MESA originated in 1971 shortly after the formation of the National Oceanic and Atmospheric Administration (NOAA) in 1970 brought together a number of organizations with responsibilities and expertise in research related to the coastal zone and adjacent waters. These organizations are: National Weather Service (NWS), National Ocean Survey (NOS), National Marine Fisheries Service (NMFS), Environmental Research Laboratories (ERL), National Environmental Satellite Service (NESS), and Environmental Data Service (EDS). These NOAA components have numerous programs that deal with specific problems related to estuarine and coastal environments. None, however, is concerned with comprehensively describing processes and eventually predicting responses of the coastal environment as a dynamic system in order to address the broad spectrum of marine coastal problems.

The function of MESA is to integrate the existing NOAA capabilities in estuarine and coastal research

into a cohesive effort in selected geographic areas. This involves some redirection of existing NOAA programs and the establishment of new programs using MESA resources. In addition, MESA issues grants and contracts for work to supplement the in-house NOAA capabilities and to provide a mechanism by which new concepts, expertise, and research can be introduced into MESA.

MESA serves as a focus for cooperative efforts with other Federal, State, and local agencies, universities, industry, ecological and environmental groups, and others to help resolve specific coastal problems. The objective of the MESA program is to identify and measure the impact of man on the marine environment. This requires that we:

1. Describe, understand, and monitor physical, geological, chemical, and biological processes of marine environmental systems in territorial, boundary, and international waters around the United States;
2. Analyze impacts of natural phenomena or man-made alterations on marine environments; and
3. Provide information and specialized support for the effective management of marine areas and for the rational use of their resources.

MESA is currently conducting three regional projects. They are independently managed by the project offices, and coordinated by a program office within ERL. Each project was selected on the basis of critical research needs for understanding man's impact on the marine environment and for aiding coastal zone management.

Figure 1. The New York Bight.

The first MESA project was initiated in the New York Bight because of the extremely heavy impact of man's activities, particularly ocean dumping, in this vital area.

The other two MESA projects are the Deep Ocean Mining Environmental Study (DOMES) and the MESA Puget Sound project, and are both based in Seattle, Wash. The purpose of the DOMES project is to identify potential environmental problems resulting from deep ocean mining of nodules containing manganese, copper, nickel, and cobalt. Information gathered also will be used to develop guidelines for the design of industrial mining equipment and operational techniques. DOMES research is being conducted in an area of commercial mining interest southeast of Hawaii. MESA Puget Sound studies include the evaluation of the effects of municipal and industrial waste discharges into southern Puget Sound and of increased oil transportation and refining activity on northern Puget Sound.

B. The MESA New York Bight Project

The New York Bight is adjacent to one of the most populated and industrialized regions in the world. The bight and its related shore have served many purposes; for example, a playground, dump, sewer, transportation route, fishery area, and mineral source. Recent recon-

naissance assessments have raised the possibility that this marine region has, in many respects, been strained beyond the capacity of the ecosystem to revitalize itself under its present loading conditions (National Marine Fisheries Service, 1972). MESA New York Bight Project research is designed to assess the present condition of the bight ecosystem and its capacity to withstand further degradation. The project has two main objectives:

- Objective No. 1. To determine the fate and effects of pollutants on the New York Bight ecosystem, with particular emphasis on ocean dumping; and
- Objective No. 2. To identify and describe the important subsystems, processes, and driving forces operating in the New York Bight as a whole and to define their interrelationships and rates of change.

The New York Bight includes 15,000 square miles of ocean south of Long Island and east of New Jersey (see fig. 1). Research on adjacent bay and estuary systems by other organizations and institutions is being coordinated with project activities.

The MESA New York Bight Project, scheduled for completion in 1980, is an integrated study of the physical, chemical, geological, and biological characteristics of the marine environment. The project provides agencies, policy makers, planners, and the public with information and criteria to use in making decisions.

C. Project Background

The initial concepts of MESA had been documented in a technical plan, which was formulated through the efforts of a NOAA-wide committee. This plan served as a working document for review by the National Academy of Sciences, Committee Advisory to NOAA (CANOAA), in March 1972. Incorporating suggestions from CANOAA, NOAA proceeded to contract with Westinghouse Electric Corporation (1972) for the preparation of an initial Project Development Plan. The plan, while still in preparation, was reviewed by CANOAA in July 1972. The final document was again reviewed by members of CANOAA before submission to the Office of Management and Budget in autumn 1972.

In January 1973, the MESA New York Bight Project received initial funding and began hiring staff members. Headquarters management was transferred from the

Associate Administrator for Marine Resources to the Office of Coastal Environment in March 1973. Field operations began in May 1973; in August 1973, the Project Office at Stony Brook, N. Y., and the Operations Base at Floyd Bennett Field (Brooklyn, N. Y.) were established. Overall management of the MESA Program was transferred in April 1974 to ERL, headquartered in Boulder, Colo.

II. PROJECT MANAGEMENT AND ORGANIZATION

A. Program Office, Project Office, Operations Base, and Research Vessels

Overall responsibility for the MESA Program resides with the MESA Program Office within NOAA's Environmental Research Laboratories. The Program Office is responsible for the management of all MESA projects, and for providing administrative, support, and advisory services to the projects as required. The New York Bight Project is managed through a Project Manager and his Project Staff assigned to Stony Brook. The Project Manager is responsible for overall scientific and technical guidance in the area of experimental design, data management, and data analysis. He also directs project implementation, oversees day-to-day management operations, and maintains appropriate control over technical quality, scheduling, and financial aspects of the project. The Project Staff administers the scientific program and provides centralized operational support for the scientific research conducted largely by other NOAA components, universities, and contractors under negotiated agreements with the Project Manager. Specifically, the responsibilities of the Project Staff include the:

1. Provision of broad scientific and technical direc-

tion in the area of experiment design, data analysis, and data management;

2. Accomplishment of technical integration and monitoring of scientific progress;
3. Maintenance of a user-directed issue orientation within the basic plan;
4. Elicitation and maintenance of participation by the many organizations associated with the bight;
5. Management of fiscal resources of the project; and
6. Elicitation of adequate feedback from specific users and beneficiaries of the project results.

Under an Operations Officer who reports directly to the Project Manager, the Project Operations Base at Floyd Bennett Field in Brooklyn provides facilities for: ship berthing and staging; equipment storage; calibration, maintenance, and repair of instrumentation and hardware; laboratory analyses of physical, chemical, and geological samples; and accommodations for visiting scientists. Responsibilities of the Operations Officer and his Operations Support Staff encompass logistics support, overall accountability for the project's navigational equipment (including shipboard instrumentation and land-based transmitting towers), scheduling of ship operations, and conduct and coordination of the multifaceted scientific operations aboard NOAA and contract research vessels.

Figure 2. MESA New York Bight Project Organization.

The organizational structure for the MESA New York Bight Project is summarized in figure 2.

The project is supported by NOAA vessels assigned to operate in the bight. NOAA ship *Ferrel* was assigned to the project from August through December 1973 and from April through December 1974. NOAA ship *George B. Kelez* joined the project in late winter 1975, providing year-round support. Other NOAA vessels participating at various times in the New York Bight operation include the *Peirce*, *Researcher*, *Albatross IV*, *Delaware II*, *Oregon II*, and *Rorqual*.

B. Guiding Documents

Project Development Plan. The Project Development Plan (PDP) presents an overall view of the project and serves as a general guide for addressing the complex, pressing environmental issues affecting the bight. The PDP encompasses the project's origin, rationale for existence, objectives, scientific and technical program, management structure, milestones, and budget projection. The PDP also gives a brief description of the New York Bight and known or anticipated human impacts; also included is a description of the general approach MESA is using for each of its major objectives and a management plan which details the

structure of MESA-related organizations. Also discussed in the PDP are advisory bodies and other groups acting as participants within the MESA New York Bight Project. The PDP is not intended to describe in depth the technical details of the project, which are found in the MESA New York Bight Technical Plan.

Technical Plan. Annual Technical Plans (TP) further define for each fiscal year the coordinated activities of the project and focus on assessment of man's impact on the New York Bight. The TP establishes general research areas for proposed efforts by various NOAA components, other agencies, institutions, and universities. The technical program for the MESA New York Bight Project for Fiscal Year 1974 was guided by several letters, memoranda, and agreements between the Project Office and the participating organizations and individuals. The Fiscal Year 1975 Technical Plan identified specific areas of research and methods of response in biological, chemical, geological, and physical oceanography.

Data Management Plan. The Data Management Plan outlines policy and procedure for availability of MESA Project data, provides guidelines and procedures for data management, and identifies the specific roles of NOAA and other organizations and individuals in data management.

In general, MESA principal investigators are responsible for providing appropriate NOAA Data Coordinators with forms which describe what data were collected, when, where, and by whom within 30 days after collection. Principal investigators generally are not responsible for making data available to other investigators.

The Environmental Data Service (EDS) is responsible for archiving MESA Project data, for providing summaries that indicate how much data of specified types are available for particular areas and times, and for insuring efficient data retrieval. Typically, requests for MESA project data are handled by the EDS/MESA Data Coordinator, National Oceanographic Data Center, Page Building 1, Washington, D.C. 20235.

The MESA Project Data Manager is responsible for developing, in close collaboration with EDS and other NOAA components, the combined man/computer systems necessary to insure both integrity of data and their orderly flow. He is also responsible for overseeing efficient and responsive operation of all data management operations.

III. INTERAGENCY RELATIONSHIPS AND PUBLIC PARTICIPATION

A. Contributing NOAA Activities and Other Project Participants

Being an interdisciplinary oceanographic study, the MESA New York Bight Project has brought together an experienced group of scientists from NOAA and from universities, private organizations, and other agencies working under contract to NOAA. Those elements of NOAA directly involved with scientific and technical efforts in, and related to, the bight are shown in table 1.

Several NOAA laboratories associated with the project have lead responsibilities for conducting MESA research activities in the New York Bight. To expand their capacity to meet project objectives, contracts and grants are awarded to, and cooperative efforts are undertaken with, groups having special interests, capabilities, and experience relating to the New York Bight. Appendix A lists contracts and grants let to institutions with which the project has been involved, and Appendix B lists bight-related research contracts and grants of general interest to, but not supported by, the project.

B. Interagency Relationships

The MESA New York Bight Project Staff has maintained informed contacts with members of Federal, State, and local governmental agencies responsible for research, planning, and management in the New York Bight region. Formal interagency coordination is achieved through the MESA New York Bight Advisory Committee and related Advisory Panels. Contacts were maintained with representatives of Region II, the U.S.

Environmental Protection Agency, and its Edison, N.J., Water Quality Laboratory regarding research on, and management of, ocean dumping activities. Efforts were directed toward informing agencies of MESA Project activities and MESA-related activities of other institutions and toward coordinating research efforts.

In addition, MESA personnel have had numerous meetings with representatives of universities, corporations, environmental groups, professional societies, research institutions, and the New York City Chamber of Commerce. The most frequent contacts have been made to review progress of MESA research and to exchange ideas for potential research support. Discussions with potential users of MESA Project data and information were also frequent.

C. MESA Advisory Committee

In order to assist in successfully meeting the objectives and responsibilities of the New York Bight Project, a New York Bight MESA Advisory Committee with three Advisory Panels has been established. Members of two of the panels are from Federal, State, and local agencies and from the academic community. The third panel, composed of representatives of citizen's groups and industry, provides an interface with a broad spectrum of the population.

The purpose of the Advisory Committee and its three Advisory Panels is to provide MESA with broadly based guidance on its technical program and users needs. The project relies upon its Advisory Committee to assist in planning and reviewing operations and in disseminating and utilizing information. In order to advise on the conduct, content, and coordination of the MESA Project, the Advisory Committee collects, analyzes, and synthesizes information on the needs and uses for marine

ecosystems information on the New York Bight and on the concerns and views of citizens and industrial organizations regarding the bight. In performing these functions, the Advisory Committee may receive testimony from individuals and organizations outside its supporting panels.

Information User Advisory Panel. This panel provides the Advisory Committee advice on the needs and uses for marine ecosystems information by Federal, State, and local organizations responsible for making decisions, establishing policies, or enforcing regulations on matters that affect the New York Bight marine ecosystem. The Panel also reviews the relevancy of New York Bight Project studies and operations to such needs and uses.

Scientific and Technical Advisory Panel. This panel give the Advisory Committee advice on interrelationships between fields of research and investigation, on coordination and merit of scientific and technical efforts; and on common data, information, and operational requirements of such efforts.

Citizen and Industrial Advisory Panel. This panel offers the Advisory Committee advice on key concerns of citizens and organizations involving conservation, protection, and uses of the New York Bight and on key concerns of those businesses that depend on the bight for their business endeavors. The ultimate beneficiary of the project is the individual citizen; this panel provides a primary mechanism by which he can directly express his concerns.

Membership on the Advisory Committee and Advisory Panels is held by organizations outside of NOAA. The committee and each panel may have no more than 15 member organizations; as many as four members of each panel may also serve on the committee. The Advisory Committee now has seven members; the Information User Advisory Panel nine, the Scientific and Technical Advisory Panel eight, and the Citizen and Industrial Advisory Panel ten members. The existing member organizations are listed in Appendix C.

The first meeting of the MESA Advisory Committee and Advisory Panels was held at Stony Brook on July 16, 1974. Transcripts of meetings are available for review at the MESA Project Office, the National Weather Service Office (Mineola, N.Y.), and the National Marine Fisheries Service Sandy Hook Laboratory (Highlands, N.J.). Copies of shorter summaries of the meeting are available upon request from the MESA Project Office.

Each of the panels met a second time on February 11, 1975. Much of each meeting was devoted to reviewing MESA efforts with respect to ocean dumping by some of its principal investigators. The latter portion of each meeting focused on future research directions of the project and finalized recommendations for the Advisory Committee.

The Committee met on March 11, 1975. The morning session centered on two presentations by MESA principal investigators; "The Biological Implications of Ocean Dumping," and "The Chemical Implications of Ocean

Dumping." The afternoon session resulted in the Advisory Committee voting on 32 Panel recommendations.

During this March meeting, the Advisory Committee approved the following recommendations:

1. MESA's original Objective No. 1¹ should be rewritten to delete the phrase "... with particular emphasis on ocean dumping".
2. MESA's original Objective No. 3² should emphasize rates of change.
3. All comments on MESA's original Objective No. 2³, be tabled.
4. Research that relates to pathogenic human viruses in shellfish, in the water column, and in the sediment should be done in collaboration with other agencies such as the Food and Drug Administration and Environmental Protection Agency.
5. Research should be undertaken on short-term ecosystem responses to contaminants and on the effects of contaminants (including organic compounds and metals) upon specific marine organisms.
6. Research using cutin and optical whiteners should be explored as sewage indicators.
7. MESA should develop a monitoring rationale for the New York Bight ecosystem, and this should be thought of as a national model for such monitoring.
8. The project should continue studying the influence of Hudson Estuary nutrients and contaminants on primary productivity.
9. A study relating productivity to bottom-living invertebrates should be tabled until the project has a better definition of the studies to be accomplished and the specific parameters to be measured.
10. The study relating the meteorological processes driving storm-generated circulation and transport was approved, and it was recommended that the study should be coordinated with similar interest groups.
11. The project should study the dynamic nature of the Hudson Shelf Valley as part of a regional study. This too should be coordinated with other groups.

¹Objective No. 1. Determine the fate and effect of pollutants on the New York Bight ecosystem, with particular emphasis on ocean dumping.

²Objective No. 3. Identify and describe the important subsystems, processes, and driving forces operating in the New York Bight as a whole and define their interrelationships and rates of change.

³Objective No. 2. Quantify the environmental factors involved in the location, design, construction, and operation of major offshore facilities.

ACTIVITY	ROLE
HEADQUARTERS	
Office of Coastal Environment	Responsible for MESA Program Beginning March 1973
Office of Marine Resources	Policy guidance
Office of Sea Grant	
New York State Sea Grant Program	MESA New York Bight Atlas and research collaboration
MAJOR LINE COMPONENTS	
National Ocean Survey	
Office of Marine Surveys and Maps	
Oceanographic Division	Major role in physical oceanography and remote sensing
Coast Mapping Division	Lead responsibility for bathymetric mapping and nautical charting
Office of Marine Technology	
Engineering Development Laboratory	Instrumentation design, testing, and evaluation; engineering support
National Oceanographic Instrumentation Center	Instrument calibration
Office of Fleet Operations	Vessel support
Atlantic Marine Center	Operation assistance
National Weather Service	
Eastern Region	Forecasts for field operations; marine meteorological data acquisition and analysis
National Environmental Satellite Service	
Spacecraft Oceanography Project	Remote sensing studies
Environmental Data Service	
National Oceanographic Data Center	Oceanographic data products and services including archiving and retrieval
National Climatic Center	Meteorological data products and services including archiving and retrieval
National Geophysical and Solar Terrestrial Data Center	Geological and geophysical data products and services including archiving and retrieval
Environmental Science Information Center	Information products and services including archiving and retrieval
Center for Experiment Design and Data Analysis	Consultant in experimental design and data analysis
Environmental Research Laboratories	
Office of Programs	Responsible for MESA Program beginning April 1974
MESA Program Office	Responsible for MESA Program beginning October 1974
Atlantic Oceanographic and Meteorological Laboratories	Lead responsibility for geological and physical oceanography; major role in geochemical oceanography
National Marine Fisheries Services	
Middle Atlantic Coastal Fisheries Center	Lead responsibilities for biological oceanography; major role in chemical oceanography
Sandy Hook Laboratory	
Milford Laboratory	
Oxford Laboratory	
Northeast Fisheries Center	

Table 1. Contributing NOAA Activities and Their Roles in the New York Bight Project

12. The project should accept a more aggressive role in coordination of efforts by all agencies, Federal and otherwise, that are involved in producing data concerned with the New York Bight.
13. Chairpersons of the Advisory Panels should be nonvoting members of the MESA Advisory Committee.
14. Responses to all recommendations of all panels should be sent to all members by the MESA Project Office at least 1 week before the next panel meeting.
15. Bacteriology studies by MESA should be accomplished by professional laboratory personnel using American Public Health Association standard procedures where applicable.
16. MESA should *strive* to characterize surface currents, refined to 1-minute blocks, for all seasons of the year. (This information is requested by the U.S. Coast Guard for use in search and rescue operations and in predicting oil spill movement.)
17. Inventory information should be developed on existing resources in the bight area (e.g., fisheries, shellfishes, water, sand and gravel, etc.), and how these resources are distributed spatially and temporally.
18. MESA should make every effort to provide data and reports to user agencies as soon as possible.

IV. SUMMARY OF RESEARCH ACTIVITIES AND RESULTS

The bight (see fig. 1) is an estuarine and coastal region of about 15,000 sq nmi (50,000 sq km), extending seaward from the shores of New Jersey and Long Island for 80 to 100 nmi (150 to 185 km) to the edge of the Continental Shelf. Large amounts of pollutants are introduced into the bight from municipal, domestic, and industrial wastes, ocean dumping, urban runoff, and atmospheric fallout. MESA oceanographic studies within the New York Bight are providing an understanding of the important physical, geological, chemical, and biological processes within the bight and their effects on the fate of pollutant inputs.

Physical Oceanographic Program. This program depends upon studies by ERL's Atlantic Oceanographic and Meteorological Laboratories (AOML) and the National Ocean Survey (NOS) on:

1. circulation and transport,
2. water mass distribution and modification,
3. waves and tides, and
4. weather and air/sea interactions within the New York Bight.

Data from drifter and current meter studies within the bight have permitted a preliminary description of current patterns. An important result of these studies, related to mixing of waters within the bight, is that a clockwise gyre appears to dominate inner bight circulation during much of the year. Because circulation data indicate that flow over the Outer Continental Shelf is generally toward the southwest and because flow along the southeast edge of the inner bight gyre is also to the southwest, it is not yet clear how far seaward the gyre circulation extends. Water column characterization studies, conducted in conjunction with the circulation studies, have resulted in a further understanding of the general characteristics and seasonal fluctuations of bight waters.

Two permanent and several short-term coastal tide stations have been installed to augment the National

Tide Network for the bight area. Short-term bottom pressure measurements were also obtained on the shelf during spring of 1974 and 1975. These pressure data have provided information on tides and on water movements associated with tides on the Continental Shelf, on long-period waves, and on wind setup.

Geological Oceanography. AOML scientists have performed geological investigations in the New York Bight involving inventories of the general characteristics of the substrate; they are now studying the dynamics of sedimentation.

Bathymetric maps (compiled from a MESA-contracted Corps of Engineers hydrographic survey in 1973) have been prepared for the inner bight. A comparison of these maps with those from the last bathymetric survey of the area in 1936 have permitted an assessment of sediment accumulation rates over the inner bight, in general, and at dump sites, in particular.

An experiment to measure the transport of sand within the bight monitored the movement of sand tagged with ruthenium in waters approximately 60 ft (18 m) deep. Results of the study support the hypothesis that limited transport of sand occurs during most of the year, but that significant sand transport occurs during severe storms. An extensive series of observations during September to November 1974, on concentrations of suspended particulate matter in the inner bight, has been summarized and interpreted in report form.

Chemical Oceanography. This program involves studies conducted at AOML, Middle Atlantic Coastal Fisheries Center (MACFC), and various colleges and universities. It determines the extent and dynamics of chemical contamination within bight sediments, waters, and biota.

Manhattan College, through a MESA grant, has estimated the sources and magnitudes of contaminant inputs to the bight. The study measured the relative con-

tributions of four major sources of contaminants:

1. ocean dumping of sewage sludge, dredge spoils, building and construction debris, and acid and chemical wastes;
2. municipal and industrial wastewater;
3. atmospheric fallout; and
4. runoff.

Data were synthesized for each source to estimate the relative inputs of solids, organic matter, nutrients, trace metals, and microbes. It was determined that the majority of contaminants is contributed by the New York metropolitan area, through the Hudson/Raritan estuarine system (see fig. 1), although the relative contaminant contribution of different sources varied greatly.

Under a MESA contract, the University of Rhode Island analyzed atmospheric samples for trace metals. With the exception of sodium, concentrations of trace metals in sampled aerosols over the bight were approximately 10 to 20 percent of the mean concentrations observed during a 2-year period at several locations over New York City. The results of the study indicated that atmospheric inputs may account for as much as 13 percent of the lead, 8 percent of the zinc, 5 percent of the iron, and 1 to 2 percent of the cadmium input to the bight. In conjunction with this study, Brookhaven National Laboratory has analyzed elemental and isotopic sulfur in atmosphere samples from the bight.

The State University of New York, under contract to MESA, has made a preliminary assessment of the seasonal variation of temperature, salinity, dissolved oxygen, turbidity, chlorinity, inorganic nitrogen, and phosphate of bight waters. These were selected as indicators of the magnitude and variability of flow of water, particulate matter, and associated contaminants across the Sandy Hook-Rockaway Point transect (see fig. 1). An important result of this study is that net mass transport over a tidal cycle is generally toward the bight in the vicinity of Sandy Hook and toward the harbor in the vicinity of Rockaway Point. While the results indicate that sewage sludge is the principal direct source of ammonia, its biological effects appear to be localized and short term.

The decomposition rate of sedimentary organic matter within the bight was quantified in August and December 1974 and in February 1975 by measuring rates of uptake of oxygen at the sediment-water interface. Rates of sedimentary oxygen utilization within the bight vary with water temperature and tend to be depressed over some dumped wastes during summer and fall.

A study has been initiated to examine sediment reworking and diagenesis and their effects on contaminant exchange with the overlying water. The first efforts have focused on methodology and measurements of the vertical distribution of the nuclides lead-210 and thorium-228 and -234 in the sediments to determine the rate of sedimentation and the rate of reworking by storms and bottom animals.

Water column chemistry studies are conducted as part of the water column characterization cruises. These

studies, initiated in fiscal year 1974, have been continued for further analysis of water quality within the bight. Suspended particulates have been sampled for analysis of carbohydrates, proteins, and total organic carbon. Some samples have been extracted with organic solvents to determine the aliphatic and aromatic hydrocarbon, fatty acid, and methanol-eluting fractions. Identifications are being confirmed with gas chromatography/mass spectrometry. Other components, including chlorinated hydrocarbons, are also being identified.

Biological Oceanography. The National Marine Fisheries Service MACFC is the focal point for most of MESA's biological studies in the New York Bight. Here the objective is to determine the magnitude, cause, and dynamics of ecosystem degradation and recovery within the bight. The first step is to define and inventory where organisms live, how numerous they are, and what factors influence their distribution and abundance. This is a prelude to studies of process and rate aspects of the ecosystem that will characterize the roles or influences of environmental variables and of the biotic components of the ecosystem.

During fiscal year 1975, in collaboration with other agencies (U.S. Food and Drug Administration, the Nassau County Department of Health, the Town of Hempstead—Department of Conservation and Waterways, the New York State Department of Environmental Conservation, and the U.S. Environmental Protection Agency—EPA), MESA estimated the numbers of total coliform and fecal coliform bacteria in sediments at 20 locations south of Long Beach, N.Y. The measured concentrations were high enough to indicate coliform bacteria contamination to distances of 5 nmi offshore of Long Island. These results are comparable to previous coliform measurements throughout the inner bight, with the exception of high concentrations measured at the dump sites. Fecal coliforms were not found at five stations within two areas designated by the EPA as potential locations for offshore alternative dump sites. However, at these latter five locations, *Clostridium* (presumed to be *C. perfringens*) and *Vibrio* were found in rather high numbers. As *C. perfringens* is present in fecal material and because spores of this species can survive for long periods, the species is sometimes used as an indicator of domestic sewage contamination. The distribution of *Vibrio* species is important because it causes diseases in both man and fish.

Studies are being performed on the prevalence and causes of fin rot disease in some benthic fish. This is characterized by erosion of the fins, starting at the outer edges of the fin and progressing to the base. To determine which bacteria are present at the sites of fin erosion, 99 bacterial isolates were taken from the lesions of about 40 diseased winter flounder (*Pseudopleuronectes americanus*), the fish most susceptible to fin rot in the bight. Several common marine bacteria were found, with *Pseudomonas*, *Achromobacter*, and *Flavobacterium* being most common. The variety of

bacteria identified with the fish lesions indicate that other pathogens or factors may be involved. Diseased tissues were also extensively studied. Failure to find either *in situ* bacteria or any pronounced inflammatory response to specific bacteria is evidence that the onset of this fin rot disease may not be bacterial. These findings are in contrast with evidence that bacteria do cause fin rot in some other areas.

Bight waters and sediments have been analyzed for ordinarily harmless coliform bacteria and for other bacteria that are resistant to antibiotics. Several locations at and near the dump sites, and near shore, yielded bacterial strains resistant to several heavy metals and to tetracycline. These strains have been confirmed as resistance transfer (R+) donors; that is, they can transfer resistance to a spectrum of metals and/or antibiotics to normal nonresistant bacteria. For example, coliform bacteria acts as a reservoir or vector by which resistance to tetracycline can be transferred from a pathogen such as *Salmonella* to another *Salmonella*. The widespread distribution of "transfer resistant" bacteria in nature and in man has been documented only in recent years. The presence of these resistant bacteria in the bight is not presently viewed as a public health threat. However, their widespread distribution is a striking demonstration of natural selection and bacterial accommodation to human contaminants.

Measurements of phytoplankton density and productivity in the waters of the New York Bight, Lower Bay, Raritan River, and the lower Hudson River indicated that productivity within the inner bight is less than measured in the Hudson and Raritan Estuaries, but larger than measured in the outer bight. An estimated annual phytoplankton production of 370 g of carbon per square meter within the inner bight is similar to that of productive upwelling areas and results from a substantial influx of nutrient-rich surface water from the Hudson/Raritan estuarine complex.

Biological investigations have contributed to a better understanding of the distribution of benthic invertebrates and of fin rot disease in fish. Although there is no evidence of widespread changes in species composition of benthic invertebrates throughout the whole bight, recent findings are in agreement with a previous study which documented substantial modifications in species composition and abundance caused by dredge spoil and sewage sludge dumping.

The project sponsored a study aimed at the development of a comprehensive conceptual representation of the bight, including the processes of ocean circulation, sediment transport, water quality, and ecologic interaction. The study, recently completed, provides a framework for establishing research and field investigation priorities and for developing and evaluating future models of oceanic processes and critical ecological systems.

Research Planned For Fiscal Year 1976. Additional current meter and bottom pressure data will be obtained for use in determining long-term features of the Conti-

ental Shelf circulation and the dynamics of Hudson Shelf Valley flow. Water column characterization studies in the Hudson Shelf Valley and vicinity will be continued in conjunction with circulation studies of these areas. Data from these studies will be used as input to a diagnostic model of bight circulation.

A new program will determine how important meso-, regional-, and micro-scale meteorological events are to bight circulation and sediment transport. The effects of major storm events will be emphasized. Meteorological buoys will be deployed early in the fiscal year over locations on the Outer Continental Shelf, in the Hudson Shelf Valley, and in the Baltimore Canyon Trough. Another installation is scheduled for the Georges Bank area in February or March 1976.

Continued studies will be performed on pollutant inputs, dynamics of phytoplankton and zooplankton in the inner New York Bight, distribution of and contaminant impacts upon benthic invertebrates, distribution and sources of sewage-derived sedimentary material, and release of contaminants from the sediments to the water column.

The MESA New York Bight Project is providing the EPA oceanographic data and reports on its alternative sewage sludge dump sites within the bight.

A study will determine the abundance of strains of *Staphylococcus aureus* resistant to cadmium, mercury, zinc, and lead in the sediments of the New York Bight and will look for correlations between this resistance and the resistance to antibiotics such as penicillin and methicillin. *S. aureus*, a serious cause of disease in man and animals, is relatively tolerant of sea water.

The effects of polluted sediments on the contracting of fin rot by winter flounder will be further studied by placing caged fish in and around sewage sludge and dredge spoil dump sites. Additional studies in aquaria will expose winter flounder to sediments from dump sites. The prevalence and distribution of anomalies other than fin rot in finfish species (and, to a limited extent in shellfish) will also be determined.

The incidence of cytogenetic abnormalities in fish eggs and early stage larvae from the neuston (floating-surface layer) will be investigated. This will be the first step in an attempt to determine the significance of mutagenic contaminant effects upon fish with early life history stages spent at least partially in the neuston. Field data will be augmented with data from experimental chronic exposure of fish and their spawned eggs to one or more contaminants considered most likely to be mutagenic factors in the New York Bight.

Supporting activities include publication of the MESA Atlas of the New York Bight, an associated monograph series (discussed in the following section), refinement of the data management system, interpretation of other available ecosystems information, and development of a rationale for the monitoring of ocean dumping.

V. PUBLICATIONS AND INFORMATION EXCHANGE

A. The MESA Atlas of the New York Bight

The MESA Atlas is intended to summarize and integrate available information and data on the bight for decisionmakers and their technical advisors, industrial and individual users of the bight, and scientists. The atlas is being prepared in two stages. Technical summaries of rather broad topics are published individually as soon as they are prepared and edited. These technical summaries will then be integrated into a cohesive cross-referenced book and edited to insure readability by people without technical backgrounds.

The technical summaries will be released in the *MESA New York Bight Atlas Monograph* series. Authors have been selected to write these summaries on more than 30 different topics; all manuscripts are expected to be completed by June 1976. The series of manuscripts is designed to cover classical oceanographic topics, commercial resources, management of resources, and uses of the bight and its shore zone. Thus, in addition to strictly oceanographic information, reports are being written on sand and gravel deposits, fishing resources, aquaculture, artificial reefs, responsibilities of governmental agencies, ocean waste disposal, air quality, energy sources, port facilities, transportation, industrial growth, demography, and recreation—all with respect to the New York Bight. These reports are designed to provide early synthesis of existing information and to document information gaps, primarily facilitating research planning by MESA scientists and others. The reports will also be useful to decisionmakers and the public.

The basic principle behind the atlas is to combine the more than 30 separate topics into a comprehensive unit to illustrate the dynamic system which is designated as the New York Bight—a complex interplay among physical, biological, and human elements and between coastal processes and deepwater conditions. To facilitate this integration, the atlas will emphasize four-color charts in three standard scales, photographs, and diagrams. Wherever possible, data will be portrayed on charts. Standard charts have been prepared by the American Geographical Society for the atlas and atlas monographs. The book will be about 300 pages in length, and the text supplementing the graphics will be written for both the public and the scientist.

Production of the *MESA New York Bight Atlas Monograph* series and the atlas has been contracted to the New York State Sea Grant Program. Consultation on publications details and graphics is being provided by the American Geographical Society. The atlas is scheduled for publication in 1976.

B. Other Publications

A *Preliminary MESA New York Bight Environmental Data Base Directory* was compiled for MESA by the Environmental Data Service (EDS) in September 1973. This directory, an initial compilation and description of data files relevant to the New York Bight, has been augmented extensively. New entries have been added to an expanded version which is to be published soon.

The directory lists the institutions holding data files, names, addresses, and phone numbers of contacts responsible for data; location of data collection; narrative description and index of terms describing data; period of data coverage; volume of data and frequency of collection; data storage medium; restrictions on availability; and secondary storage locations of data.

The MESA New York Bight Bibliography. This bibliography, containing more than 2,400 items, was prepared during fiscal year 1974 for the MESA New York Bight Project by NOAA's Environmental Science Information Center (ESIC). The bibliography is a single source of literature pertinent to the New York Bight. It is available through the Government Printing Office in a two-volume set: the first contains actual citations, and the second contains subject and author indexes to aid in locating references of interest. In addition, the bibliography is automated into the EDS Oceanic and Atmospheric Scientific Information System (OASIS), a reachable information storage and retrieval system operated by ESIC. By utilizing the computer aspect of the bibliography, a user will receive only information for a specific desired area and/or time, but not the entire file.

Scientific, Technical, and Information Reports. Another system for disseminating information about the bight is through the *MESA Report Series*. This series of reports includes data and information about environmental and ecological baselines and processes of the New York Bight.

The *MESA Report Series* and other publications listed in the Bibliography can be obtained, at a nominal cost, from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Data

Reports, Technical Memoranda, Technical Reports, and Special Reports will be issued on a continuing basis for the duration of the project.

In addition to special MESA publications, numerous articles have been submitted by MESA investigators to recognized scientific journals on their scientific efforts in the New York Bight. A complete list of such articles is included in the Bibliography.

C. Public Hearings

In 1974, public controversy arose over the existing practice of dumping sewage sludge in the apex of the New York Bight. The most common concern has been the lack of information on the New York Bight ecosystem and its response to being used as a repository for wastes generated in the New York metropolitan area. Long-term efforts of the project will provide a better understanding of the bight to guide future management decisions. Because of the critical nature of the sewage sludge dumping problem, three public hearings were held.

The first, called by Mr. Gerald M. Hansler, Administrator, Environmental Protection Agency, Region II, was held on February 8, 1974, to discuss decisions on applications for ocean dumping permits. Requests had been made for project findings applicable to the impact of sewage sludge during dumping in the New York Bight. The formal presentation summarized assessment of information to that date.

The second, called by New York State Assemblyman Peter A. Berle, was held March 22, 1974, on sewage sludge disposal. Sewage sludge dumping at the existing site and recommendations for possible alternative sites were the focuses of the presentation.

The third, called by U.S. Senator James L. Buckley for the Subcommittee on Environmental Pollution of the Senate Public Works Committee, was held on August 2, 1974. This hearing was called to resolve conflicting reports on whether the disposal of sewage sludge in the New York Bight poses a threat to Long Island beaches. Testimony from the MESA Project was requested to provide scientific input regarding the potential for sludge migration out of the disposal area and its implications on recreation and on marine life.

D. MESA-Sponsored Workshops

The MESA Project sponsored several workshops during fiscal years 1974 and 1975. Each of these workshops was called to address specific problem areas, improve coordination, and integrate field investigations for optimum utilization of project resources. In general, these workshops included investigators from other organizations as well as representatives from NOAA. These workshops are listed below:

May 3, 1973

Topic: MESA Field Efforts

Purpose: To integrate the multidisciplinary NOAA activities and to eliminate duplicative efforts in the bight.

August 10, 1973

Topic: MESA Biological Contractors Workshop #1

Purpose: To review progress made by individual contractors and to exchange up-to-date information.

September 4-5, 1973

Topic: Chemical Oceanography Workshop

Purpose: To identify chemical problems which MESA should study and to assign priorities to these problems.

February 12, 1974

Topic: Instrument Calibration Workshop

Purpose: To improve calibration of instrumentation, such as current meters, used in physical oceanographic studies in the bight.

March 14, 1974

Topic: Information Exchange Between NOAA Investigators

Purpose: To review results of work-in-progress in order to redirect and amplify efforts in specific areas.

June 4, 1974

Topic: Nutrient Chemistry Workshop

Purpose: To bring together all investigators studying nutrients in the bight to discuss analytical methods and calibration problems and initiation of cooperative efforts.

June 17, 1974

Topic: MESA Biological Contractors Workshop #2

Purpose: To review results of work-in-progress and exchange ideas for future studies.

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September 10-12, 1974

Topic: Symposium on Ecological Modeling in a Resource Management Framework (co-sponsored with Resources for the Future, Inc., at Brookings Institute)

Purpose: To bring together persons actively involved in ecological modeling to exchange information and aid development of resource management.

October 8-9, 1974

Topic: Oceanographic Workshop at Brookhaven National Laboratory (BNL)

Purpose: To discuss future efforts and direction of the Brookhaven National Laboratory/MESA Cooperative Biological Emission Program

March 10-12, 1975

Topic: Physical Oceanography of the New York Bight Workshop at BNL

Purpose: To present physical oceanography research programs in the New York Bight and to discuss cooperative efforts and future plans.

April 10, 1975

Topic: Public Health Workshop convened by EPA

Purpose: To assess the public health significance of a MESA investigation (Koditschek and Guyre, 1974) which found transfer resistance bacteria in sediments and waters of the New York Bight and to initiate a future symposium on this subject.

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Charnell, R. L., G. S. Maul, and R. H. Qualset

Application of ERTS to marine water quality monitoring.

Presentation at the 55th Annual Meeting of the American Geophysical Union, Washington, D.C., April 1974.

Cok, A. E.

Structural instability of the nearshore ridge and swale topography, Fire Island, New York.

Presentation at the Geological Society of America meeting, Miami Beach, Fla., November 1974.

Drake, D. E., and P. E. Butcher

Dispersal of waste solids in the New York Bight.

Presentation at the Geological Society of America meeting, Miami Beach, Fla., November 1974.

Drake D. E., D. A. Segar, R. L. Charnell, and G. A. Maul

Comparison of optical measurements and suspended solids concentrations in the ocean.

Presentation at the National Oceanographic Instrumentation Center Turbidity Workshop, May 1974.

Hansen, D. V.

Shelf circulation studies at NOAA/AOML.

Presentation at the Workshop/Conference on Shelf Dynamics, Annapolis, Md., April 1974.

McKinney, T. F., and D. J. P. Swift

Side-scan sonar evidence of large-scale current lineations on the Central New Jersey Continental Shelf, USA.

Presentation at the Bordeaux Symposium, Bordeaux, France, September 1973.

Murchelano, R. A.

Histopathology of fin rot disease in winter flounder from the New York Bight.

Presentation at the Wildlife Disease Association, July 1974.

Pearce, J. B.

Use of benthic communities as indicators of oil pollution.

Presentation at the American Petroleum Institute meeting, Boston, Mass., March 1974.

Segar, D. A.

The MESA New York Bight Project and chemical oceanography.

Presentation at the 1974 Annual Meeting of the American Geophysical Union, Washington, D.C., May 1974.

Segar, D. A., G. A. Berberian, R. L. Charnell, D. E. Drake, P. E. Belcher, and G. A. Maul

The New York Bight. Some observations of the NOAA Marine EcoSystems Analysis (MESA) Program.

Presentation at the 38th Annual Meeting of the American Society of Limnology and Oceanography, Seattle, Wash., June 1974.

Sindermann, C. J.

A biologist's view of the Stockholm Conference on the Human Environment.

Presentation at the Third Food-Drugs from the Sea Conference, Univ. of Rhode Island, Kingston, R.I., January 1973.

Sindermann, C. J.

An assessment of human impact on coastal ecosystems and living resources of the New York Bight.

Presentation at the International Council for the Exploration of the Sea, Copenhagen, Denmark, October 1974.

Sindermann, C. J.

Fisheries implications in planning offshore ports.

Presentation at MTS, TAMU, Univ. of Dela., Short course in offshore port planning, Washington, D.C.

Stubblefield, W. L., and D. J. P. Swift

Influence of sub-surface structure during submarine construction of ridge and swale topography, Central New Jersey Shelf.

Presentation at the Geological Society of America meeting, Miami Beach, Fla., November 1974.

Stubblefield, W. L., and D. J. P. Swift

Ridge and swale topography of the Central New Jersey Shelf; active relict hydraulic responses.

Presentation at the 55th Annual Meeting of the American Geophysical Union, Washington, D.C., April 1974.

Swanson, R. L.

On-going NOAA activities related to ocean dumping in the New York Bight.

Presentation at the National Academy of Sciences/National Research Council Dumping Workshop at Woods Hole, Mass., September 1974.

Swift, D. J. P.

Outer Continental Shelf sedimentation.

Presentation at the American Geophysical Union Short Course, Washington, D.C., November 1974.

Swift, D. J. P., and J. W. Lavelle

Sand transport on the Continental Shelf.

Presentation at the Geological Society of America meeting, Miami Beach, Fla., November 1974.

Swift, D.J.P., J.W. Lavelle, and J. McHone

Morphology and grain size characteristics of the shoreface; inferences concerning the littoral sand budget.

Presentation at the 55th Annual Meeting of the American Geophysical Union, Washington, D.C., April 1974.

APPENDIX A

MESA NEW YORK BIGHT PROJECT

RESEARCH CONTRACTS AND GRANTS

CONTRACT TITLE	PRINCIPAL INVESTIGATOR	SCHEDULE	FUNDING LEVEL
Meteorological forcing fields of the New York Bight	RSMAS/C.N.K. Mooers	FY76	51k
Data buoy support	NOS NDBO/Mike Hall	FY76	17k
NWS support— Eastern Region	NWS Eastern Region/ W. McKee & J. Allen	FY74-76	FY74-35k FY75-35k FY76-35k (requested)
NESS/NASA experiments	NESS-NASA/J. Sherman & J. Muggler	FY73-75	No project funds except operational and planning support
Sludge tracking acoustic experiment	AOML ORSL/John Proni	FY76	28.5k
Bottom pressure program	AOML PhOL/D.V. Han- sen & H.O. Mofjeld	FY75-76	FY75-50k FY76-52.1k
Wave refraction study	CCNY/Dr. Pierson	3½mo. NYU 14mo. CCNY 6mo. no cost extension	16k-NYU 52k-CCNY
Tidal analysis (coastal)	NOS C33/C. Fisher		No MESA funds except for instrumen- tation and some operational support required
Sealevel fluctuation study	NOS C3/S. Hicks	FY74-75	FY74-1k FY75-1k
Moored current meter program	AOML PhOL/ D.V. Hansen	FY73-76	FY73-60k FY74-45k FY75-70k FY76-56.6k
Aandreaa initial processing	NOS C33/C.Fisher	FY74-76	FY74-20k FY75-40k FY76-60k
Cyclesonde study	University of Miami/ J.C. Van Lear	12mo. (6/5/73- 6/5/74)	35.5k
Tidal curret analysis	NOS C33/C. Fisher	FY74-76	FY74-50k FY75-60k FY76 -52k
Synoptic study of surface and bottom drift in the New York Bight	SUNY(MSRC)/Dr. Baylor	13mo. (1/3/74 —2/4/75)	11.8k approximately 41k in matching funds
Trackable Lagrangian (seabed) drifter study	NASA Langley/J. McFall		18k (EPA funds)
Water column characterization program	AOML PhOL/D.V. Han- sen, R.B. Starr, & G.A. Maul	FY73-76	FY73-60k FY74-45k FY75-80k FY76-71.3k
Tritium analysis	University of Miami/		6k (EPA funds)
Preliminary field experiments in preparation for a large scale instrumentation of the nearshore marine zone.	University of Massachu- setts Coast Research Center/Dr. Allen Niedoroda	6mo. (June- December 1975)	15k
Resuspension characteristics of cohesive bottom sedi- ments in the New York Bight Apex	MIT/Dr. J.B. Southard	FY76	12k
Processing and preliminary analysis of data previously collected in the frictional boundary layer New York Bight	University of Chicago/ Dr. Robert Miller	FY76	15.3k
Substrate inventory program	AOML MG&G/ Dr. George Freeland	FY73-76	FY73-120k(278.4) FY74-100k(285) FY75-150k(432.5) FY76-78.7k(365)

CONTRACT TITLE	PRINCIPAL INVESTIGATOR	SCHEDULE	FUNDING LEVEL
Sand transport program	AOML MG&G/ Dr. J. William Lavelle & Dr. Donald Swift	FY73-76	FY73-60k(278.4) FY74-150k(285) FY75-150k(432.5) FY76-79.7k(365)
Shoreface study	AOML MG&G/ Dr. Donald Swift	FY76	42.7k(365) may be asking for as much as 250k additional funding in FY76
Box coring program	AOML MG&G/	FY76	19.2k(365)
Suspended sediment transport program	AOML MG&G/Dr. Yenug & Mr. Nelsen	FY74-76	FY74-35k(285) FY75-130k(432.5) FY76-58.9k(365)
Suspended sediment tracer study	AOML MG&G/ Dr. J. William Lavelle & Dr. Donald Swift	FY76	27.9k
Phytoplankton productivity and nutrient recycling in the inner New York Bight	CUNY/Thomas C. Malone	36mo.	FY74-33k FY75-73.3k
Phytoplankton productivity— Raritan Bay	NOAA MACFC/J. Thomas	FY73-75	FY73-20k FY74-63k FY75-34k
Ciliated protozoa	University of Maryland/ E. Small	July 72- June 74	FY73-38k FY74-12.4k
Transfer resistant bacteria of the New York Bight	Montclair State College/ L. Koditschek	June 73- July 75	FY74-10k FY75-18k
Benthic respiration	NOAA MACFC/ J. Thomas	FY73-75	FY73-41k FY74-31k FY75-38k
Benthic invertebrate distribution and abundance	NOAA MACFC/ J. Pearce & K. McNulty	FY73-76	FY73-40k FY74-51.3k FY75-80k FY76-177.8k
Fish and shellfish	NOAA MACFC/ Dr. Aaron Rosenfield— Oxford, Md., Lab.	FY75-76	FY75-16k FY76-95k
Benthic ecology data analysis	NOAA CEDDA & Fordham University/Dr. Richard Rozett & Dr. Jack Jalickee	FY76	34.5k
Statistical analysis of benthic sample data from the New York Bight area	Dr. Saul & Dr. Saila	2 years	FY74-10k FY75-10k (FY76-10k anticipated)
Quantitative distribution of macrobenthic invertebrates of the Middle Atlantic region	NEFC/ Dr. Roland L. Wigley	July 75- June 76	FY76-52.4k
Environmental induced mutagenesis in marine fishes	NOAA MACFC/ Dr. A. Longwell —Milford, Conn., Lab.	FY76	145k
Heavy metal and antibiotic resistance in <i>Staphylo-</i> <i>coccus aureus</i> studies in the New York Bight	/Dr. John F. Timoney	2 years	FY76-21.7k
Resource distribution and abundance	NOAA MACFC/A. Merrill	FY73-75	FY73-33k FY74-53k FY75-36k
MESA Atlas	New York Sea Grant Institute/ Dr. D.F. Squires	FY 73-75	FY73-125k FY74-96.9k FY75-90k
Geochemical efforts	AOML PhOL/Segar, Berberian & Cantillo; MG&G/Hatcher, Keister & West	FY74-76	FY74-\$45,841 FY75-178.5k FY76-192.9k
Determination of phosphate fluxes across the sediment water interface in New York Bight	Florida State University/ Dr. John W. Morse	January 75- June 75	\$2,953

CONTRACT TITLE	PRINCIPAL INVESTIGATOR	SCHEDULE	FUNDING LEVEL
Organic and heavy metal geochemistry of nearshore organic rich muds, sand and gravel bottom sediments and suspended sediments, with regard to sediment origin New York Bight	Brooklyn College/ Dr. John C. Stewart, Dr. William, & H. Harris	September 75– August 76	\$30,220
Magnitude of contaminant inputs to the New York Bight	Manhattan College/ Dr. James A. Mueller & Dr. John A. Jeris	June 74– February 75	35k
A study of the sources, transport and reactions of suspended particles in waters of the New York Bight	University of South Florida/Dr. Peter R. Betzer	February 75– April 76	\$49,063
The use of Pb ²¹⁰ , Ra ²²⁶ and Th ²³⁴ in determining the accumulation rates and mobilization of coastal sediments	Yale University/ Dr. Karl K. Turekian	June 74– August 76	\$51,094
Atmospheric trace metals over the New York Bight	University of Rhode Island/Dr. Robert A. Duce	June 74– June 75	\$3,825
Determination of anthropogenic fluxes of carbon and heavy metals into the sediments of New York Bight	State University of New York at Stony Brook/ Dr. Oliver A. Schaeffer	September 75– August 76	\$27,882
A study of the variation of nutrients across the Sandy Hook-Rockaway Point transect, New York Bight	State University of New York at Stony Brook/ Dr. Iver W. Duedall	October 73– July 74	\$48,771
Heavy metal concentrations at the apex of the New York Bight	New York Ocean Science Lab./Dr. James E. Alexander	November 73– February 74	\$9,945
Conceptual representation of the New York Bight	Water Resources Engin- eers/Dr. Donald E. Evenson	June 73– June 75	\$186,303
MESA dynamics physical oceanography	NOAA/Dr. D.V. Hansen	FY74	89.8k
Marine ecological system analysis-engineering support	NOAC/C. Kearsse	FY74	350k

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APPENDIX B

PARTIAL LISTING OF MARINE RESEARCH ACTIVITIES IN THE NEW YORK BIGHT REGION WHICH ARE NOT SUPPORTED BY MESA

(Data from Smithsonian Science Information Exchange,
Inc., Washington, D.C.)

CONTRACT TITLE	PRINCIPAL INVESTIGATOR	SCHEDULE	FUNDING LEVEL	SUPPORTING AGENCY
Study of setting, attachment and growth of <i>Codium fragile</i> on shellfish in Long Island	New York State Department of Environmental Conservation/ R.E. Fox	July 72— June 73	\$10,150	U.S. Dept. of Commerce— NOAA NMFS
Studies on the methods for control of <i>Codium fragile</i> in Long Island Sound	Connecticut State Department of Environmental Protection/	July 72— June 73	8,621	U.S. Dept. of Commerce— NOAA NMFS
A study of the migratory behavior of American shad	Connecticut State Department of Environmental Protection/W.C. Leggett	July 72— June 73	\$8,500	U.S. Dept. of Commerce— NOAA NMFS
An interdisciplinary study—the estuarine and coastal oceanography of Block Island Sound and adjacent New York coastal waters	New York Ocean Science Lab/Dr. R. Nuzzi	July 72— June 73	Funds Unknown	NASA
Cyclesonde measurements in the New York Bight	University of Miami/ J.C. Van Leer	May 73— May 74	Funds Unknown	U.S. Dept. of Commerce— NOAA ERL
Pre-operational aquatic studies-Shoreham	New York Ocean Science Lab/J.C. Baiardi	July 73— July 74	Funds Unknown	Long Island Lighting
Pre-operational aquatic structure-Shoreham	Long Island Lighting Company/	July 73— June 74	Funds Unknown	Long Island Lighting
Pre-operational aquatic studies-Shoreham	Long Island Lighting Company/	July 73— June 74	\$20,000	Long Island Lighting
Marine ecological study at Shoreham, Long Island, New York	New York Ocean Science Lab/Dr. Austin, J.H. Alexander, & A. Dagostino	January 73— June 74	\$1,500	Long Island Lighting
Benthos of the Dunwoodie-Glenwood Interconnection, Northport, Shoreham	New York Ocean Science Lab/A. Dagostino, J. Alexander, H. Austin, & R. Nuzzi	July 72— June 73	Funds Unknown	Affiliated College & University, Inc.
Thermal combustion lab for analysis of dissolved organic carbon in seawater	Brookhaven National Lab/ G.M. Woodwell & P. Rich	July 72— June 73	Funds Unknown	U.S. Atomic Energy Commission—Biomedical & Env. Res. Div.
Community oxygen metabolism of Flax Pond, New York	Brookhaven National Lab/ G.M. Woodwell & C.A. Hall	July 73— June 74	Funds Unknown	U.S. Atomic Energy Commission—Biomedical & Env. Res. Div.
Production and role of aquatic bio-detritus in a tidal salt marsh	Brookhaven National Lab/ G.M. Woodwell & D. Whitney	July 73— June 74	Funds Unknown	U.S. Atomic Energy Commission—Biomedical & Env. Res. Div.
Quantitative value of different forces of energy in microorganisms and salt pond	Brookhaven National Lab/ G.M. Woodwell & C.A. Hall	July 72— June 73	Funds Unknown	U.S. Atomic Energy Commission—Biomedical & Env. Res. Div.
Oceanography of Block Island Sound (zooplankton and ichthoplankton)	New York Ocean Science Lab/Dr. H.M. Austin & D.M. Stoops	July 72— June 73	Funds Unknown	Suffolk County Govt., New York
The effect of thermal enrichment on oyster beds in Indian River Bay, Delaware	Delmarva Power & Light Company/	July 73— June 74	Funds Unknown	Delmarva Power & Light Company
Differential susceptibility of crustaceans to predation by fish	University of Delaware/ J. Born	September 72— August 73	\$18,500	U.S. National Science Foundation—Div. of Environmental Sciences

CONTRACT TITLE	PRINCIPAL INVESTIGATOR	SCHEDULE	FUNDING LEVEL	SUPPORTING AGENCIES
Effects of persistent pollutants on bird populations	University of California/ R.W. Risenbough	December 72— November 73	\$32,450	U.S. National Science Foundation—Div. of Biological & Medical Science
The loan of equipment to the University of Connecticut in support of physical, chemical and geological oceanographic research	University of Connecticut/ P. Dehlinger & W. Lund	July 73— June 74	\$44,989	U.S. Dept. of Defense— Navy
Estuarine studies	Brookhaven National Lab/ G.M. Woodwell	July 73— June 74	\$75,000	U.S. Atomic Energy Com- mission—Biomedical & Env. Res. Div.
Terrestrial ecology	Brookhaven National Lab/ G.M. Woodwell	July 73— June 74	\$185,000	U.S. Atomic Energy Com- mission—Biomedical & Env. Res. Div.
The effects of environmental stress on the community structure and productivity of salt marsh epiphytic communities	CUNY/J. Lee, W.A. Muller, M. McEnery, J. Harrison & E. Kennedy	September 73— August 74	\$47,300	U.S. Atomic Energy Com- mission—Biomedical & Env. Res. Div.
Hard clam survey of Delaware Bay	Delaware State Department of Natural Resources/ Dr. D. Mauser	July 72— June 73	\$10,000	U.S. Dept. of Com- merce—NOAA NMFS
Live oyster bed and cultch survey of Delaware Bay	Delaware State Department of Natural Resources/ R.A. Peck	July 72— June 73	\$9,000	U.S. Dept. of Com- merce—NOAA NMFS
Atmospheric pollutant trans- port and deposition on the sea surface	University of Rhode Island/R.A. Rice	February 74— January 75	\$11,600	U.S. National Science Foundation—Div. of National & International Programs
Effects of passage of marine plankton through the cool- ing water system of nuc- lear power plants	Woods Hole Oceanogra- phic Institute/ E.J. Carpenter	July 72— June 73	\$80,000	Northeast Utilities Service
Remote sensing of Long Island Sound	U.S. Department of the Interior/F.H. Ruggles	July 72— June 73	Funds Unknown	U.S. Dept. of the Interior —Geological Survey —Water Resource Division
Salinity of Delaware Estuary	U.S. Department of the Interior/T.E. White	July 72— June 73	Funds Unknown	U.S. Dept. of the Interior —Geological Survey —Water Resource Division
Sea state and ocean color studies from satellite	U.S. Department of Com- merce/Dr. A.E. Strong	July 72— June 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—National Environmental Satellite Service
Southeast Florida Project	U.S. Department of Com- merce/D.V. Hansen	July 72 June 73	\$583,000	U.S. Dept. of Commerce —NOAA ERL
Disease resistant oysters	Rutgers State University/ H.H. Haskin	July 74— June 75	Funds Unknown	New Jersey State Government
Natural seed oyster beds of the Delaware Bay	Rutgers State University/ H.H. Haskin	July 74— June 75	Funds Unknown	New Jersey State Government
Detailed soil survey of the state	Conn. Agric. Expt. Station/D.E. Hill	July 74— June 75	Funds Unknown	Connecticut State Government
Dispersion in the Upper Delaware Estuary	Rutgers State University/ R.C. Ahlert	July 74— June 75	\$3,204	U.S. Dept. of the Interior —Office of Water Resource Research
Control of BOD upset in the Delaware Estuary	University of Delaware/ M.M. Denn	July 73— June 74	\$8,600	U.S. Dept. of the Interior —Office of Water Resource Research
Shellfish culture using the heated effluent from elec- tric power plants	University of Connecticut/ S.Y. Feng	July 73— June 74	Funds Unknown	U.S. Dept. of the Interior —Office of Water Resource Research

CONTRACT TITLE	PRINCIPAL INVESTIGATOR	SCHEDULE	FUNDING LEVEL	SUPPORTING AGENCIES
Identification and determination of trace amounts of organic and inorganic contaminants in the Delaware River and Bay	Delaware State College/ G.R. Seidel & H.R. Williams	July 73— June 74	\$9,775	U.S. Dept. of the Interior —Office of Water Resource Research
Effects of salinity and other water quality parameters on New Jersey oyster beds	Rutgers State University/ H.H. Haskin	July 73— June 74	Funds Unknown	U.S. Dept. of the Interior —Office of Water Resource Research
Hydrology of constructed lagoon systems connected to tidal estuaries	Delaware State Division of Fish & Wildlife/ F.C. Daiber	July 73— June 74	\$5,925	U.S. Dept. of the Interior —Bureau of Sport Fisheries & Wildlife— Federal Aid Division
Inventory of marine water courses	Rhode Island State Division of Fish & Wildlife/J.A. Stolgitis	July 72— June 73	\$2,400	U.S. Dept. of the Interior —Bureau of Sport Fisheries & Wildlife— Federal Aid Division
Wildlife indexes	New Jersey State Division of Fish & Game/ F. Ferrigno	July 72— June 73	\$1,800	U.S. Dept. of the Interior —Bureau of Sport Fisheries & Wildlife— Federal Aid Division
Ecology and management of mosquito impoundment	New Jersey State Division of Fish & Game/ F. Ferrigno	July 72— June 73	\$1,800	U.S. Dept. of the Interior —Bureau of Sport Fisheries & Wildlife— Federal Aid Division
Biology in manmade lagoons and natural tidal tributaries	Delaware State Division of Fish & Wildlife/ F.C. Daiber	July 73— June 74	\$5,925	U.S. Dept. of the Interior —Bureau of Sport Fisheries & Wildlife— Federal Aid Division
Water quality in manmade lagoons and natural tidal tributaries	Delaware State Division of Fish & Wildlife/ F.C. Daiber	July 73— June 74	\$5,925	U.S. Dept. of the Interior —Bureau of Sport Fisheries & Wildlife— Federal Aid Division
Hydrological circulation in manmade lagoons and natural tidal guts	Delaware State Division of Fish & Wildlife/ F.C. Daiber	July 72— June 73	\$1,950	U.S. Dept. of the Interior —Bureau of Sport Fisheries & Wildlife— Federal Aid Division
Remote temperature profiles	Connecticut State Department of Environmental Protection/ Dr. W.R. Whitworth	July 72— June 73	\$600	U.S. Dept. of the Interior —Bureau of Sport Fisheries & Wildlife— Federal Aid Division
Long-term effects of light and nutrients on edaphic marsh algae and spermatophytes	Delaware State Division of Fish & Wildlife/ F.C. Daiber	July 72— June 73	\$878	U.S. Dept. of the Interior —Bureau of Sport Fisheries & Wildlife— Federal Aid Division
An analysis of the weakfish population in the Delaware Bay	Delaware State Division of Fish & Wildlife/ F.C. Daiber	July 72— June 73	\$3,923	U.S. Dept. of the Interior —Bureau of Sport Fisheries & Wildlife— Federal Aid Division
Delaware Bay raft culture of oysters study	University of Delaware/ D. Maurer & K.S. Price	July 72— June 73	Funds Unknown	U.S. Delaware River Basin Commission
Community trophic structure of estuarine foraminifera	University of Connecticut/ L. Frankel	December 73— November 74	\$8,000	U.S. National Science Foundation—Division of Environmental Sciences
Bacterial growth and the Delaware Estuary model	Drexel University/ E.R. Glaser	September 72— August 73	Funds Unknown	U.S. National Science Foundation—Division of Engineering
Environmental impacts of petroleum industry in the Delaware Estuary	Rutgers State University/ W. Whipple	March 74— February 75	\$284,000	U.S. National Science Foundation—Division of Environmental Sciences & Resources

CONTRACT TITLE	PRINCIPAL INVESTIGATOR	SCHEDULE	FUNDING LEVEL	SUPPORTING AGENCIES
Navy environment nearshore and coastal environment	University of Delaware/ W.S. Gaither	July 73— June 74	\$80,000	U.S. Dept. of Defense— Navy
Application of ecological, geological & oceanographic ERTS-a imagery of Delaware coastal resources planning	University of Delaware/ V. Klemas, R.R. Jordan, & J.M. Goodman	January 74— December 74	\$0	NASA—Organization & Management Office— University Affairs Office
Skylab earth resources experiment package application to ecological, geological and oceanographic investigation of Delaware Bay	University of Delaware/ V. Klemas, R.R. Jordan, & B. Kingsam	September 73— August 74	\$0	NASA—Organization & Management Office— University Affairs Office
Application of ecological, geological and oceanographic arts-an imagery to Delaware's coastal resources planning	University of Delaware/ Dr. V. Klemas	July 72— June 73	Funds Unknown	NASA
A study of weight loss in American shad during the fresh water migration	Essex Marine Lab/ W.C. Leggett	July 72— June 73	\$45,000	U.S. Dept. of Commerce—NOAA NMFS
The role of benthic organisms as elements of an ecological warning system	Delaware State Division of Fish & Wildlife/ C.A. Lesser, R.B. Biggs	September 72— August 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—Sea Grant Office
Alternative growth paths and policies for coastal zone community development in Delaware	University of Delaware/ D.K. Smith	September 72— August 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—Sea Grant Office
Biochemistry of organic matter in Delaware Bay and the adjacent Atlantic Ocean	University of Delaware/ F.M. Swain	September 72— August 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—Sea Grant Office
Coastal storm damage with special reference to the Delmarva region	University of Delaware/ F. Swaye & J. Mather	September 72— August 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—Sea Grant Office
Geologic history of shoreline rates of change and bottom morphology	University of Delaware/ J.C. Kroft	September 72— August 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—Sea Grant Office
Biological effect of overboard spoil at the Lewes, Delaware, Ferry Terminal	University of Delaware/ D. Mauer & R. Biggs	September 72— August 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—Sea Grant Office
New food resources of Delaware Bay	University of Delaware/ V. Lotrich	September 72— August 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—Sea Grant Office
Coastal zone development objectives	University of Delaware/ W.S. Gaither & J.M. Goodman	September 72— August 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—Sea Grant Office
Analysis of research requirements in Delaware Bay	U.S. Delaware River Basin Commission/ D. Pollis	August 72— July 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—Sea Grant Office
Trace metals in estuarine organism and sediments	University of Delaware/ R.B. Biggs	September 72— August 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—Sea Grant Office
The nitrogen cycle in the Delaware Estuary	Rutgers State University T.J. Tuffy J.V. Hunter, & J. Cirello	July 74— June 75	\$13,056	U.S. Dept. of the Interior —Office of Water Resource Research
The carbon cycle of an estuary	Brookhaven National Lab/ G.M. Woodwell, D. Whitney & C. Hall	July 73— June 74	Funds Unknown	U.S. Atomic Energy Commission—Bio- medical & Env. Res. Div.

CONTRACT TITLE	PRINCIPAL INVESTIGATOR	SCHEDULE	FUNDING LEVEL	SUPPORTING AGENCIES
Determinations of heavy metal wastes in Long Island Sound	University of Connecticut/ P. Dehlinger	July 72— June 73	\$75,000	U.S. Dept. of Commerce —NOAA—Sea Grant Office
Carbon budget of Flux Pond Estuary, Long Island, New York	Brookhaven National Lab/ G.M. Woodwell, P. Rich & C.S. Hensser	May 73— June 74	\$105,000	U.S. National Science Foundation—Division of Environmental Sciences
Size analysis and heavy mineral distribution in Delaware Bay sediments	University of Delaware/ B.P. Glass	September 72— August 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—Sea Grant Office
Seismic reflection surveys of sedimentary structures of Delaware Bay	University of Delaware/ R.E. Sheridan	September 72— August 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—Sea Grant Office
Groin study on the north shore of Suffolk County, Long Island, between Orient Point and Port Jefferson Harbor	New York Ocean Science Lab/Dr. T. Omholt	February 73— March 74	Funds Unknown	New York Ocean Science Lab
Estuarine and coastal water dynamics controlling sediment movement plus plume development in Long Island Sound	U.S. National Aero. & Space Administration/ F.H. Ruggles	July 72— June 73	Funds Unknown	NASA
Ecosystem investigations sediment analysis of bottom grab samples	Lehigh University/ Dr. J.M. Parks	July 72— June 73	\$19,800	U.S. Dept. of Commerce —NOAA NMFS
A study of local collective flow near the bay and ocean floor	University of Delaware/ F.A. Costello	September 72— August 73	Funds Unknown	U.S. Dept. of Commerce —NOAA—Sea Grant Office
Interdisciplinary study of the estuarine and coastal oceanography of Block Island Sound and adjacent New York waters	Long Island University/ E. Yost & R. Hollman	February 73— January 74	\$0	NASA—Organization & Management Office— University Affairs Office
Effect of topography and network density on areal distribution of prescription	University of Delaware/ Dr. R. Mather	July 74— June 75	Funds Unknown	U.S. Dept. of the Interior —Office of Water Resource Research
Tidal discharge research, New Jersey	U.S. Department of the Interior/A.C. Lendo	July 72— June 73	Funds Unknown	U.S. Dept. of the Interior —Geological Survey— Water Resource Division
The determination of the frequency of drought flow of varying degrees of severity and duration	U.S. Department of the Interior/E.G. Miller	July 73— June 74	\$2,000	U.S. Dept. of the Interior —Geological Survey— Water Resource Division
The collection of records of tidal stage and discharge	U.S. Department of the Interior/A.A. Vickers	July 73— June 74	\$20,749	U.S. Dept. of the Interior —Geological Survey— Water Resource Division
Hydrologic interpretations based on remote sensing techniques, Long Island, Lake Ontario, Chesapeake Bay	U.S. Department of the Interior/E.J. Pluhowski	July 72— June 73	Funds Unknown	U.S. Dept. of the Interior —Geological Survey— Water Resource Division
Submerged diffusers for thermal discharge in coastal waters	MIT/Dr. Harleman	July 73— June 74	Funds Unknown	Stone & Webster Engineering Corp.
Water quality study of Montauk Harbor, Long Island, New York, using a hydraulic model	New York Ocean Science Lab/J.P. Hunt & T. Omholt		Funds Unknown	New York Ocean Science Lab

CONTRACT TITLE	PRINCIPAL INVESTIGATOR	SCHEDULE	FUNDING LEVEL	SUPPORTING AGENCIES
Monitoring thermal discharge from Northport Power Station	Long Island Lighting Company/	July 73— June 74	Funds Unknown	Long Island Lighting Company
Development and testing of numerical models of pollution of the New York Bight	U.S. Navy/Z. Laevastu	July 72— June 73	\$48,500	U.S. Environmental Protection Agency—Office of Research & Development
Surface water movements in New York Harbor	Long Island University/ J. Tyler	July 73— June 74	Funds Unknown	U.S. Dept. of Transportation—Coast Guard
Development of a management model for the west end of Long Island Sound	State University of New York/M.J. Boman	October 72— September 73	Funds Unknown	U.S. Dept. of Commerce—NOAA—Sea Grant Office
Water quality planning	Connecticut State Department of Environmental Protection/R.B. Anderson	July 73— June 74	Funds Unknown	U.S. Environmental Protection Agency—Office of Research & Development
Long Island Sound regional study water quality management plan	New York State Department of Environmental Conservation/ R.C. Pleasant	July 73— June 74	Funds Unknown	U.S. Environmental Protection Agency—Office of Research & Development

APPENDIX C
ORGANIZATIONAL REPRESENTATIVES TO THE NEW YORK
BIGHT MESA
ADVISORY COMMITTEE AND SUPPORTING PANELS

THE CENTRAL COMMITTEE

CHAIRPERSON - R. L. Swanson
Project Manager
MESA New York Bight Project

EXECUTIVE SECRETARY - Stanley Chanesman
MESA New York Bight Project

Mr. Russell Ernst
Regional Supervisor
Division of River Basin Studies
U.S. Fish and Wildlife Service

Mr. Thomas R. Glenn, Jr.
Director and Chief Engineer
Interstate Sanitation Commission

Mr. Arthur Godfrey
National Advisory Committee on
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Mr. Stephen Gordon
Asst. Commissioner for Metropolitan
New York Affairs
New York State Department of
Environmental Conservation

Col. Thomas C. Hunter, Jr.
District Engineer
U.S. Army Corps of Engineers

Mr. Martin Lang
First Deputy Administrator
New York City Environmental
Protection Administration

Mr. Bernard Manowitz
Associated Universities, Inc.
Brookhaven National Laboratory

Dr. Clifford S. Russell
Resources for the Future, Inc.

Dr. Richard Spear
Chief
Surveillance and Monitoring Branch
U.S. Environmental Protection Agency

Ms. Claire Stern
Executive Director
Long Island Environmental Council

Mr. James T. B. Tripp
Environmental Defense Fund

INFORMATION USER ADVISORY PANEL

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National Weather Service-NOAA

Mr. Frank Basile
Bureau of Land Management
U.S. Department of the Interior

Dr. Seville Chapman
Director
Assembly Scientific Staff
The Assembly, State of New York

Mr. Gordon C. Colvin
New York State Department of
Environmental Conservation

Dr. William O. Forster
Environmental Programs
Division of Biomedical and
Environmental Research
U.S. Energy Research &
Development Agency

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Director and Chief Engineer
Interstate Sanitation Commission

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District Engineer
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Executive Director
Nassau-Suffolk Regional Planning
Board

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Gateway National Recreation Area

Mr. Martin Lang
First Deputy Administrator
New York City Environmental
Protection Administration

Mr. Fred N. Rubel
Marine Environmental Protection
Staff
Third U.S. Coast Guard District (M)

Dr. Richard Spear
Chief
Surveillance and Monitoring Branch
U.S. Environmental Protection Agency

Harold F. Udell
Commissioner
Department of Conservation and
Waterways, Town of Hempstead

CAPT James L. Verber
Northeast Technical Services Division
U.S. Food and Drug Administration

Mr. Hall Winslow
Coordinator
Environmental Studies
Tri-State Regional Planning
Commission

Mr. John Wrenn
Assistant to the Chief Engineer
The Port Authority of New York and
New Jersey

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American Littoral Society

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Environmental Control Department
NL Industries, Inc.

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Environmental Affairs
Public Service Electric and
Gas Company

Mr. Keith G. Hay
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Mr. John R. Jannarone
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Consolidated Edison Company of
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National Boatmen's Alliance

Mr. Richard H. Miller
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Long Island Fishermen's Assoc.

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Ms. Barbara Swartz
Environmental Quality Chairperson
League of Women Voters of New York

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Environmental Defense Fund

Mr. Christopher M. Weld
National Coalition for Marine
Conservation

SCIENTIFIC AND TECHNICAL ADVISORY PANEL

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MESA New York Bight Project

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Chemical Oceanography
New York Ocean Science Laboratory

Mr. Peter Anderson
Surveillance and Analysis Division
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Dr. Gabriel T. Csanady
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Col. Thomas C. Hunter, Jr.
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Marine Sciences Research Center
State University of New York

Prof. James Simpson
Lamont-Doherty Geological
Observatory of Columbia University

Dr. Donald F. Squires
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Dr. L. A. Walford
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New Jersey Marine Sciences Consortium

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