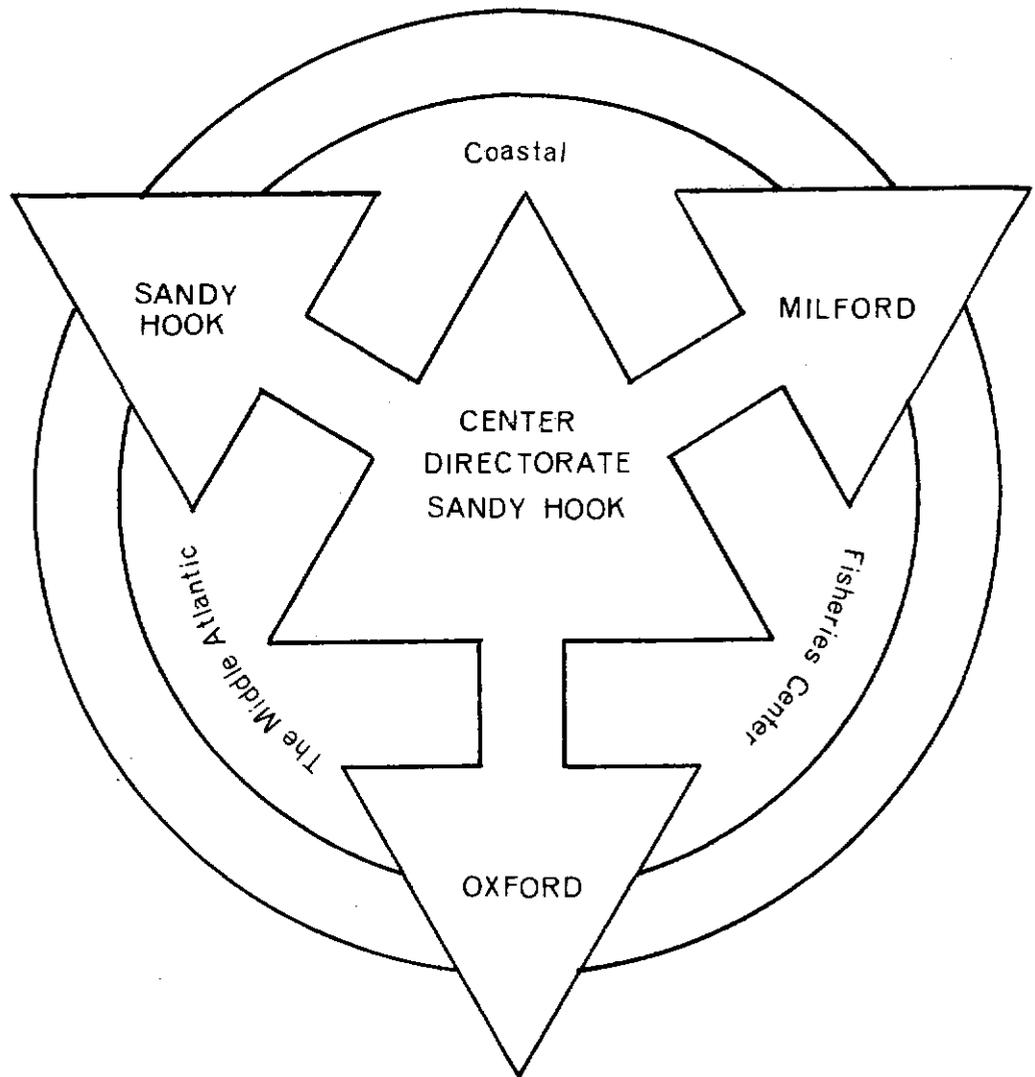




BIOLOGICAL STUDIES IN THE NEW YORK BIGHT:  
A REVISED PROPOSAL BY THE MIDDLE ATLANTIC COASTAL  
FISHERIES CENTER, NMFS, TO NOAA-MESA FOR FUNDING  
IN FY 1975

U.S. DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service  
Northeast Region

MIDDLE ATLANTIC COASTAL FISHERIES CENTER



Informal Report No. 21-A

May 10, 1974

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## I. INTRODUCTION

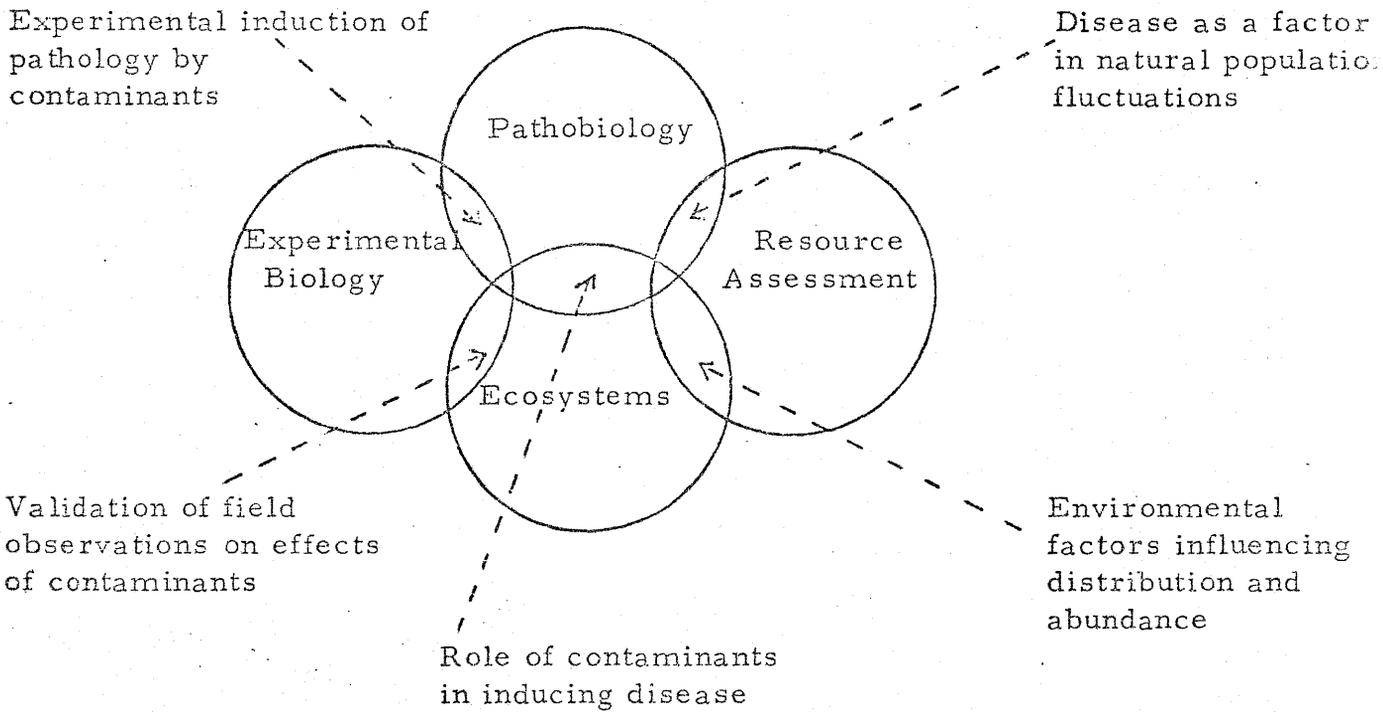
The New York Bight, as defined for biological purposes, includes the Atlantic continental shelf area from Montauk Point, N. Y. to Cape May, N. J. -- including the lower Hudson estuary, Raritan Bay, and Long Island Sound. The apex area of the Bight has received greatest attention in FY 1974 and will receive continued attention in the first half of FY 1975. The inner reaches of the Bight are among the most degraded waters on this planet, yet such waters are still heavily used for sport fishing and some commercial fishing. Heavy industry and heavy ship traffic characterize the apex area, and the human population on its shores includes some 11 million.

A number of independent studies of the Bight and its resources have been carried out since the 1940's. These studies have provided some information useful to an overall understanding of the area as a productive system. Thus some information is available on hydrography, and on effects of ocean disposal of wastes. The most extensive work was carried out by the then Sandy Hook Marine Laboratory (now a component of this Center) from 1968 to 1972 under contract with the Corps of Engineers. An extensive report of findings was published in 1972, and has been widely distributed and used since then. A number of universities, such as CUNY and Stony Brook have carried out specialized studies, usually because of the particular interest of individual faculty members, or the availability of Corps of Engineers funding.

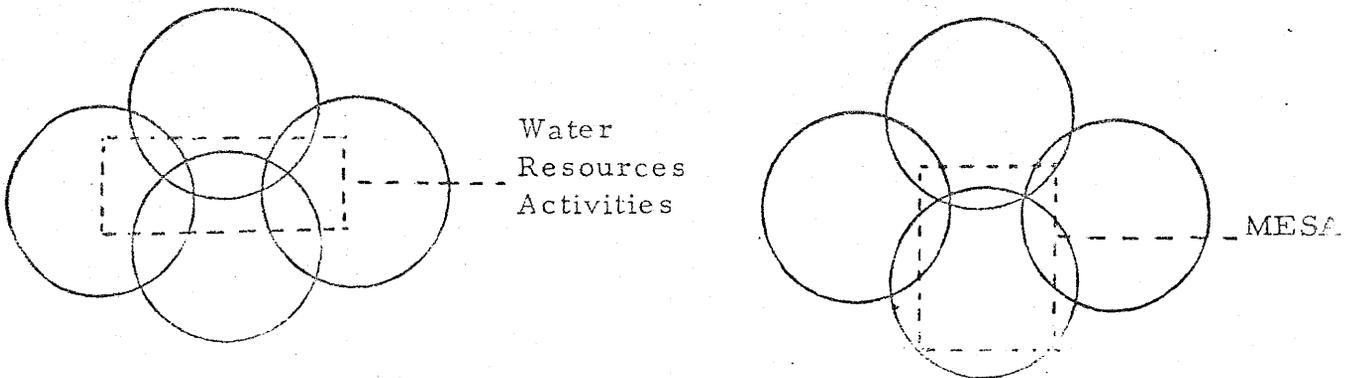
The Middle Atlantic Coastal Fisheries Center (MACFC), a component of the National Marine Fisheries Service, has as its mission the development of information about fish and shellfish stocks of the Middle Atlantic Bight, and about the marine ecosystems which support the resource species. The New York Bight is an integral part of the Middle Atlantic Bight. Use of the Bight apex area as a major disposal site for wastes makes it imperative that we assess and understand the effects of such practices on living resources and ecosystems.

The inception of the NOAA-MESA New York Bight Project late in FY 1973 provided opportunity to expand ongoing and planned research in the New York Bight, augmenting NMFS in-house programs with MESA funding. MESA funding in FY 1973 constituted 7% and in FY 1974 8% of the total MACFC budget, of which approximately one-half is spent on environmental and related studies. The major research areas of the Center, their interrelations, and their relation to the MESA New York Bight project are diagrammed on the following page.

Major Research Areas of MACFC and  
Their Interactions



Special Activities of the Center as Related  
to Major Program Areas



## II. HISTORY OF MESA-FUNDED BIOLOGICAL RESEARCH IN THE NEW YORK BIGHT

Responsibility for biological research to be carried out under the NOAA-MESA New York Bight Project was delegated to the Middle Atlantic Coastal Fisheries Center in FY 1973, with the understanding that a significant part of the work would be carried out by contract with universities. Other MLC's of NOAA were given responsibility for other areas of the total New York Bight Project.

Several generations of planning documents (MACFC Informal Reports No. 3, 8, and 9, led to submission to MESA of MACFC Informal Report No. 13 "A proposal by the Middle Atlantic Coastal Fisheries Center for MESA funding of New York Bight biological studies" on March 26, 1973. After some modifications and negotiations, the proposal was accepted and funded in FY 1973 at \$235.5K and in FY 1974 at \$339.2K (with an additional increment of \$21K received on April 18 -- resulting in a FY 1974 total of \$360.2K as of May 10, 1974).

Field work began as quickly as possible in the late spring of 1973 in several of the proposed research areas, and research contracts were given to a number of universities, as indicated in the following table (page 4).

During FY 1974, other MLC groups began their activities, and a number of workshops were held (data formats, chemistry, relation of physical-geological research to biological research). Major NMFS vessels (Albatross IV and Oregon II) were made available for quarterly two-week cruises, and smaller NMFS vessels (Rorqual, Xiphias, Shang Wheeler) were used for local studies in the apex area. Major NMFS-funded environmental studies in Long Island Sound, Raritan Bay, and on the New Jersey coast have greatly supplemented the MESA-funded work, and extensive fish resource assessment cruises (with part of the charter costs supported by MESA) have added substantially to our information about economic resources in the New York Bight and adjacent waters.

Although we are actually, on the date of this proposal, approximately one year into active research under MESA funding, a number of significant advances in our understanding have been made. These, together with our projected milestones for FY 1974, are summarized in the next section. Despite the progress made, there are still gaps in our information, as indicated in the following two diagrams (p. 6 and 7).

MESA CONTRACT FY 73 & 74

Contract No.	Monitor	Agency	Principal Investigator	Title	Cont. Amt.	Eff. Date	Oblig. Date	Est. Comp.
03-3-043-53	Pearce	U. of Rhode Island	Dr. Sailer	Statistical analysis of benthic sample data from N.Y. Bight area.	35.7	6/15/73	6/15/73	12/15/74
03-3-043-54	Pearce	Trenton State College	Prof. Rose	Analysis of benthic samples collected by NOAA-MESA Program.	16.8	6/6/73	6/6/73	12/6/73
03-3-043-48	Pearce	U. of Maryland	Dr. Small	Analysis of ciliate protozoa associated with man induced change to sublittoral environment of N.Y. Bight	36.5	5/15/73	5/15/73	5/31/74
03-3-043-50	Pearce	Adelphi Univ.	Dr. Cok	Provide chemical and physical analysis of up to 1000 samples of bottom sediments taken from the Apex of the N.Y. Bight.	11.5	6/1/73	6/1/73	5/31/74
03-4-043-309	Pearce	State U. of N.Y. Stony Brook	McHugh	Detailed historical study of domestic commercial and recreational and foreign fisheries of N.Y. Bight.	25.0	9/12/73	9/12/73	8/31/74
03-4-043-311	Pearce	City College of N.Y.	Tietjen	Determine biomass and temporal fluctuation in the distribution and abundance of benthic meiofauna through MESA defined Apex N.Y. Bight.	14.2	9/10/73	9/10/73	8/31/74
03-4-043-310	Pearce	City College of N.Y.	Malone	Study seasonal variation in the distribution and magnitude of phytoplankton and zooplankton in dumping grounds of N.Y. Bight.	33.3	9/10/73	9/10/73	8/31/74
03-4-043-315	Pearce	City College of N.Y.	Dr. Lee	Research of Environmentally sensitive foraminifera theoretically capable of developing chronological data on increments of the pollutant burden in N.Y. Bight.	24.4	12/73	1/74	1/75

MESA CONTRACT FY 73 & 74

Contract No.	Monitor	Agency	Principal Investigator	Title	Cont. Amt.	Eff. Date	Oblig. Date	Est. Comp.
03-304-3-54	Pearce	Trenton State (Extension)	Rose	Analysis of Benthic Samples	12-0	1/1/74	1/1/74	6/15/74
	McNulty	Montclair State College	Koditscheck	Study of Antimicrobial Resistant Bacteria Isolated from Sediments in the Area of the Sewage Dump Sites in the New York Bight.	6.3		5/6/74	12/74

Primary  
productivity,  
phytoplankton

Benthos -  
distribution  
and abundance

Benthic fish -- assessment  
and fin rot

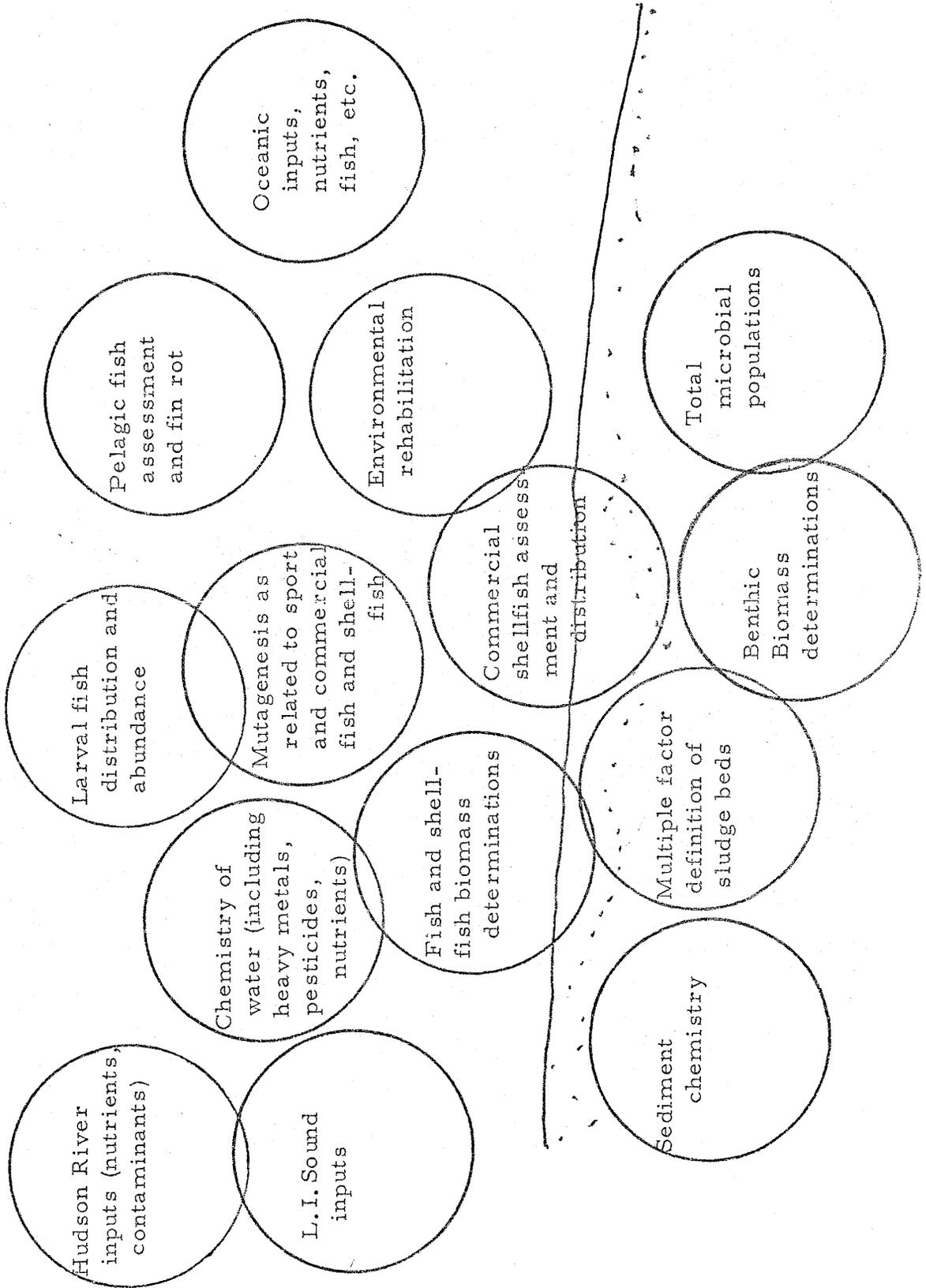
Sediments -  
grain size,  
organics,  
metals

Microbiology -  
(bacteria in  
sediments as  
related to  
fin rot)

Benthic  
respirometry

Meiobenthos - as  
indicators of  
pollution

RESEARCH NEEDS



### III. SIGNIFICANT ACCOMPLISHMENTS

1. During the first nine months of the MESA/Biology Program, emphasis was placed on the field operations and data collection aspects of the program. Such efforts involved planning and conducting (1) six major long-duration cruises totalling 86 sea days and (2) 46 short-duration cruises totalling 132 sea days.

2. Among the above cruises, some 16 were devoted to large-scale studies on the etiology, incidence and prevalence of fin rot diseases in demersal finfish. Demonstrated with 95% probability: that the epicenter of fin rot disease for five (5) species of flatfishes is located in the Raritan Bay-New York Bight apex. Demonstrated: that seasonal incidences (degree of infection) of fin rot disease in winter flounder can exceed 30% of the total winter flounder catch in and around the dump site areas. Demonstrated: that while there is a marked seasonal variation in incidence (possibly due to migratory behavior patterns) of fin rot disease, the prevalence of the disease remains centered in the New York Bight apex.

3. Among the above cruises were six devoted to resource assessment (abundances and spatial and temporal distributions) of the demersal finfishes. Demonstrated: that, at least on a seasonal basis, some degrees of avoidance of specific oceanic areas, those characterized by sediments with 10% or higher oxidizable organic carbon content, may be practiced by demersal finfish.

4. Studies on meiofaunal samples derived from the above cruises have (1) demonstrated that the sediments, water columns and water surfaces above dredge spoil and sewage dump sites may be characterized by a dominance of bacterivorous protozoans (amoeboid and ciliated) and (2) demonstrated that the numbers (diversities) of protozoan genera may be reduced by up to 50% over these same sediments.

5. Studies on multi-replicated benthic macrofaunal samples demonstrated that precision of studies (reproducibility; "limits of confidence") of replicate samples may approach 00% if 13 replicates are taken. Indications are that this level of sampling intensity may be further reduced and the degree of precision increased. Work is continuing. Preliminary suggestions as to suitable benthic macrofaunal and meiofaunal indicator organisms have been put forward for consideration.

6. Characterization of the mechanical properties of sediment samples (grain size, carbon content, etc.) from the New York Bight apex is proceeding. A preliminary sediment distribution map of the apex has been produced. This map will be updated and extended as the cruises continue.

7. A large benthic sorting center and museum was designed and established to process and to accession MESA benthic and planktonic collections. Seven MESA-funded sorters, identifiers and supervisory personnel are being accommodated and the museum has a present capacity for over 5,000 samples.

8. Despite frustrating delays in construction and shipment of the Pamatmat multiple corer and associated electronic equipment, comprehensive sea bottom respiration (oxygen consumption) studies were initiated during the February 1974 cruise of the R/V Albatross IV in the New York Bight apex. These studies, the first ever performed on the east coast, yield data which directly reflects the environmental condition of the apex floor.

9. A complex but workable and standardized system of sample workup, involving taking of samples, coding them, logging them on master station logs, followed by distribution to widely separated cooperating researchers, and by checking for timely submission of data against the station logs. Such samples are routinely distributed to and data received from: (1) sediment analysis task, (2) environmental chemistry task, (3) benthic macrofaunal task, (4) benthic meiofaunal (4) tasks. Samples for benthic respirometry, microbiology, nutrient concentrations, and routine chemical oceanographic parameters are worked up separately but are included on the station master logs.

MESA: Scheduled Milestones, Fiscal Year(s) '73 and '74

<u>Milestones</u>	<u>Completion Date</u>	<u>Remarks</u>
1. Development of Field Sampling Design		
a) Statistical Analysis of Existing Data	12/30/73	Completed
b) Reconnaissance Census; Field Operations	12/30/73	Completed
c) Reconnaissance Census; Analysis	12/30/73	75% complete
2. Automatic Data Processing		
a) Designs	12/30/74	Completed
b) Data processing	Continuing	
3. Baseline: Benthic Respirometry		
a) Tool up and testing	12/30/73	Completed
b) Field collections - NYB Apex	9/30/74	On schedule
c) Analyze field collections - Apex	3/30/75	On Schedule
4. Baseline: Benthic macrofaunal distribution		
a) Field collection - NYB Apex	12/30/74	On schedule
b) Analyze field collections - NYB Apex	3/30/76	On schedule
c) Megabenthos - mortality rates	Continuing	NMFS financed
5. Baseline: Benthic Meio-fauna Distribution		
a) Nematodes - NYB Apex	3/30/75	On schedule
b) Ciliated protozoa - NYB Apex	3/30/75	On schedule
c) Amoeboid protozoa - NYB Apex	Continuing	NMFS financed
d) Foraminiferan Protozoa - NYB Apex	12/30/74	Just started. Contract effective 1/1/74
6. Baseline: Microbiology Sediment and Water Column		NMFS financed in fiscal years 73 and 74
a) Field collections - NYB Apex	6/30/74	NMFS financed in fiscal years 73 and 74
b) Analysis field collections - NYB Apex	3/30/75	Requested MESA funding fiscal 75

<u>Milestones</u>	<u>Completion Date</u>	<u>Remarks</u>
7. Baseline: Plankton Primary Productivity		
a) Field collections - NYB Apex	9/30/74	On schedule - CCNY contract
b) Analyze field col- lections - NYB Apex	3/30/75	On schedule - CCNY contract
c) Field collections - Raritan Bay	9/30/74	On schedule
d) Analyze field col- lections - Raritan Bay	3/30/75	On schedule
8. Baseline: Finfish Distribtuion		
a) Field collections - NYB Apex	9/30/74	On schedule
b) Analyze field col- lections - NYB Apex	6/30/75	On schedule
c) Historical Review	6/30/74(5)	On schedule - SUNY contract
9. Baseline: Contaminants		
a) Sediments and water columns	Not funded	Requested MESA funding for fiscal 75
b) Living resources	Not funded	NMFS financed in fiscal 75
10. Baseline: Sediment Analyses		
a) Field collections - NYB Apex	9/30/74	On schedule
b) Analyze field col- lections - NYB Apex	6/30/75	On schedule

The following tabulation is an analysis of progress to date on MESA/Biology tasks. Of some 28 milestones, four have been completed, 15 tasks are on schedule, one is of a continuing i.e., unscheduled nature, six future and six are being financed by NMFS and are operating under different scheduling. Thus, of a total of 28 milestones, delays in completion and/or progress have occurred in only two cases. One delay was incurred by an overly conservative estimate of man power needs and remedial action has been taken. We expect completion by September 30, 1974. The second case involved delays: 1) funding was deferred by MESA for fiscal years 73 and 74, 2) an MACFC decision to fund the contract out of overhead funds was approved and the contract finally became effective on January 1, 1974. Work is now underway. We expect no untoward delay in completion.

<u># of</u>	<u>Milestones Completed</u>	<u>On</u>	<u>Delayed</u>	<u>Continuing</u>	<u>NMFS</u>
		<u>Schedule</u>			<u>Financed</u>
3	2	0	1	0	0
2	1	0	0	1	0
3	1	2	0	0	0
3	0	2	0	0	1
4	0	2	1	0	1
2	0	0	0	0	2
4	0	4	0	0	0
3	0	3	0	0	0
2	0	0	0	0	2
2	0	2	0	0	0
<u>28</u>	<u>4</u>	<u>15</u>	<u>2</u>	<u>1</u>	<u>6</u>

1/ Does not include work planned outside the New York Bight Apex.

Note: This chart is reproduced without change from our FY 1974 MESA proposal. Items 9 and 10 have not been included in our FY 1975 proposal.

III MACFC - Proposed MESA Investigations

	FY-73	FY-74	FY-75	FY-76	FY-77
1. Development of Field Sampling Design					
a) Statistical Anal. Existing Data: 26 Key Stations : All previous stations (2400)					
b) Reconnaissance Census: Field Collections Existing Strata Macrofauna Meiofauna (Nematodes) Heavy metals Sediment Analyses					
c) Reconnaissance Census: Analyze Field Collections Variance - station, stratum, strata Biomass, indicator taxa, all species					
2. Automatic Data Processing (ADP) - all biological investigations					
a) Format Design					
b) Data Processing					
3. Baseline Benthic Respirometry					
a) Tooling up and testing methodology					
b) Field Collections in Apex of N. Y. Bight (Delaware II or comparable vessel)					
c) Analyze Field Collections from Apex					
d) Field Collections in Remaining Bight (Delaware II or comparable vessel)					
e) Analyze Field Collections from Remaining Bight					
4. Baseline Benthic Macrofaunal Distribution and Census					
a) Field Collections in Apex of Bight (Delaware II or comparable vessel)					
b) Analyze Field Collections from Apex of Bight					
c) Field Collections in Remaining Bight (Delaware II or comparable vessel)					
d) Analyze Field Collections from Remaining Bight					
e) Macrobenthos Mortality Rates					
5. Baseline Benthic Meiofaunal Distribution and Census					
a) Nematodes Field Collections in Apex of Bight (Delaware II or comparable vessel) Analyze Field Collections from Apex of Bight Field Collections in Remaining Bight (Delaware II or comparable vessel) Analyze Field Collections from Remaining Bight					
b) Ciliated Protozoa Field Collections in Apex of Bight (Delaware II or comparable vessel) Analyze Field Collections from Apex of Bight Field Collections in Remaining Bight (Delaware II or comparable vessel) Analyze Field Collections from Remaining Bight					
c) Amoeboid Protozoa Field Collections in Apex of Bight (Delaware II or comparable vessel) Analyze Field Collections from Apex of Bight Field Collections in Remaining Bight (Delaware II or comparable vessel) Analyze Field Collections from Remaining Bight					
d) Foraminiferal Protozoa Field Collections in Apex of Bight (Delaware II or comparable vessel) Analyze Field Collections from Apex of Bight Field Collections in Remaining Bight (Delaware II or comparable vessel) Analyze Field Collections from Remaining Bight					
6. Baseline Microbiology - Sediment and Water Column					
a) Field Collections in Apex of Bight (Delaware II or comparable vessel)					
b) Analyze Field Collections from Apex of Bight					
c) Field Collections in Remaining Bight (Delaware II or comparable vessel)					
d) Analyze Field Collections from Remaining Bight					
7. Baseline Plankton and Primary Productivity					
a) Field Collections in Apex of Bight (Delaware II or comparable vessel)					
b) Analyze Field Collections from Apex of Bight					
c) Field Collections in Raritan Bay (65 ft. vessel available)					
d) Analyze Field Collections from Raritan Bay					
e) Field Collections in Remaining Bight (Delaware II or comparable vessel)					
f) Analyze Field Collections from Remaining Bight					
8. Baseline Finfish Distribution and Census					
a) Field Collections in Apex of Bight (Delaware II or comparable vessel)					
b) Analyze Field Collections from Apex					
c) Field Collections in Remaining Bight (Delaware II or comparable vessel)					
d) Analyze Field Collections from Remaining Bight					
e) Historical Review					
9. Baseline Contaminants					
a) Sediments and Water Columns Field Collections in Apex of Bight (Delaware II or comparable vessel) Analyze Field Collections from Apex Field Collections in Remaining Bight (Delaware II or comparable vessel) Analyze Field Collections from Remaining Bight					
b) Living Resources Field Collections in Apex of Bight (Delaware II or comparable vessel) Analyze Field Collections from Apex Field Collections in Remaining Bight (Delaware II or comparable vessel) Analyze Field Collections from Remaining Bight					
10. Baseline Sediment Analyses					
a) Field Collections in Apex of Bight (Delaware II or comparable vessel)					
b) Analyze Field Collections from Remaining Bight					
c) Field Collections in Remaining Bight (Delaware II or comparable vessel)					
d) Analyze Field Collections from Remaining Bight					

MESA Funded inhouse  
MESA Funded contract  
NMFS Funded  
Reports



#### IV. GENERAL RESEARCH PLAN FOR FY 1975

MESA-funded biological research in the New York Bight in FY 1975 will continue to focus on the apex area for at least the first half of the year, and then will begin to shift emphasis to the south coast of Long Island or to the deep water alternate dump site(s), once its (their) location(s) has been determined. Since flexibility for such shift is built into several task proposals, and some preliminary work is being done. We, for example, conducted two cruises along the south shore of Long Island in response to need for local information about sludge movement; and we are one of the major participants in the preliminary study of a proposed deep water dump site, scheduled for May 1974. We also plan two major shellfish sampling and assessment cruises in the Middle Atlantic Bight in June and August, 1974. However, it will be necessary to complete in an orderly fashion the research funded in FY 1974 before any drastic reorientation can be made.

University contract research will continue with roughly the same orientations as in FY 1974, since two years constitutes a realistic minimum for most research contracts. Most of the present contracts will be planned for termination at the end of FY 1975, at which time others will be phased in. The levels of funding must be drastically reduced in FY 1975, however, because of the limitation on total target allowance from MESA for biological work conducted by or supervised by this Center.

Two areas of needed expansion in FY 1975 are (1) sorting, identifying, and analyzing benthic samples, and (2) comparing of fish and shellfish populations of the Bight with adjacent continental shelf areas. The two tasks involved with this work are correspondingly the largest in our proposal. We must complete analyses of the benthic samples and of the fish surveys before moving on to additional field surveys.

The major categories of biological research (listed as tasks in our FY 1973-74 proposal) continue to be reasonable subdivisions for planning and budgeting purposes, even though a number of them are closely related. These same task categories have been used in the present proposal, except that Task No. 9 (Contaminant Analysis) and Task No. 10 (Sediment Analysis) will be funded thru AOML (verbal information from MESA-NYB Project Office). It should be reemphasized that much of the in-house environmental and experimental research of this Center, funded at well over a million dollars, is directly or indirectly supportive of the MESA New York Bight Project.

The fundamental hypothesis underlying all MESA/Biology studies is that man-induced changes in the marine environment affect, to a greater or lesser degree, all marine organisms living therein. Such effects may include but are not limited to (1) species abundance and/or diversities, (2) behavioral changes such as avoidance, (3) gross pathologic conditions, (4) mutagenicity in embryos, juveniles and adults, (5) aerobic and/or anaerobic conditions of the water column or sediments, and (6) changes in dominant microbial, meiofaunal and macrofaunal species, in primary productivity and in bottom respiration and oxygen consumption. Man-induced environmental changes may include but are not limited to (1) total % organic carbon content of sediments, (2) heavy metal (and other contaminants) content of sediments and water columns, (3) excess nutrient levels.

## V. TASK AND WORK UNIT DESCRIPTIONS -- FY 1975

### Introduction

The immediate need for extensive investigations of man's effects on the coastal zone was stressed in two reports prepared by special oceanography committees of the National Academy of Sciences (NAS). These reports entitled, "Wastes Management Concepts for the Coastal Zone; Requirements for Research and Investigation" (NAS, 1970) and "Marine Environmental Quality; Suggested Research Programs for Understanding Man's Effect on the Oceans" (NAS, 1971), emphasized the need for highly quantitative, well analyzed biological data to "... be used to make management decisions that allow and ensure the continued existence of a functioning and productive ocean" (NAS, 1971).

Subsequently the Smithsonian Advisory Committee (SAC) completed a paper, "Report on Studies of the Effects of Waste Disposal in the New York Bight" (SAC, 1972). This report made numerous recommendations in regard to future research.

All of the aforementioned documents stressed the need for a sampling design and protocol to eliminate bias and result in data which "... will allow conclusions to be reached on a basis of predetermined levels of statistical significance." In response to a request by MESA to develop a planning document for research in the New York Bight, the Middle Atlantic Coastal Fisheries Center (MACFC) developed a research program summarized in MACFC Informal Report No. 13 "A proposal by the Middle Atlantic Coastal Fisheries Center, NMFS, for MESA funding New York Bight studies". The document was submitted to MESA on March 26, 1973, and the proposed research was implemented late in FY 1973 and in FY 1974, with some modifications from the proposal as approved by the MESA New York Bight Project Manager.

The present document constitutes our proposal for continued MESA funding in FY 1975. Tasks proposed are numbered as in the FY 1974 proposal, except that Tasks 9 and 10 have been omitted (they are to be funded from other MESA sources). The total amount requested (\$450K) is the target allowance given to us verbally by the MESA-NYB Project Manager on March 19. The present proposal is a downward revision of an earlier proposal (dated March 8, 1974) for MESA biological studies funded at \$630K in FY 1975.

## Task No. 1. STATISTICAL DESIGN AND ANALYSIS

The MESA/Biology Program is designed, on a statistically-reliable basis and at a high level of probability, to demonstrate by means of computerized multi-variate analysis, any cause-effect relationship between the environmental changes and the living marine organisms, to define impacted areas as reflected by changes in biota, to single out "indicator" organisms, and to permit meaningful monitoring and prediction. The data management, processing and reduction necessary for such analyses is thus of supreme importance, requiring the utmost sophistication and reliability of programming. Current financing provides for (1) lead-time preparation, testing and adaptation of sensitive multi-variate analyses programs, (2) establishment of limits of confidence for experimental data as functions of sampling intensity, station design, sediment characteristics, species diversities, abundances and spatial and temporal distributions, (3) statistical detection and identification of "indicator" organisms, (4) statistical assessment and mapping of impacted areas, and (5) routine card punching, verification, editing, tabulation and graphic presentations of data as well as preliminary analyses (regression, etc.) of data on each experimental parameter.

### Objectives

- (1) To establish limits of confidence on submitted data as a function of sampling intensity and to make appropriate recommendations as to statistical designs necessary for stated levels of certainty in environmental monitoring and prediction functions.
- (2) To detect and to document environmentally-impacted marine areas.
- (3) To develop, test and adapt sensitive computerized programs for multi-variate analyses.
- (4) To detect and to identify key indicator organisms.

### Description

Effective multi-parameter research, responsive to mission-oriented and public needs, must be designed throughout with a view to (1) rigorous statistical validity, (2) statistically acceptable procedures for analyses of interactions, and (3) with clearly stated limits as to the possibility of acceptable extrapolation of the results. This work unit, responsive to all MESA/Biology work units, is designed to ensure that MESA management recommendations, affecting decisions involving billions of dollars, will withstand rigorous and searching questioning, and, as such, requires the utmost in statistical expertise and the highest priorities.

### Procedures

Data tabulations, as submitted, are subjected to a battery of discriminating and selective tests to achieve information on the types and number of impacted areas, and on the types and characteristics of "indicator" organisms. Existing and new computer programs for multi-variate analyses are being tested and adapted for suitability at this time to ensure the availability of a sensitive debugged computer program for such analyses when necessary.

### Products

Demonstrate sampling intensity necessary for up to 95% confidence limits of biological data and of the number of stations and sampling intensity necessary for future environmental monitoring and prediction capabilities.

Prepare and submit a sensitive, tested computer program suitable for multi-variate analysis of biological and contaminant data for the New York Bight.

TASK NO. 1 -- BUDGET SUMMARY -- FY 1975

Contract services	<u>12.0</u>
Task total	12.0

Note: Present contract of 35.5K with Dr. Saul Sails of URI for statistical design was effective 6/15/1973 and terminates 12/15/1974. Progress in research is contingent on timely receipt of data tabulations. The FY1975 proposed amount of 12.0K would extend the contract to 6/30/1975 at present level of funding.

## Task No. 2: ADP FORMAT AND OPERATIONS

The Middle Atlantic Coastal Fisheries Center is developing a single, multidisciplinary data bank for NMFS/MACFC and NOAA/MESA operations in the New York Bight (as defined by MESA). Standard punched cards and tapes will be used. Location, in all cases, to be specified by longitude and latitude. Biological entities to be identified either by the alpha numeric system (Bullis, et al) of eleven digits or by the "Woods Hole" system of some 6 digits. It is anticipated that each station card set or subset will contain (1) location, (2) oceanographic conditions, (3) atmospheric conditions, (4) species (finfish), (5) sediment analysis, (6) heavy metals content (sediment), (7) heavy metals content (water column), (8) heavy metals content (tissues), (9) species (macrobenthos), (10) species (meiobenthos), (11) species (microbenthos), (12) abundances, (13) distributions, (14) physiological effects, (15) pathological effects, (16) phytoplankton, (17) zooplankton, (18) diversity indices, (19) nutrients (water column), (20) pesticides content (water column), (21) pesticides content (tissues), (22) primary productivity and such other items as may be deemed necessary.

The purpose of the proposal is also to make available a comprehensive set of programs such that every item of experimental data contains (1) confidence limits, (2) has undergone analysis for outliers and is compatible with other data for comprehensive analyses of variance and covariance as well as several types of regression analyses. The plan for fiscal '75 is a system capable of routinely preparing, handling and analyzing increments of a minimum of 50,000 cards per year.

### Objectives

1. Develop, verify, edit, tabulate and tape, by station, season strata, all biological data derived from or related to MESA field biological operations.
2. Subject all data to a variety of computerized statistical analyses for limits of confidence, regression, etc.
3. Prepare all data tabulations in a form suitable for efficient subsection to subsequent (1) multivariate analyses and (2) studies of interactions between trophic levels as well as for rapid retrieval in response to inquiries relating to problems of (1) primary productivity, (2) biological effects of contaminants, (3) public health implications, etc.

4. Fulfill all NOAA/MESA data archiving obligations through NODC by actual deposit and/or source identification.

5. Prepare graphic apex-wide (SYMAP) presentations, by season, for each major biological parameters.

### Description

Much of the work will be performed in-house (Objective #1), with the exception that routine card punching, first verification, etc. will be performed through contract with a cooperating local academic institution. All NOAA/NODC archiving requirements will be the responsibility of the in-house ADP group (Objective #4). Necessary computer programs for Objectives #2 and #5 have been prepared, debugged and are in standard usage. Final data tabulation formats (Objective #3) must await recommendations resulting from current contract studies (Task No. 1). ADP group is responsible for checking all data submissions against parameter lists (observables) by season and station, for the maintenance of sample (and/or data) transmission logs and for quarterly reports on currency of data management activities.

Technically, the MESA/Biological Program involves the accumulation, assimilation and interpretation of a wide range of dissimilar data in terms of the effects of man-induced changes in the marine environment and is further complicated by seasonal, areal and spatial considerations. An objective scientific evaluation of the biological and socio-economic effects of ocean dumping requires the development of management recommendations, which can withstand the most rigorous statistical and legal analysis and which clearly indicate the limits of confidence to be placed thereon. The interpretations and recommendations must also provide a statistically acceptable basis for subsequent monitoring of the dump site areas and for predictions of the biological and socio-economic impact of proposed future environmental changes.

### Procedures

The ADP group responds to expressed needs of research personnel, according priorities to those research groups evidencing slippages in maintaining scheduled research progress. Three in-house personnel will be supplemented by contractual services in key punching (2 man-years). MESA operations will receive 50 percent of the time of all in-house personnel and the entire services of contractual personnel. Support requirements include a modernized sorter machine which would eliminate the present need for use of expensive computers for print-outs of data tabulations. Operational and analytical strategy would be based on recognized research parameters (observables), established and anticipated within analytical computer programs. Requirements from other work units are (1) routine submission of station logs and sample distribution listings, (2) requests for analytical evaluation of submitted data tabulations, and (3) requests for graphic representations of geographical variations in each observable.

Products:

(1) Data tabulations (print-outs) by season and station for each observable.

(2) Data analyses, upon request, to evaluate usefulness of each data submission (std. deviations, regressions, etc.).

TASK NO. 2 -- BUDGET SUMMARY -- FY 1975

Salaries

Programmer/data manager (part-time) 10.0

Contract Services

Key punching and computer time 20.0

Task Total 30.0

Note: The MESA-oriented activities (in-house and contractual) of the MACFC's ADP unit, will be directed toward the timely and efficient tabulation, testing and reduction of data submitted from other MESA-financed research groups, with the ultimate aim of achieving an effective, and sophisticated presentation of data in support of MESA decisions and recommendations.

### Task No. 3. BENTHIC RESPIROMETRY

Because one of the major pollution problems in the New York Bight is the large input of organic wastes (sewage sludge and dredge spoils) to the benthos of these waters, some understanding of the net difference between rates of input and rates of disappearance of these organic wastes is deemed necessary in order to determine their impact on the local marine environment.

#### Objective

To measure seabed consumption and map the present rates of decomposition of organic wastes occurring as a result of biological and non-biological processes in the apex of the New York Bight.

#### Description

From the results of this study and additional information concerning the extent of organic wastes in the Bight and the rates of impact and export by physical means, the following will be determined: 1) the rate at which organic wastes are accumulating or disappearing in certain areas, 2) the quantity of organic input in various areas of the New York Bight can accommodate without deleterious effects to the living marine resources, and 3) the time required for the sediments to return to a homeostatic condition capable of accommodating predictable, but as yet unknown, quantities of organic matter. Baseline decomposition rates will be mapped to monitor the spread of pollutants in the future and to provide policy makers with usable information on quantities of organic matter that delineated areas of the Bight could accommodate temporarily without deleterious effects.

The results will be of particular value in relation to the hydrography and transport studies proposed by AOML.

#### Procedures

Measurements of seabed oxygen consumption are being, and will be, made quarterly on shipboard at a standardized set of grid stations covering the apex of the New York Bight. Additional stations can be, and have been, added to the standard grid to provide coverage of special or contingency samples sites. A multiple corer taking four simultaneous cores is used to collect the samples which are processed according to the methods of Parnatmat (1971). A minimum of four cores per station are taken. Many of the areas in the apex require 2 to 5 casts of the multiple corer to obtain a minimum of four cores per station. It appears that in certain limited

locations of the apex, the multiple corer may not be suitable for sampling due to the sediment type. In these areas we propose to measure seabed oxygen consumption by the methods of Smith (1972) using bell jars placed on the bottom by divers. Such sampling requires the use of a small vessel.

Collection of samples using the multiple corer requires a stable platform capable of 24 hour operation throughout periods of 10-15 days. Laboratory space (150 ft.<sup>2</sup>), electrical capacity (30 amps), suitable winch and wire for the multiple corer (~1500 lbs.), and superior navigational capabilities are required. A minimum of four scientists are required for seabed oxygen consumption measurements. RAYDIST operators required would be in addition to the four scientists.

To date, one quarterly cruise (January 1974) has been accomplished measuring total seabed oxygen consumption of 45 stations (180 cores) evenly spaced over the apex. Such sampling should continue through March-April 1975 to provide a one full year plus one quarter overlap in sampling.

As a consequence the milestones listed in MACFC Informal Report No. 13 (MESA Proposal for FY 1974) should be moved two quarters into the future. Such slippage is necessary to offset late arrival of primary equipment (multiple corers) and to allow a one quarter overlap on an annual cycle for sampling the apex. If deemed necessary, additional sampling in specialized areas or in the greater Bight could also be accomplished during this time if appropriate vessel time is allotted.

### Products

Products in the form of raw and analyzed data, charts, graphs, SYMAPs, interim and final reports are forthcoming. Special contingency reports concerned with unique occurrences can be developed.

Products will be prepared in such form that they could be incorporated into MESA atlases, reports and other documents prepared at the MESA project and program offices.

Multivariate analyses with the products of other work units listed in this proposal will allow the establishment and presentation of precise boundaries for the distribution of the effects of sludge and spoils. These boundaries can then be used to assess subsequent spread due to continued ocean disposal and massive movements following storms as well as the effects which might follow pollution abatement.

TASK NO. 3 -- BUDGET SUMMARY -- FY 1975

<u>Salaries</u>	
1 Oceanographer (GS-09)	14.0
1 Fishery biologist (GS-07)	10.0
1 Technician (temporary) (GS-04)	8.0
Supplies	<u>6.0</u>
Task Total	38.0

#### Task No. 4: BENTHIC MACROFAUNA

The benthic macroinvertebrates are the only broad category of marine organisms which show the immediate and integrated effects of environmental perturbations. A number of authors have emphasize the use of benthic organisms as indicators of environmental change. As presented in MACFC Informal Report No. 13, we are using historical, reconnaissance and recent data, collected on quarterly cruises, to document the distribution and diversity of benthic organisms in relation to demonstrable change in the physico-chemical environment. In conjunction with Prof. Saul Saila, University of Rhode Island, we are developing sampling protocol and statistical analyses which demonstrate the adequacy of our sampling efforts as well as relating populations to known and measurable indicators of environmental change, including changes in the geological, chemical and other elements of the biological food chain.

Work units included in this task are:

- Work Unit A. Field collections in the Bight apex.
- Work Unit B. Sort, identify and record data from field collections.
- Work Unit C. Analyze data from field collections.

#### WORK UNIT A. FIELD COLLECTIONS IN THE APEX OF THE NEW YORK BIGHT

##### Objective

Collections of benthic macrofauna will be made at predetermined stations on a quarterly basis throughout a one-year period; overlap will occur in two consecutive summer sampling periods. A single cruise remains to be completed in FY'74 and a final summer cruise will be conducted in July or August, FY'75. Subsequent cruises for collection of macrofaunal benthos will be in a monitoring mode in FY'76 and FY'77.

##### Description

When processed and analyzed these samples will yield data relating living resources to degree of environmental perturbations which in turn can be used to determine 1) subsequent areal changes in environment due to specific activities, 2) field effects of measurable amount of contaminants or physical stress and 3) impact of such activities on commercial and recreational living resources. In toto these data will provide rationale to all other MESA related work in geology, physico-chemical oceanography and other disciplines and permit managers and decision makers to conduct an adequate decision making process.

Field collections in remaining Bight are scheduled to commence during the second half of FY'75. Any proposal in regard to this research must be based on the requirements of the MESA Program office and directions from that office. It is not feasible to develop a definitive proposal and budget without adequate guidelines as to those areas which MESA wishes to emphasize, i. e., 1) all of the remaining Bight, 2) existing alternative disposal sites, or 3) as yet unspecified alternative sites.

### Procedures

Samples are collected using a Smith-McIntyre quantitative bottom grab. Additional stations can be (have been) added to provide coverage of special or contingency sampling sites. Replicate (5) samples are taken at each station on a quarterly basis; aliquots of sediment are collected from each grab for sediment mechanical and chemical analyses and benthic meiofauna.

Collection of samples requires stable platform capable of 24-hour stations throughout periods of 10-15 days as well as a scientific party of 7-12 personnel. If a designated NMFS vessel is available little support is required of NOAA-MESA other than navigational (RAYDIST) expertise.

This work unit is closely related to Tasks No. 3, 5, 9 and 10, inasmuch as samples are provided to these work units and final data analyses from them are integrated with measurements and analyses taken for Unit 4A.

### Products

Products in the form of raw and analyzed data, interim and final reports are being developed in accord with the milestones indicated in MACFC Report No. 13 -- our proposal for FY 1974. Special contingency reports concerned with unique occurrences, i. e., supposed movement of sludge, have already been filed with the MESA Project Office.

Products are prepared in standard format, i. e., data sheets, etc., and presentation form, i. e., standard charts, SYMAP, etc., which lend themselves to immediate incorporation into MESA atlases, reports and other documents prepared at the MESA project and program offices.

To date, in addition to and on the basis of historical data, macrofaunal samples have been collected during a reconnaissance survey and three quarterly cruises. A fourth cruise will be made in FY'74 and a final summer cruise will be completed in July or August, FY'75.

Approximately 500 grab samples are collected during each quarterly cruise. These samples, plus those collected during the reconnaissance cruise, are being sorted, identified and the resulting data recorded.

## WORK UNIT B. SORT, IDENTIFY, AND RECORD DATA FROM FIELD COLLECTIONS FROM THE BIGHT APEX

### Objective

Sort, identify and record benthic macrofaunal samples collected under Work Unit 4A.

### Description

Sorting, identification and recording of data from field collections on standard forms will (1) allow the preparation of data and interim reports and (2) form the basis for detailed statistical analyses necessary to the integration of macrofaunal data with other biological and physico-chemical data.

### Procedures

Technical aspects of Work Unit 4B are based on Work Unit 4A. The program has sufficient flexibility to meet unusual information needs and is highly oriented towards understanding the impact of environmental perturbations on living resources, including relationships to marine finfish and shellfish.

Successful completion of Work Unit 4B is not contingent upon additional NOAA-MESA personnel or physical services; it is, however, highly dependent upon adequate funding for temporary personnel to complete the sorting and identification of benthic macrofauna as well as continuation of contractual agreements for data analyses. The latter includes both MLC ADP facilities and data analyses completed by Prof. Saul Saila.

### Products

The FY'75 effort in Work Unit 4B will allow the preparation of SYMAP presentations which indicate the distribution of benthic macro-invertebrates in relation to known contaminants and degrees or gradients of environmental perturbation. Data will be in several forms, i. e., distribution of indicator species, diversity, and, eventually, biomass or equivalent calories.

## WORK UNIT C. DATA ANALYSES

### Objective

Analyze benthic macrofaunal data, for use by a wide spectrum of user groups.

### Description

Analytical strategies include analyses performed by the University of Rhode Island under Contract No. 03-3-043-53 and subsequent extensions of this contract. These analyses have included determination of statistically adequate sampling programs for 1) benthic macroinvertebrates, and 2) heavy metal burdens. Future tasks include the development of multivariate analyses and ADP programs to 1) relate the distribution and diversity of benthic macroinvertebrates with distribution and abundance of contaminants, and 2) provide an index to degree of environmental perturbation which will make possible an assessment of future change in the distribution of contaminants.

### Procedures

Multivariate analyses of sediment heavy metal burdens, organic matter, coliform bacteria distribution and macrofauna will allow the establishment and presentation of precise boundaries for the distribution of the effects of sludge and spoils.

These boundaries can then be used to assess subsequent spread due to continued ocean disposal and massive movements following storms as well as the effects which might follow pollution abatement.

### Products

Reports and publications will translate the broad data base into conclusions relevant to the needs of a variety of user groups.

TASK NO. 4 -- BUDGET SUMMARY -- FY 1975

Salaries

1 Supervisory fishery biologist	20.0
2 Part-time identifiers	12.0
8 Contract or work-study sorters	40.0
2 Temporary identifiers	18.0

Equipment

Microscopes	6.0
Smith McIntyre grab	2.0

Supplies	<u>2.0</u>
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Total Task	100.0
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## Task No. 5. MEIOFAUNA

We propose to continue meiofaunal research through FY 1975 with continuing emphasis on three groups: ciliated protozoans, foraminiferan protozoans, and benthic nematodes. Our immediate interest is to assign them roles as indicator organisms of New York Bight pollution. We realize, however, that the meiofauna perform important energy transformations in ecosystems, and that they help in important ways to determine the fate of pollutants. It seems axiomatic to us that the impact of pollution on living resources is incomplete without qualitative and quantitative knowledge of the meiofauna, which despite their minute size -- roughly between that of bacteria and that of organisms discernable to the naked eye -- can make up to 90% of the biomass of benthic organisms. We propose MESA funding of three work units:

- Work Unit A. Ciliated Protozoans.
- Work Unit B. Foraminiferan Protozoans.
- Work Unit C. Benthic Nematodes and Meiofaunal Biomass.

Because of the MESA target allowance assigned to this Center for biological research, we have reduced funding to two-thirds that requested in our initial FY 1975 proposal with the probable result that the time required to accomplish task objectives will be greatly prolonged, or that the scope of the research will be reduced.

### WORK UNIT A. CILIATED PROTOZOANS

#### Objectives

Determine the areal and seasonal distribution of ciliated protozoans above, on, and within sediments derived from sewage sludge, dredging spoils, and acid wastes, as well as in suitable control areas; develop understanding of their quantitative relationships to the kinds and degrees of pollution and to other organisms in the New York Bight; select indicator organisms; make preliminary appraisals of their role in nutrient fluxing and as reservoirs of viral and bacterial endosymbionts of possible significance as pathogens of living fishery resources.

#### Description

MESA-funded contract research on ciliated protozoans commenced in early FY 1974. Initial work indicates in part that few ciliates inhabit the sewage sludge deposits, that a lens of relatively high numbers of ciliates exists over the sewage sludge deposits in a saucer-like shape, and that these ciliates are mainly bacterivorous. Much time and effort to date have been devoted to testing various methods of extracting the organisms from water and sediments, work that is now nearly completed.

These efforts appear to be completely justified on the basis that to our knowledge no study of sublittoral ciliated protozoa from polluted marine habitats exists. We propose that this work merits continuation in order that the responses of these organisms to conditions in New York Bight may be more adequately understood.

### Procedures

One full year of quarterly samples will have been taken by the end of the current fiscal year, and one cruise in August 1974 will provide overlap with samples taken in August 1973. Supplemental sampling has been accomplished aboard AOML cruises and additional supplemental sampling in FY 1975 is planned.

Both shipboard and land-based extraction procedures will continue to be used. Two techniques have been employed effectively on sediment -- one on board ship (Uhlig's) and the other on land (Lackey's). Another method proved to be superior for extraction of ciliates in the water column (cascade of filters) but one additional method remains to be tested (Foerst centrifuge).

We anticipate that quantitative data can be obtained more readily in the future now that procedural problems are solved for the most part.

### Products

The principal investigator submitted a six-month report in December 1973, and on February 22, 1974, he presented a seminar at the Sandy Hook NMFS Laboratory. Future products will include continued six-month reports and technical papers plus verbal presentations as appropriate to disseminate results to scientists and public officials charged with environmental management.

## WORK UNIT B. FORAMINIFERAN PROTOZOANS

### Objectives

Determine the qualitative and quantitative distribution of benthic and planktonic foraminifera in the New York Bight; demonstrate relations of waste disposal practices to foraminiferan distribution; compare the occurrence of existing foraminifera with that in recent sediments (deposited within the past 100 years, approximately); relate existing foraminiferal distribution to that of concurrently-studied biota and physico-chemical factors.

### Description

Although MESA funding of this contract began near the end of second quarter of FY 1974, field samples of planktonic and benthic foraminifera were taken and preserved during all quarterly cruises beginning in August 1973. The sampling strategy is that subsamples of plankton and sediment collected for phytoplankton and macrobenthos be analyzed for foraminifera, thus effecting coordination and economy of overall effort.

Past studies attest to the value of foraminifera as indicators of environmental characteristics. Because their shells fossilize easily, their occurrence in sediments can provide useful indices of past environmental conditions when correlated with rates of sediment deposition. The sampling strategy of this study assures insofar as possible that useful correlations will be developed and that the foraminifera can be considered along with other groups in the overall understanding of biological effects of pollution in the New York Bight.

Insufficient data have accumulated to date to indicate trends. Procedural details received consideration at the Sandy Hook Laboratory seminar on February 22, 1974, and a preliminary verbal report by the principal investigator indicated that the foraminifera were conspicuous by their absence from the most polluted sediments. We recognize the potential indicator value of this group and propose continuation of the study at about the present level of funding to the end of FY 1975.

### Procedures

Subsamples of seasonally-collected plankton tows and Smith-McIntyre grab samples will continue to be preserved in a 1:500 rose bengal buffered sea water formalin solution. The living foraminifera take up the stain and therefore are readily separable from the non-living organisms. Measurements of Eh, pH, pore water volume, and organic carbon of sediments will continue, and be used ultimately along with other environmental measurements to analyze areal and vertical distributions.

In the laboratory the foraminifera are separated from the other meiofauna and other materials by passing them through a series of sieves. The foraminifera in each sieve are picked out under a dissecting microscope with the aid of camel's-hair brushes and glass needles, and mounted on conventional micropaleontological slides for identification and enumeration.

### Products

The principal investigator and other foraminiferan specialists have surveyed littoral muds and clays of the greater New York Metropolitan region, and have found in general that surface populations are sparse although varied and abundant populations are present in sub-surface samples. These results tend to confirm the usefulness of foraminifera as indicators of recent man-induced environmental perturbations.

No written reports exist at present; the first is due after six months of MESA funding. We anticipate that the results of this research will be communicated in the future by a combination of six-month reports, scientific papers, seminars, and possibly conferences with public officials.

### WORK UNIT C. NEMATODES AND MEIOFAUNAL BIOMASS

#### Objectives

Determine seasonally the areal distribution and abundance of nematodes, and the meiofaunal biomass in surface sediments; relate the observed distributions to other biological and physical measurements; develop understanding of the causes of the observed distributions in the New York Bight.

#### Description

MESA funding began in the first quarter of FY 1974 with the understanding that research in the first year would consist essentially of a seasonal survey of benthic meiofauna in the Bight area. Detailed descriptions of meiofaunal taxonomy, evaluation of the effects of environmental stress, and the role of the meiofauna in the New York Bight ecosystem -- especially quantitative relationships -- were conceived as subjects for subsequent consideration after attaining a basic understanding of seasonal and spatial distributions. We look upon continuation of MESA funding as essential to attainment of both goals.

Sampling strategy is identical with that of the foraminifera. In fact, identical subsamples from Smith-McIntyre grab samples will continue to be examined for their contained foraminifera, nematodes, and other meiofauna, thereby establishing the basis for unified treatment of results.

Of the 21 studies known to us dealing with marine meiobenthos, only that of Dr. Grant Gross and his associates at Stony Brook, N. Y., treated polluted habitats -- all of them within metropolitan New York City. Nematodes were the predominant organisms. Because they apparently tolerate conditions approaching anaerobiosis, they should have positive indicator value in organic-rich benthic habitats such as sewage sludge dump sites, and they should play a major role in metabolizing organic wastes. Mainly for these reasons we strongly favor continuation of this research.

### Procedures

As described under FORAMINIFERANS, above, subsamples from Smith-McIntyre grab samples will be stained and preserved in the field. In the laboratory, two sieves are being employed to separate organisms from sediments; the organisms passing through a 0.50 mm sieve yet retained on a 0.044 mm sieve (mesh openings) constitute the meiofaunal sample. Organisms are then identified, enumerated and weighed (wet).

In addition, the organic content and pore water volume of sediments are being determined by standard methods in the laboratory. These measurements are supplemental to those being accomplished under a separate MESA contract (see Task No. 10, SEDIMENTS).

### Products

The principal investigator participated in a project review at the Sandy Hook NMFS Laboratory on February 22, 1974, during which he indicated that numerical variability seemed surprisingly low in a few of 20 replicate samples taken in reconnaissance sampling. As mentioned above under other meiofaunal studies, we anticipate that products will include six-month reports, technical papers, and verbal presentations.

TASK NO. 5 -- BUDGET SUMMARY -- FY 1975

Contracts

Ciliated Protozoans, University of Maryland	17.0
Foraminiferan Protozoans, College of City University of New York	8.0
Nematodes and Meiofaunal Biomass, College of City University of New York	<u>8.0</u>
Task Total	33.0

Note: Proposed contract funds are designed to extend each contract to July 1, 1975, regardless of date of inception of the contract, at 2/3 the funding level of each existing contract.

## Task No. 6: MICROBIOLOGY

Microbiological studies related to living resources of the New York Bight can be roughly categorized as those concerned with environmental microbiology and those concerned with effects of bacteria on living resources. MACFC has had ongoing general studies in both categories, and these can be more closely focused on problems in the Bight. To do this effectively, we are proposing MESA funding in two work units:

Work Unit A. Microbiology -- fish and shellfish.

Work Unit B. Microbiology -- sediments and water column.

### WORK UNIT A. FISH AND SHELLFISH

#### Objective

Develop understanding of the distribution and abundance of abnormalities in fish and shellfish; understand the causes of the abnormalities; determine impact on living resources of the New York Bight.

#### Description

Microbiological studies in the New York Bight were carried out under NMFS funding for FY 1973 and FY 1974. Studies have concentrated on fin rot disease of fish (and related abnormalities in crustaceans) and on the environmental factors which cause or are related to the disease. At present we do not feel that this is a single disease entity, but rather a generalized sign of environmental degradation -- operating thru chemical contaminant stress on fish combined with high bacterial populations produced by organic loading of inshore waters and sediments. We are interested in the disease for the following reasons: (1) its impact on fish populations resident in or migrating thru the New York Bight; (2) environmental factors contributing to the disease; and (3) the utility of the disease as an indicator of coastal environmental degradation. Staff members from all three laboratories of the Center have been involved in various aspects of the fin rot problem, and efforts will be even more sharply focused on the problem in FY 1975. Much of the effort is NMFS supported, MESA is asked to provide funding for temporary field samplers and laboratory aides and for vessel time.

## Procedures

Studies of distribution and abundance of fin rot should be expanded. Monthly sampling cruises to Sandy Hook Bay, sludge dump site, and the control area in Great Bay will continue. Staff members will participate in spring and fall resource assessment cruises from Block Island to Cape Hatteras.

Bacteriological studies to demonstrate possible relationships between bacteria and fish lesions will be expanded. Isolates should give some indication of the predominant genera, and will provide material for experimental challenges.

Immune responses of fish with fin rot and normal fish will continue. Fish with disease will be tested for antibodies to certain isolates, and immune responses of diseased and stressed fish will be compared with normal fish.

Experimental studies in aquaria, and possibly in cages in the dump site area, will be carried out to determine the time sequence for various phases of the disease, and to determine mortality rates produced by the disease complex.

## Products

Products of this task include preparation of three papers on fin rot disease in fish, exoskeletal erosion in lobsters and crabs, and rot disease of caridean shrimps. The first paper in this series was published in August, 1973. Additional outputs include reports of prevalences of fin rot in coastal locations from Block Island to Cape Hatteras, with concentration in the New York Bight. Since the problem of fin rot has emerged in other parts of the United States and the world, fundings should have broad significance.

## WORK UNIT B. SEDIMENTS AND WATER COLUMN

### Objective

Develop understanding of the microbial populations of the New York Bight, particularly as they may be affected by man's activities. Of particular interest are bacterial indicators of pollution, and bacteria which may be pathogenic to fish and shellfish.

### Description

This task has been supported by NMFS funds in FY 1973 and FY 1974. Much of the effort will continue to be funded by NMFS in FY 1975. MESA is asked to provide funds for one temporary technician and minimal vessel charters. Sufficient insights have been gained in the work to date to warrant additional work in specific areas which are relevant to the objectives of the New York Bight Project. Problems to be approached are:

- (1) What changes in the microbial flora of inshore waters, sediments, and organisms can be attributed to increasing levels of pollutants, microbial or otherwise?
- (2) What effects result from organic loading of inshore waters by domestic pollution? Are populations of bacteria which constitute the normal flora of the area enhanced, selectively changed, suppressed, etc.?
- (3) What changes are occurring in the anaerobic environments in bottom sediments as a result of ocean dumping, ocean outfalls, chemical contamination, etc.?
- (4) If populations of certain bacteria are significantly enhanced by organic loading of inshore waters, which of these are able to act as facultative pathogens of fish, shellfish and food chain organisms?

Some information exists about the distribution of coliform bacteria in the New York Bight, but information on other genera of significance to living resources (Vibrio, Pseudomonas, Aeromonas, Pasteurella, Clostridium, etc.) is very scarce.

Because of the MESA target allowance assigned to the Center for biological research, we have reduced the number of technicians requested in our original FY 1975 proposal from two to one and have reduced vessel charter costs one-half. The effect of these reductions will be that fewer samples can be taken and processed than originally planned.

#### Procedures

Proposed studies will include a general bacterial examination of highly contaminated and uncontaminated areas. Included will be organisms of human origin, of terrestrial origin, and normal estuarine and marine bacteria. The distribution and relative abundance of fecal coliforms will constitute a baseline study, on which related studies will be based. Such related studies include the marine vibrios which are emerging as pathogens or potential pathogens of fish and shellfish. One species is known to be pathogenic to humans. The distribution and abundance of vibrios in the environment will be examined. Other studies will include members of the Pseudomonas-Aeromonas group, which can be pathogenic for many groups of animals, and which have recently been identified as facultative pathogens of fish from highly contaminated inshore waters. A study will be made of distribution and abundance of members of these genera in inshore waters, polluted and unpolluted.

### Products

Products of this task will include preparation of a detailed map of the distribution and relative abundance of fecal coliforms in the New York Bight, and similar maps for vibrios and other bacterial genera. Relationship with other indicators of pollution will be determined, as will possible relationships with occurrences of abnormalities in fish and shellfish.

TASK NO. 6 -- BUDGET SUMMARY -- FY 1975

<u>Salaries</u>		
3 Technicians/aides (GS-04)		24.0
<u>Contracts</u>		
Vessel charters		<u>2.0</u>
Task total		26.0

## Task No. 7. PLANKTON AND PRIMARY PRODUCTION

Plankton and primary productivity studies are concerned with the effects of current dumping practices and local pollution generally on planktonic food chains in the New York Bight. Dissolved nutrients and particulate matter from the Hudson and Raritan Rivers as well as from dumped materials undergo complex interactions with ambient environmental factors in the Bight to yield plankton. We have divided the task into two work units which are separated geographically but united technically. One, which we propose to continue funding under a university contract, considers both the Hudson River estuary and the Bight apex; the other, conducted in-house by MACFC, considers Raritan, Sandy Hook and Lower Bays. Because the Hudson estuary portion of the university study is funded from other sources we propose MESA funding for only the Bight apex portion. Thus, two MESA-funded work units are involved:

Work Unit A. Plankton and Primary Productivity --  
Bight Apex.

Work Unit B. Plankton and Primary Productivity --  
Raritan Bay.

### WORK UNIT A. PLANKTON AND PRIMARY PRODUCTIVITY -- BIGHT APEX

#### Objectives

Document spatial and temporal variations in phytoplankton productivity and determine the environmental factors responsible for these variations. Document the relative magnitude of organic carbon input due to phytoplankton production, estuarine runoff and dumping. Evaluate the effects of these relative magnitudes in determining the eutrophication potential of the New York Bight and its susceptibility to eutrophication in terms of nutrient inputs, photosynthetic capacity and grazing patterns which will affect the degree to which organic material can accumulate in the system.

#### Description

Study during the first year of research (FY'74) is evaluating spatial and temporal variations in phytoplankton production in terms of concurrent variations in light intensity, nutrient inputs, the abundance of particle grazers, water column stability and estuarine runoff.

The study is focusing on the impact of coastal zone dumping practices and estuarine runoff on spatial and temporal distributions of detritus, suspended lithogenic material and nutrients as they affect netplankton and nanoplankton productivity.

In FY'75, the program will include measurements of respiration, assimilation and growth of particle grazers in the Bight. This will provide information on the direct effects of current dumping practices, and the proportion of autochthonous and allochthonous organic inputs actually entering pelagic food chains. Proposed funding for this contract extension is one-third below that requested in our original FY 1975 proposal -- an economy measure which may well prolong considerably the time needed to analyze field data, or which may reduce the scope of the work proposed.

### Procedures

Proposed studies will include a series of measurements at stations in the Lower Hudson Estuary (Tappan Zee Bridge) out to and including the various disposal sites and control areas in the apex of the New York Bight. The stations will be occupied at approximately monthly intervals except when greater frequency is required to provide more detailed coverage of the perturbations and of the magnitude and time-course of the response(s). The frequency of observation will depend on how rapidly the phytoplankton can potentially respond. Preliminary measurements indicate that such a time interval between observations would have to be no more than 7 days. Measurements to be made include: incident radiation and submarine light penetration, temperature, salinity, dissolved oxygen, nutrients ( $\text{NH}_3$ ,  $\text{NO}_2$ ,  $\text{PO}_4$ ,  $\text{SiO}_3$ ) particulate organic carbon and nitrogen, ATP, phytoplankton and microzooplankton enumeration and taxonomy, pigment analyses ((chlorophyll-a and phaeopigments), primary productivity, and respiration, assimilation and growth of particle grazers in the Bight.

Ship-time at \$750/day (\$45,000/60 days) will be provided by the Institute of Oceanography of the City University of New York.

This study is highly relevant to other studies in the New York Bight, particularly those concerning the benthos which receive their food supply from the water column and to the physical, chemical and geological programs of AOML. Inputs to this study should include physical, geological and chemical oceanography of the area as well as results of the plankton and primary productivity study in Raritan, Lower and Sandy Hook Bays - estuarine areas affecting the apex of the New York Bight.

### Products

We have received a detailed progress report from the university contractor which provides all data accompanied by appropriate commentary covering monthly cruises from September through December 1973. In the future we anticipate regular six-month progress reports including graphs, charts and tables from the contractor plus scientific papers, special written reports, and verbal summaries, seminars and commentaries as required.

### WORK UNIT B. PLANKTON AND PRIMARY PRODUCTIVITY - RARITAN BAY

### Objectives

In general this work unit and the preceding one have similar objectives, though working in different but related geographical areas. Document spatial and temporal variations in phytoplankton productivity in Raritan, Sandy Hook and Lower Bays and determine whether or not certain environmental factors are responsible for these variations. Document oxygen consumption in the water column (beginning late FY'75) and compare these rates with the various rates of inputs of organic carbon to the system to determine the relative degree of organic loading on the system.

### Description

The first year of research (beginning November 1973) is being spent evaluating spatial and temporal variations in phytoplankton production and biomass, light intensity, nutrients, and physical parameters of the water column. The study will remain reasonably stable (more stations will be added) through mid-FY'75 to complete a full annual cycle. Beginning late FY'75 measurements of oxygen consumption in the water column will be added to the present study. This addition will assist in determining the extent of organic loading on the system.

### Procedures

A series of stations in Raritan, Lower and Sandy Hook Bays have been established by selecting certain stations originally established by the U. S. Environmental Protection Agency for monitoring these waters. Our stations are being sampled monthly, but, depending on available vessel time, will be sampled more intensively during the course of several phytoplankton blooms. These stations are set up not only to

follow spatial and temporal variations in Raritan, Lower and Sandy Hook Bays, but to provide additional information concerning the input of these waters into the apex of the Bight. Measurements to be made include: incident radiation and submarine light penetration, temperature, salinity, dissolved oxygen, nutrients ( $\text{NH}_3$ ,  $\text{NO}_2$ ,  $\text{NO}_3$ ,  $\text{PO}_4$ ), particulate organic carbon and nitrogen, phytoplankton enumeration and taxonomy, pigment analyses (chlorophyll-a and phaeopigments), primary productivity (both dissolved and particulate) and respiration rates by plankton in the water column.

This study is particularly related to the foregoing work unit, plankton and primary productivity in the Bight apex. The two studies compliment each other by increasing geographical coverage while maintaining intensive sampling, all during the same annual cycle.

#### Products

Products in the form of raw and analyzed data, charts, graphs, SYMAPs, interim and final reports are forthcoming. Special contingency reports concerned with unique occurrence can be developed. Products will be prepared in such form that they could be incorporated in MESA atlases, reports and other documents prepared at the MESA project and program offices.

TASK NO. 7 -- BUDGET SUMMARY -- FY 1975

Salaries	25.0
Equipment	6.0
Supplies	3.0
Contracts	<u>18.0</u>
Task Total	52.0

Note: Major equipment needs include peristaltic and submersible pumps with spare motors, depth gauge, thermistor for pump, recorders, fluorometer, millipore filter pump, refrigerator for storage of ammonia samples on boat, and freezer-refrigerator for laboratory.

## Task No. 8. RESOURCE DISTRIBUTION AND ABUNDANCE

The MACFC Resource Assessment Investigations conducts spring and fall coastal finfish resource assessment cruises along the entire Middle Atlantic Bight from Block Island to Cape Hatteras -- providing information on distribution and abundance of many fish species. Sampling stations are based on a randomized pattern related to depth strata.

Beginning in FY 1974, with partial support from MESA for vessel charters, additional trawling stations were occupied in the New York Bight apex area. These surveys will be continued in FY 1975 and will be augmented by monthly transects through the apex area and out to the edge of the continental shelf. Some of the objectives are to determine relative abundance of fish in the apex area as compared to that in adjacent areas, to determine relative abundance of abnormal fish in the apex area as compared to that in adjacent areas, and to determine movements of fish into and out of the apex area. Requested funding would provide for limited vessel time, and personal services (field personnel). It should be clearly understood that most of the costs of these cruises are borne by NMFS.

There is an additional need to determine the present distribution and abundance of molluscan shellfish resources in the New York Bight, and to compare these with distribution and abundance in the Middle Atlantic Bight. A survey cruise for this purpose, partly supported by MESA funds, is planned for FY 1975.

An essential aspect of fishery resource analysis is thorough examination of historical data. Fisheries of the New York Bight have undergone a general decline in recent years (with some exceptions). While the causes are complex, it is likely that environmental degradation is an important factor. Recent studies by Dr. J. L. McHugh, SUNY, Stony Brook, have documented some of the changes which have occurred. Dr. McHugh's most recent study was financed by MESA funding in FY 1974. His present contract will terminate on August 31, 1974. We propose to extend this contract one year at 3/5 of the present funding level.

Based in part on this historical review, and on results of trawling surveys, it is now time to carry out detailed analyses of fish stocks in the New York Bight, to determine relative abundance indices, biomass, mortality rates, etc. That part of the study directly relevant to the New York Bight should be funded by MESA. Funds were requested in our original FY 1975 proposal, but because of the target allowance indicated by the MESA Project Office for this Center in FY 1975, no funds are requested in the revised proposal. Hopefully, these analyses can be implemented in FY 1976.

MESA-supported resource assessment studies proposed for FY 1975 include 3 work units:

- Work Unit A. Finfish resource distribution and abundance.
- Work Unit B. Shellfish resource distribution and abundance.
- Work Unit C. Historical review of fishery resources (contract).

## WORK UNIT A. FINFISH RESOURCE, DISTRIBUTION AND ABUNDANCE

### Objective

Objective of this Coastal Resource Assessment Investigation's (CRAI) phase is to provide information on distribution, size, and relative abundance of fish species.

### Description

The CRAI survey effort conducts a regular series of spring and fall coastal finfish resource assessment cruises along the entire Middle Atlantic Bight from Block Island to Cape Hatteras. These surveys have been augmented to include an intensive sampling in the New York Bight and particularly the apex area on a quarterly basis. In addition, a monthly transect series is planned from the Raritan Bay area through the apex to the head of the Hudson Canyon to increase short-term variations in population structure. These surveys are designed to provide information on fish migratory patterns, and to assess the impact of the stressed apex area in relation to the resource available to the commercial and recreational fisheries. Patterns of migration have a particular significance to those studying the origin and dispersal of fin rot disease.

### Procedures

Sampling is done with a standard trawl net fished in a prescribed fashion for a constant time as developed for MARMAP groundfish surveys. The distribution of effort for the quarterly surveys is stratified by depth, and positions are logged according to MESA protocol. Vessels used include NOS' Delaware II, Albatross IV, Oregon II, and charter craft. Within the limits of stratification, tow stations are chosen by random selection to satisfy statistical requirements. Catches are identified to species, species groups are weighed, measured, inspected for incidence of fin rot and selected samples frozen for special studies. Personnel interested in fish disease make up a part of each scientific watch group. Requests for specimens to be used for heavy metal, pesticide, coliform and other bacterial analyses are routinely satisfied. Surface and bottom salinity and temperature are hydrographic parameters routinely recorded at each station.

## Products

Preliminary cruise reports are routinely available within one month after completion of a cruise. All data are keypunched and logged into a data bank established by NEFC. This data bank is accumulating comparable material for fish catch made in systematic surveys over the Atlantic shelf. Data are retrievable for investigators interested in fish species, biomass, distribution, and size groups. Researchers, resource management policy makers, conservationists, commercial and sportfish interests, all have need of these data.

## WORK UNIT B. SHELLFISH RESOURCE, DISTRIBUTION AND ABUNDANCE

### Objective

Objective of this Coastal Resource Assessment Investigation phase is to provide information on distribution, size, relative abundance, and condition of harvestable shellfish resources.

### Description

The CRAI survey effort, as part of a historical series of shellfish resource inventories, will conduct an intensive survey of harvestable shellfish resources inhabiting bottoms inside and outside the MESA area. Species of particular interest include the hard clam, the surf clam, and ocean quahog. The survey, conducted during the summer, will be designed to provide information on the impact of the stressed apex area as it affects the condition and density of these resources.

### Procedures

Sampling of benthic shellfish is done with a standard hydraulic dredge towed over the bottom for a constant unit of time. Survey results will be based on a grid sampling of fifty stations in the apex area and twenty-five stations in each of two contiguous areas to the east and south of the MESA apex. Identification, counts, weights and measurements are normally conducted on shipboard, with selected samples returned to the laboratory for analyses of length-weight parameters, for studies in gametogenesis and development of a condition index based on percent of total solids. Material will be available for cooperators interested in heavy metal, pesticide and bacterial analyses of shellfish tissue. The vessel planned for the offshore survey is the Delaware II. A commercial vessel may be chartered to conduct part of the investigation.

## Products

Preliminary cruise report is planned for one month after completion of cruise. Detailed statistical analyses follow after laboratory determinations are completed. Survey results are presented in a fashion which highlights the significant differences determined for the apex area, but in an established format which treats historical comparisons of distribution and density of shellfish resources. Data will be made available to other MESA researchers interested in multivariate analysis of bottom type, diet items and other influences suspected to affect the shellfish resource. Researchers, resource management policy makers, conservationists and commercial interests all have need of these data and results.

Work Unit C. HISTORICAL REVIEW OF FISHERY RESOURCES  
(CONTRACT)

Objective

Objectives of this study is to provide a historical documentation of the commercial New York/New Jersey fisheries landings from the New York Bight as related to man-made changes.

Description

Using existing Federal, State and local statistics, this contract study will develop a comprehensive study, by species and poundage, of the fluctuation and species shifts in the commercial and recreational fish landings in New Jersey, supplementing an existing study of the same nature for the New York Commercial fisheries. Earliest catch records date from the 1880's but regular annual statistical surveys date from 1929. This study, looking deeply into the probable causes for such fluctuations and species shifts will lend historical credence and support to current resource assessment studies (Work Unit A and B). This study of long-term trends in landings, of the interactions of the fisheries with the resources and with economic and socio-political activities in the Bight, is essential for an understanding of today's conditions.

Funding has been reduced to three-fifths of that originally proposed -- an action which may lengthen the time to complete analyses, or reduce the intensity of effort.

Procedures

1. Develop a bibliography of the marine fisheries and fishery resources of New York Bight, commercial and recreational, domestic and foreign. Collate and critically analyze the results of these studies.
2. Using published statistics of the commercial fisheries of New York Bight, analyze and attempt to interpret historic trends in fishery landings of the bordering states, using the literature analysis in project (1) above as an aid to interpretation. Compare and collate with the already published New York study (McHugh, 1972) and with more detailed analyses underway or planned.
3. Correspond and meet with scientists and administrators in New Jersey and New York to locate unpublished information and experience that may be useful in the program. Check the accuracy and completeness of conclusions with these officials. Examine in detail pertinent data from resource assessment cruises out of Woods Hole and Sandy Hook. Interview fishermen and processors as necessary.

4. Examine trends in specific fisheries in the New York Bight area, e.g., trawl, pound, net, haul seine, pots, gill nets. Analyze these trends for clues to reasons for changes in the fisheries.

5. Locate and analyze existing data on distribution, abundance, and movements of commercial and recreational fishing vessels in New York Bight.

6. Prepare final report summarizing information obtained in items 1-5 above.

#### Products

Progress report available. Preliminary graphs of fluctuations in total landings, in finfish landings and in shellfish landings, from 1880 to 1971, are available. Graphs of fluctuations in landings by species, for some 42 different species of fish and shellfish are in preparation. A technical manuscript is expected within six (6) months.

TASK NO. 8 -- BUDGET SUMMARY -- FY 1975

Salaries

Work Unit A -- 2 field technicians (temporary)	13.3
Work Unit B -- 1 field aid (3/4 time temporary)	4.7

Contracts

Work Unit A -- Vessel charters	14.0
Work Unit B -- Vessel charters	4.0
Work Unit C -- Historical review	<u>15.0</u>

Task Total	51.0
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VI. MESA/MACFC BUDGET SUMMARY AND COMPARISON:

FY 1973, 1974 and 1975 (PROPOSED)

Tasks	FY 73 Received	FY 74 Received	FY 75 Proposed
1. Statistical Design and Analysis	35.0	-	12.0 <sup>1/</sup>
2. ADP: Format and Operations	-	7.0 <sup>2/</sup>	30.0 <sup>5/</sup>
3. Benthic Respiration	41.0	31.0	38.0 <sup>6/</sup>
4. Benthic Macrofauna	40.0	45.3 <sup>3/</sup>	100.0 <sup>7/</sup>
5. Benthic Meiofauna	38.0	43.4	33.0 <sup>8/</sup>
6. Microbiology	-	16.5	26.0 <sup>9/</sup>
7. Plankton & Primary Productivity	20.0	63.0	52.0
8. Resources: Distribution & Abundances	33.0	53.0	51.0 <sup>10/</sup>
9. Contaminant Analysis	-	-	- <sup>11/</sup>
10. Sediment Analysis	11.5	-	-
11. Contaminant Effects on Resources	-	-	-
Mutagenicity	-	-	-
12. Travel <sup>12/</sup>	3.0	-	10.0
13. Support <sup>13/</sup>	14.0	20.0	68.0
Totals	235.5	279.2	420.0
14. Salary & Expenses (McNulty)	-	30.0 <sup>4/</sup>	30.0
Grand Total	235.5	309.2	450.0
Supplementary MESA Funds <sup>14/</sup>	-	30.0	-
FY 74:			
1. ADP and travel	-	(10.0)	-
2. Automation of AA Units	-	( 8.0)	-
3. Extend Koditschek study	-	( 6.0)	-
4. Additional sorters (2)	-	( 6.0)	-
5. MESA museum and sample storage	-	(13.0)	-
6. Sediment sample analysis	-	( 8.0)	-
	235.5	360.2	450.0

<sup>1/</sup> URI contract extended 6 months to terminate on June 30, 1975. Provides funds for benthos-oriented (abundances, distribution and diversities) map of NYB Apex environmental quality levels.

<sup>2/</sup> ADP operations funds supplemented in FY 74. See <sup>14/</sup> below.

<sup>3/</sup> Supplemented w/\$6.0 additional funds in FY 74. See <sup>14/</sup> below.

<sup>4/</sup> McNulty FY 74 salary - savings (\$14.0) used to renew Trenton State College (benthos sorting) contract.

<sup>5/</sup> Includes key punching contract (2 man years @ \$15.0), computer time (\$10.0) and sorter-listing machine (\$5.0).

<sup>6/</sup> Includes inhouse staff.

<sup>7/</sup> Includes inhouse staff and conversion of Trenton State and Monmouth College contracts (sorting) to work-study agreement.

- 8/ Includes pro-rata renewal of three meiofaunal contracts so that all work terminates on June 30, 1975. (Tietjen, \$18.0; Small, \$17.0; and Lee \$18.0).
- 9/ Includes inhouse studies on etiology, prevalence and incidence of fin rot disease.
- 10/ Includes vessel charters (\$14.0) and SUNY/McHugh contract renewal (\$15.0).
- 11/ A large backlog of samples exists. This task will be funded through AOML.
- 12/ Travel funds for FY 74 provided by supplementary funds. See footnote 14/.
- 13/ Support funds supplemented in FY 74. See footnote 14/.
- 14/ Breakdown of supplementary funds (FY 74) by task. See footnotes 2/, 3/, 12/ and 13/.