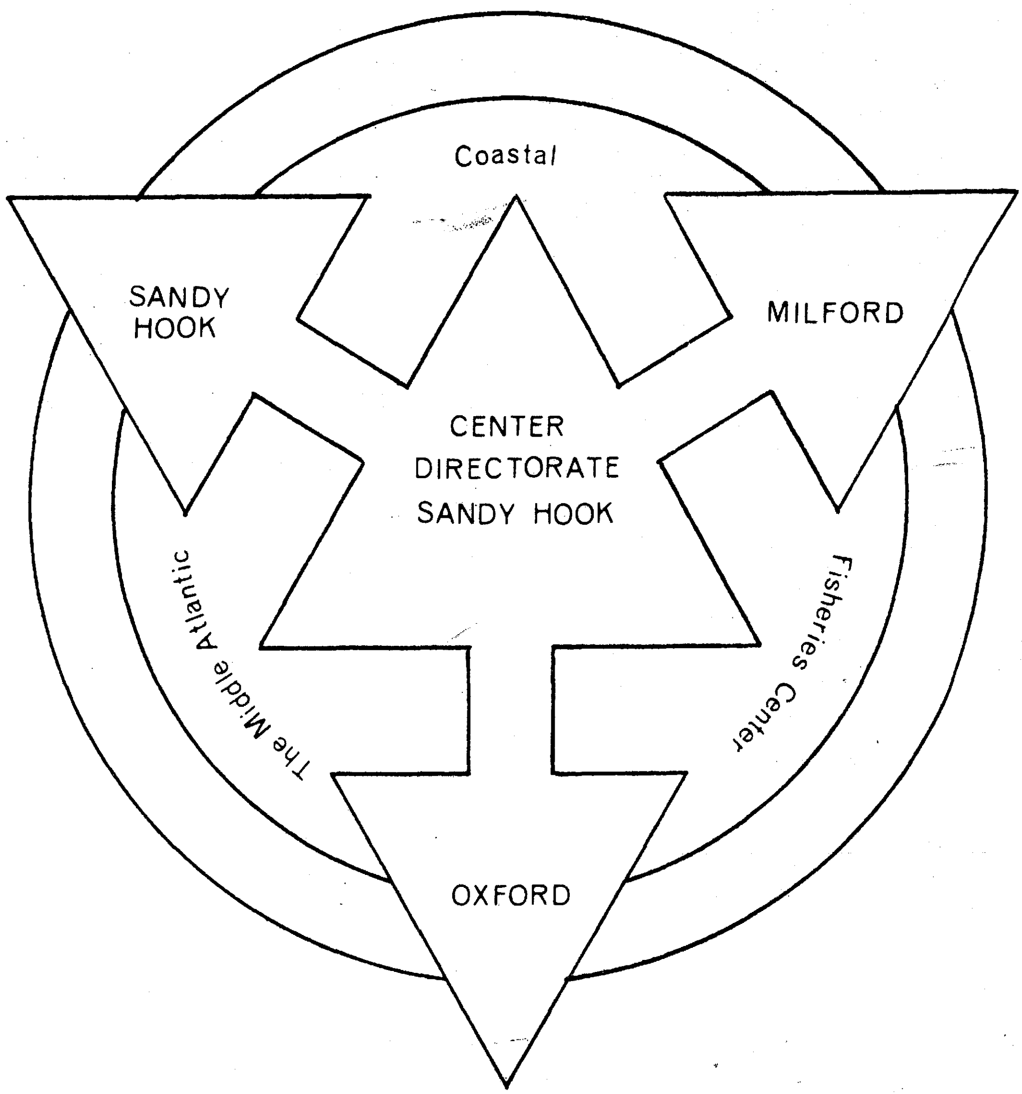
PROPOSAL FOR FY 1976 MESA-NYB FUNDING:
"RELATIONSHIP OF COASTAL POLLUTION TO PRIMARY PRODUCTIVITY AND ALGAL BLOOMS"

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

MIDDLE ATLANTIC COASTAL FISHERIES CENTER



Informal Report No. 86

October, 1975

Research Proposal

Submitted by

Middle Atlantic Coastal Fisheries Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration

to

MESA-New York Bight Program Manager
Marine Ecosystems Analysis Program
Environmental Research Laboratories
National Oceanic and Atmospheric Administration

for support of studies on:

RELATIONSHIP OF COASTAL POLLUTION TO PRIMARY PRODUCTIVITY AND ALGAL BLOOMS

Amount Requested: Phase I: (1 December 1975 to 30 June 1976): $185,200.00
Phase II: To be funded from fiscal '77 funds

Date: October, 1975

Approved by: James P. Thomas
Principal Investigator
(201) 872-0200

for John Holston
Carl J. Sindermann
Director, Middle Atlantic Coastal Fisheries Center

WORK UNIT TITLE:

RELATIONSHIP OF COASTAL POLLUTION TO PRIMARY PRODUCTIVITY AND ALGAL BLOOMS

Background:

This proposal is predicated on continuation by MESA of the ongoing integrated primary productivity studies carried on by the Middle Atlantic Coastal Fisheries Center and by Dr. Malone of CUNY. It represents (1) an expansion of current effort to include greater emphasis on the ecological role of natural and pollution-related detritus, and (2) a more detailed examination of the effects of pollutants in promoting chronic occurrence of environmentally detrimental algal blooms.

Research by the Middle Atlantic Coastal Fisheries Center will concentrate on developing research-inspired ecosystems insights in the following two areas:

Discussion of project findings:

(1) Phytoplankton is often thought of as being at the base of the food web supporting the higher trophic levels (i.e., zooplankton and fish). In open ocean waters or other areas away from terrigenous input, this may well be so. However, in coastal waters, particularly those near large metropolitan centers like New York City, it is possible that detrital input to the coastal waters may be of greater importance to the ecosystem as an energy source (i.e., food) than primary productivity. Indeed the system may be geared for such input by having a greater portion of the energy from reduced carbon pass through detritovores (i.e., bacteria, protozoa, etc.) rather than through herbivores (i.e., copepods, etc.). The implications of the presence of such an alternative, radically different food chain are obvious. The danger that one may emphasize studies of the wrong chain is real, for one may be examining only 10% of the action (see Pomeroy, 1974. The ocean's food web, a changing paradigm. Bioscience, 24: 499-504).

We know from looking at Dr. Malone's data that particulate detritus is important quantitatively. The question of its relative importance compared with primary productivity is now being examined by Dr. Malone. In oceanic waters, we know that dissolved organic carbon (dissolved detritus) is present in concentrations on an order of magnitude greater than particulate organic carbon. In the New York area, we know that ammonia and urea concentrations are high, both indicators of sewage detrital input. We may infer therefore that urban input of dissolved organic carbon to New York coastal waters is very great.

Our recent data indicate that extremely high quantities of photo-assimilated carbon are released to the extracellular environment by phytoplankton in Raritan, Lower and Sandy Hook Bays. Values in excess of 100 mg C m^{-3} hr^{-1} are being found during the summer. We have scrutinized our methods and we believe our values are real.

As a comparison, Thomas (Mar. Biol., 1971) found a high value of 2.4 mg C m^{-3} hr^{-1} as dissolved organic matter (DOM), released from phyto-plankton, to occur in the highly productive estuaries of Georgia. Anderson and Zeutschel (Limnol. Oceanogr., 1970) found values in the range of 4 to 6 mg C m^{-3} hr^{-1} in the highly productive upwelling area off the Washington coast. Ignatiades (J. Mar. Biol. U. K., 1973) found DOM values of 1 to 2 mg C m^{-3} hr^{-1} being released from natural populations of phytoplankton in two Scottish Sea lochs. Thomas (unpublished data) has found DOM values up to 8 mg C m^{-3} hr^{-1} to occur in Puget Sound, Washington, with natural populations of phytoplankton. Higher DOM values (nearly 40 mg C m^{-3} hr^{-1}) were produced by cultures of a diatom Skeletonema costatum but only after incubation in darkness for 14 days followed by exposure to light at 10,000 lumens (Ignatiades and Fogg, J. Mar. Biol. U. K., 1973). We are presently drawing the data together for a manuscript.

We are also finding that, at certain times, up to 50% of the primary productivity by phytoplankton (50% of the photoassimilated carbon) is in the form of DOM released to the extracellular environment. However, until our data analysis is further along, we hesitate to speculate on whether or not we are finding abnormally high values of percents of extra-cellular release (PER) for a highly eutrophic estuary. The expected average PER, based on the literature, should be less than 10-15%. In view of these findings we plan to investigate the relative importance of dis-solved organic carbon to the ecosystem.

Project accomplishments and projected milestones:

During the past year, we have investigated the magnitude and distri-bution of primary productivity, phytoplankton, chlorophyll, nutrients and associated variables in Raritan, Lower and Sandy Hook Bays. Monthly survey cruises were completed in March 1975. Since that time, our entire effort has been devoted to entering our raw data into the MACFC data bank for further analyses. Our input consists of 35 variables measured at twelve stations at three to five depths over a sixteen month period. All raw data except for that concerning species identification, numbers, diversity and equitability of phytoplankton have been entered into the data bank. We are now in the process of verifying and correcting this raw input wherever errors appear either in the input or in the program. Such verifi-cation is very time-consuming, but will guarantee accurate results. As a consequence, our species identification, counts, and diversity information will not be ready for computerization until March 1976. In the meantime, we expect to accomplish a thorough analysis of this data. We anticipate producing 400 SYMAP's of the data as well as a rigorous statistical analysis looking not only at variability and its sources and at confidence limits, but also at interrelationships of all the variables within a station, by depth, by month, and by year including principle components and factor analyses. And finally, we will attempt to mesh our results with those of Dr. Malone, which cover a wider, but slightly different geographical area (including the Lower Hudson River and Apex of the New York Bight).

Our basic plan of operation will be to process our present data backlog from the Raritan, Lower and Sandy Hook Bays. We expect to complete this work by submitting manuscripts for publication during winter and spring 1976. During this same time, we will gear up for full-scale field operations which will begin in late spring 1976 and will last about 1¼ years. For the field survey, we plan to increase our coverage area to include the Lower Hudson River, Raritan, Lower and Sandy Hook Bays, and the Apex. This latter will permit direct comparison with the findings of Dr. Malone. Of necessity, our stations will be more spread out than in our present study. We propose to investigate primary productivity as well as the release, assimilation and the decomposition of phytoplankton-derived dissolved organic carbon. In order to obtain rates of cycling, we also propose to measure the magnitude and distribution of the standing stocks of dissolved organic carbon in the water column. We hope to be able to compare the relative importance of phytoplankton-derived dissolved organic carbon with urban-derived dissolved organic carbon. Ultimately, our long-range objectives will be (1) to elucidate the carbon cycle for management purposes, (2) to relate organic carbon inputs and fates to living marine resources, and (3) to relate water column activities to the benthos and vice versa.

Requirements:

We request funding this year for (1) intensive data analysis and publication of several manuscripts, (2) for equipment purchase and test, and (3) for initiation of field activities. We feel that we must complete our present data analysis since we will be using the results to guide us in our proposed research. Field activities are predicated on our early ability to purchase and test a carbon analyzer suitable for water analyses and two peristaltic pumps (required for measuring the oxidation rate of dissolved organic carbon). The requested recorder (to measure photosynthetically active radiation), will automate a portion of our field activity and enable us to accomplish a broader field program where vessel time is a premium. The requested ATP photometer will enable us to determine the living microbial biomass which will affect the mineralization rates of dissolved organic carbon (Holm-Hansen and Paerl, 1972. Mem. Ist. Ital. Idrobia., 29 Suppl.: 149). All of these items require lead time for purchasing and testing.

Red tide project accomplishments and projected studies:

Through field surveys since 1968, carried out in cooperation with the N. J. Dept. of Environmental Protection, this laboratory has documented the annual occurrence of phytoflagellate blooms in New York-New Jersey waters for the last 13 years. These "red tides" have on several occasions had an undetermined but possible association with fish kills and have frequently resulted in bather discomfort, with closing of beaches and in sizeable economic losses to Monmouth County, N. J.

Empirical evidence, including the observed pattern of development of blooms and their subsequent history, suggested an association between the blooms and the advanced eutrophication of New York Harbor. Such an association was tested through study of the ability of the three most frequently dominant phytoplankton to utilize, in their nutrition, organic carbon, nitrogen, and phosphorous which available water analyses data indicated was abundant and urban waste-derived; ability to utilize organic nutrients is not universal among phytoplankters. This study (Mahoney, 1974) was completed and results show that all three species have good ability to utilize a wide variety of organic C, N and P compounds in environmentally relevant concentrations. Tests of the relative importance of organic versus inorganic N and P compounds, in terms of the amount of growth stimulated, are expected to be completed by the end of this year.

Tests of conentration levels of essential nutrients required for high rates of growth of the phytoplankters are considered a logical outgrowth of the initial studies but the execution of this work is dependent on acquisition of necessary continuous culture equipment.

Examination of other factors which are known to play important roles in bloom initiation and development including salinity tolerance, trace element and vitamin requirements, temperature, photoperiod, light intensity and effects of external metabolites is planned.

Work Plan:

1. Complete rigorous statistical analysis and interpretation of phytoplankton data for Raritan, Lower and Sandy Hook Bays (35 variables for each of 12 stations occupied during each of 16 monthly cruises) — March, 1976

2. Purchase gear necessary for dissolved organic matter (DOM) studies, water analysis, and bacterial biomass studies — November, 1975

3. Purchase continuous culture equipment necessary for nutrient status on phytoplankton "blooms". — November, 1975

4. Prepare 400 SYMAP's (graphic charts) emphasizing the data developed in Work Plan, Step #1, above. — December, 1975

5. Complete first of two major manuscripts on primary productivity of Lower, Raritan and Sandy Hook Bays. — December, 1975

6. Assemble and test purchased equipment — March, 1976

7. Initiate controlled studies of critical concentrations and nature of nutrients required for phytoplankton blooms. — January, 1976

8. Complete second major manuscript on primary productivity of Lower Raritan and Sandy Hook Bays. — April, 1976

9. Initiate 15 monthly cruises in Raritan, Lower and Sandy Hook Bays and in NYB-Apex. (Determine, on each cruise, primary productivity, release of phytoplankton-derived DOC, magnitude and distribution of standing stocks of DOC in water column, comparison of phytoplankton-derived DOC with urban-derived DOC; oxidation rates of DOC, living marine bacterial biomass and associated hydrographic data). — Monthly: June '76 thru Sept. '77

10. Coordinate findings with Dr. Malone's findings. — June, 1976

11. Complete final draft Ms on salinity tolerances of algal "blooms". — June, 1976

12. Complete studies on effects of temperature, photoperiod and light intensities on algal "blooms". — June, 1976

Work Products:

1.	Data reports (16):	Monthly distributions and abundances of phytoplankton in Raritan, Lower and Sandy Hook Bays.
2.	Techical report:	Chemical-physical data on Raritan, Lower, and Sandy Hook Bays from October 1973 to March, 1975.
3.	Technical report:	Primary productivity and phytoplankton biomass data from December, 1975.
4.	Technical report:	Utilization of pollution-related organic and inorganic form of nitrogen, phosphorous and carbon by phytoplankton. December, 1975.
5.	Technical report:	Salinity tolerances of red tide plankton originating in brackish waters. June, 1976.

BUDGET SUMMARY FY 76
December 1, 1975 thru June 30, 1976

Work Unit Title: Relationship of Coastal Pollution to Primary Productivity and Algal Blooms

Personal Service

Name and/or Position	Grade	%Time	Man Months	Cost (K)	
Dr. J. Pearce, Director of Investigations	GS-15	5	0.6	1.8	
Dr. K. McNulty, Fishery Biologist	GS-14	33	4.0	10.9	
Dr. J. Thomas, Fishery Biologist	GS-12	29	3.5	6.7	
Dr. J. Mahoney, Fishery Biologist	GS-12	58	7.0	13.2	
Mr. J. O'Reilly, Fishery Biologist	GS-09	58	7.0	9.1	
Ms. C. Evans, Botanist	GS-07	58	7.0	7.7	
Computer Programmer	GS-07	58	7.0	7.0	
Ms. M. Cohn, Biological Tech. (Micro.)	GS-05	58	4.2	3.7	
Chemist	GS-05	58	7.0	5.7	
Biological Technician	GS-04	58	7.0	5.1	
Biological Aides (3)	GS-03	58	21.0	13.5	
Total Personal Service					84.4K

Operations

Travel		4.5	
Transportation of Things		0.5	
Printing and Reproduction		2.0	
Computer (includes 400 SYMAPS @ $20.00 each)		12.0	
Contracts:			
Packard Instrument - Maintenance		1.0	
Capital Equipment:			
Carbon Analyzer	10.0		
ATP Photometer	5.0		
Recorder (Photosynthetically active radiation)	3.0		
Millipore Filtration Holders (5)	1.0		
Peristaltic Pump	2.5		
Culture System	6.0		
Total Capital Equipment		27.5	
Supplies and Expendables		7.0	
Total Operations			54.5K
Total Direct Funds			138.9
Total Support Funds (33.3% of Total Direct Funds)			46.3
Total Funds			185.2