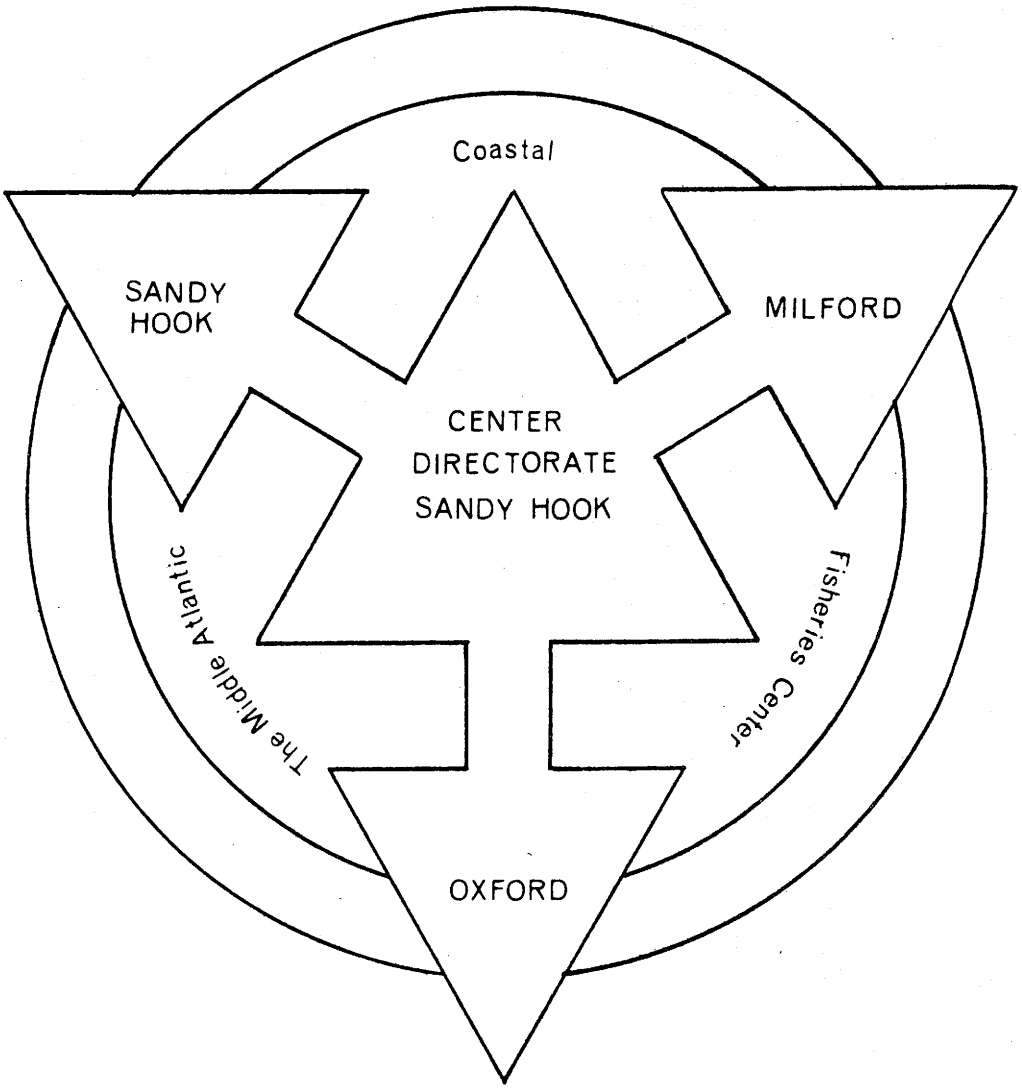
PROPOSAL FOR FY 1976 MESA-NYB FUNDING: "SEABED AND WATER COLUMN O_2 CONSUMPTION RATES IN THE NEW YORK BIGHT"

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

MIDDLE ATLANTIC COASTAL FISHERIES CENTER



Informal Report No. 87

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:

SEABED AND WATER COLUMN O_2 CONSUMPTION RATES IN THE NEW YORK BIGHT

Amount Requested: Phase I: (1 December, 1975 to 30 June 1976): $75,500.00
Phase II: To be funded from fiscal '77 funds

Date: October, 1975

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

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

WORK UNIT TITLE:

SEABED AND WATER COLUMN O_2 CONSUMPTION RATES IN THE NEW YORK BIGHT

Background:

The oceanic area, defined as the New York Bight Apex is constantly being subjected to numerous diverse and environmentally-adverse impacts, both natural and man-made. Thus, sewage sludge waste-disposal operations deposit in the Apex waters annually equivalent to 4.3 million cubic meters of sludge while dredge-spoil operations contribute some 4.6 million cubic meters of spoils. Industrial acid wastes contribute 2.7 million cubic meters of liquid chemicals each year while the wastes, human or otherwise, transported from the Hudson River and from other lesser riverine sources contribute some 3.65 million cubic meters per year (U.S., EPA, 1975; Manhattan College, 1975).

Most of these wastes (except acid wastes) contain organic materials which, upon oxidation (degradation or mineralization), consume oxygen, release electrons (or hydrogen) and yield energy (in the form of heat (calories) and end products (nutrients). The quantity of oxygen consumed may not only indicate the degree of biological and chemical activity, but may also determine, in concert with the rate of replacement of oxygen, the presence or absence of particular organisms based on their tolerance to certain levels of oxygen. The rate of oxygen consumption may also be used to indicate the quantity of organic matter that the system may process or treat (oxidize) per unit time. This quantity of processed (oxidized) material when compared with the input of organic matter to the system is one of the variables that determines whether organic matter accumulates, disappears or remains constant. (The other variables include all other mechanisms of export of organic matter from the system (re-suspension and/or transport due to waves, currents, and organisms)). Thus by measuring the rate at which oxygen is consumed (seabed oxygen consumption) one can 1) establish general levels of activity, 2) determine the rate of disappearance of organic matter due to oxidation, 3) calculate the energy (in calories) supplied to the systems by this oxidation, 4) compute the rate at which selected nutrients may be made available to the system, and 5) assess the ability of the system to assimilate continued or even increased levels of wastes.

With the likelihood of a reversal in the decision to relocate the sewage sludge disposal area to the alternate offshore sites, monitoring of the continued waste disposal activities within the apex is necessary. Such monitoring will ensure that no additional or sudden untoward effects on the living marine resources and on human health occur between now and the cessation of ocean dumping (about 1981).

During the past year and-a-half, seabed oxygen consumption and related bottom water hydrographic measurements (temperature, salinity, and dissolved oxygen including percent oxygen saturation) were obtained during five cruises to the apex of the New York Bight. Samples for seabed oxygen consumption were collected with a Pamatmat multiple corer and incubated on shipboard in a water bath thermoregulated to in situ temperature (Pamatmat, 1971; Pamatmat, 1973). Four replicate samples from each of approximately sixty stations per cruise were treated in this way. At selected stations, oxygen consumption was also determined on samples containing bottom water only (no sediment). Navigational control of the vessel for sampling was accomplished using RAYDIST. We have SYMAPed the data and from the distributional plots we have found the following:

In March 1974, seabed oxygen consumption rates were generally low (2-20 ml O_2 m $^{-2}$ hr $^{-1}$). The highest consumption values occurred in two distinctly different areas and were of about the same magnitude. The largest area was centered over the Christiaensen Basin and the upper Hudson Shelf Valley. The second area of highest rates was located just off Asbury Park, N.J. These latter consumption rates were observed nearest the coast and decreased to seaward indicating a probable localized point-source of organic matter (i.e., ocean outfall of sewage) near the coast in that region. No discernible effects on seabed oxygen consumption were observed near the acid area (40° 20'N, 73° 40'W) in March or during the other cruises.

In August 1974, in response to higher water temperatures, seabed oxygen consumption rates were generally higher throughout the apex except for the Christiaensen Basin and upper Hudson Shelf Valley. Oxygen consumption rates in this area were not only depressed (less than 10 ml O_2 m $^{-2}$ hr $^{-1}$) compared with the surrounding area, but were also more typical of winter values measured during March. Such values may be indicative of an overstressed area. The highest rates (40 ml O_2 m $^{-2}$ hr $^{-1}$) occurred on the periphery of the depressed area and decreased with distance away from it. A second area of elevated rates occurred, as in March, off Asbury Park. These were the highest values measured for the cruise (up to 60 ml O_2 m $^{-2}$ hr $^{-1}$). It is considered significant that these consumption rates were observed in turbulent, highly oxygenated coastal waters.

In December 1974, the highest values were again found over the dredge spoil and sewage sludge (Christiaensen Basin) deposits (25 ml O_2 m $^{-2}$ hr $^{-1}$). No elevated rates were observed off Asbury Park (5 ml O_2 m $^{-2}$ hr $^{-1}$). In general, rates in the apex were nearly typical of winter values.

The distribution and magnitude of rates measured in February 1975 mimicked those of December. The major differences were 1) that the rates in the waste disposal areas in February (16 ml O_2 m $^{-2}$ hr $^{-1}$) were not as high as those in December, and 2) that the size of the areas with higher rates was less in February than in December.

The cruises of March and December 1974 and February 1975 represent conditions when no thermocline was present. The water column was well mixed and bottom water well ventilated. Percent oxygen saturation of bottom water was greater than 90% throughout the apex with bottom water oxygen concentrations ranging from 8.00 ppm to 10.80 ppm. Bottom water temperatures were quite uniform throughout the apex being only slightly warmer in the deeper areas. Temperatures ranged from about 10°C in December to about 5°C in February and March. Salinity ranges from 30.00 o/oo to 33.80 o/oo being lowest near the Hudson River entrance and highest in the deeper water of the apex (30-40 m in the Christiaensen Basin and upper Hudson Shelf Valley).

The cruises of August 1974 and 1975 are representative of summer conditions when a thermocline was present between 10 m and 25 m depth. The thermocline acts to isolate bottom water from atmospheric renewal of oxygen.

In August 1974, bottom water oxygen concentrations fell to as low as 1.00 ppm; a minimum of 4 ppm is considered necessary to sustain marine life (EPA; Water Quality Standards). These low values occurred along a broad path beginning near the Shark River Inlet, N.J. and extending towards Atlantic Beach, L.I. Percent oxygen saturation of bottom water ranged from 13% off New Jersey to 100% along the Long Island coast. Bottom water temperatures ranged from 11°C to 23°C being warmest in the shallow water and coolest in the deeper water. Salinities ranged from 29 o/oo to 33 o/oo with the lowest salinities occurring near the Hudson River entrance. Again, the deeper water exhibited the higher salinities.

The August 1975 data is not presently plotted. However, dissolved oxygen concentrations in the bottom water were not as low (none less than 3 ppm) as the values for August 1974. Nor are the number of low values as numerous as the previous August. Bottom water temperatures were about the same both years for shallow areas, but were colder in August 1975 (8°C) for the deeper areas. It appears that seabed oxygen consumption may be quite different in succeeding summers and that these differences are natural and real. In point of fact, this August 1975 cruise begins our monitoring program.

Research Objectives:

1. To document the seasonal changes and impact-induced variations in seabed respiration in the New York Bight Apex; to monitor future respiration rates in the Apex during warm-water months in relation to documented respiration baselines.

2. To document respiration baselines for cold- and warm-water months for the outer continental shelf of the New York Bight and for the Hudson Shelf Valley.

3. To define clearly, via altered respiration rates, impacted Apex areas and the extent of man-induced changes in the New York Bight.

4. To measure relative importance of seabed vis-a-vis water column oxidation of organic carbon in the New York Bight.

We are now in the process of accomplishing a series of statistical analyses including multiple regressions, principle component and factor analyses. These analyses are expected to occupy the first half of FY 1976. We have also submitted an extended abstract for a paper to be presented at the New York Bight Symposium to be held at the American Museum of Natural History in New York City, 3-5 November 1975, and the proceedings of the Symposium will be published. We anticipate producing additional manuscripts during the winter and spring of 1976 as additional data analyses become available. We plan to build upon this information as it becomes available to steer us in our proposed investigations. Thus, we request funding not only to process data already collected, but also to continue a field program already underway.

Research Plan: Monitoring Comparative Water Column/Seabed Studies

We propose to monitor seabed oxygen consumption in the Apex of the New York Bight by making one cruise a year over the next several years at the time of maximum bottom water temperatures (August-September). This will allow us to see year to year differences and perhaps aid in determining long-term trends for management purposes. During the spring and early summer months, all cruises passing through the Apex area will routinely measure the bottom waters for dissolved O_2 content. This will ensure that the monitor cruises will occur during the period of greatest stress. Wider coverage of the Apex as well as a denser grid of stations over each of the impacted areas will be employed to improve definition of the impacted areas. Additional replicate samples will be processed to improve levels of confidence in the data. In addition, water column rates of oxygen consumption at selected stations will be investigated. The results will be compared with seabed oxygen consumption rates to determine the relative magnitudes and importance of water column rates vs sediment rates, i.e., to determine where the bulk of the organic matter becomes oxidized. The location and magnitude of oxidation rates has implications for management of these waste disposal areas.

Our request for the dissolved oxygen probe will allow us the additional capability to rapidly search for areas that should be investigated more intensively by providing us with real time information on dissolved oxygen concentrations. The heating and cooling units are requested as replacements for existing units.

Research Plan: Seabed O_2 Consumption in the Hudson Shelf Valley

The Hudson Shelf Valley is highly implicated in the transport of contaminants (coliforms, heavy metals, organic matter) away from the Apex. The Valley also appears to import deeper shelf and ocean waters to the Apex and could be an important route for migratory fish.

We propose to investigate seabed oxygen consumption twice a year (February-March and August-September) in the Hudson Shelf Valley and on the adjacent shelf including the proposed alternate waste disposal areas to determine distribution and levels of benthic metabolism. This has already been initiated.

Research Plan: Seabed O_2 Consumption on the Outer Continental Shelf of the New York Bight

We also propose to investigate seabed oxygen consumption rates of the outer continental shelf (100 stations) of the New York Bight twice a year with the first cruise beginning in February 1976. Such studies would act as baseline surveys in anticipation of economic development of the continental shelf.

Finally, we propose to determine how far seaward from the New York metropolitan area (Bight apex) the effects of man's activities, as exhibited by benthic metabolism, extend. This will be accomplished by examining transects extending outward from the apex.

Work Plan: (Phase I - 1 December 1975 thru 30 June 1976)

1. Complete preparation of all data reports, scientific manuscripts, etc., for NYB Apex seabed oxygen consumption studies - 4 cruises - January 1976

2. Initiate biannual OCS seabed oxygen consumption studies - occupying some 100 stations, and biannual Hudson Shelf Valley studies (10 stations) - February, 1976

3. Complete first-level work-up of cruise data April, 1976

4. Submit interim interpretive technical report June, 1976

Work Plan: (Phase II - 1 July 1975 thru 30 June 1977)

1. Complete biannual OCS and Hudson Shelf Valley seabed oxygen consumption studies - cruise #3, occupying some 100 stations. Continue Apex monitoring cruises (40 stations) September, 1976

1. Complete work-up of cruise data November, 1976

3. Submit comprehensive technical reports and scientific papers on levels and on biological and environmental significance of seabed oxygen consumption rates for the entire New York Bight June, 1976

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

Work Unit Title: Seabed and Water Column O_2 Consumption in the New York Bight

Personal Service

Name and/or Position	Grade	% Time	Man Months	Cost(K)	
Dr. J. Pearce, Director of Investigation	GS-15	5	0.6	1.8	
Dr. J. Thomas, Fishery Biologist	GS-12	29	3.5	6.7	
Dr. K. McNulty, Fishery Biologist	GS-14	12	1.4	3.6	
Oceanographer/Fishery Biologist	GS-07	58	7.0	7.0	
Computer Programmer	GS-07	58	7.0	7.0	
Biological Aides (2)	GS-03	58	14.0	9.0	
Total Personal Service					35.1K

Operations

Travel		1.5	
Transportation of Things		0.3	
Printing and Reproduction		1.5	
Computer		4.5	
Contracts:			
Lehigh University		4.5	
Capital Equipment:			
Dissolved Oxygen Probe	1.2		
Cooling Unit	0.8		
Heating Unit	0.8		
Total Capital Equipment		2.8	
Supplies and Expendables		6.5	
Total Operations			21.6K
Total Direct Funds			56.7
Total Support Funds (33.3% of Total Direct Funds)			18.8
Total Funds			75.5K