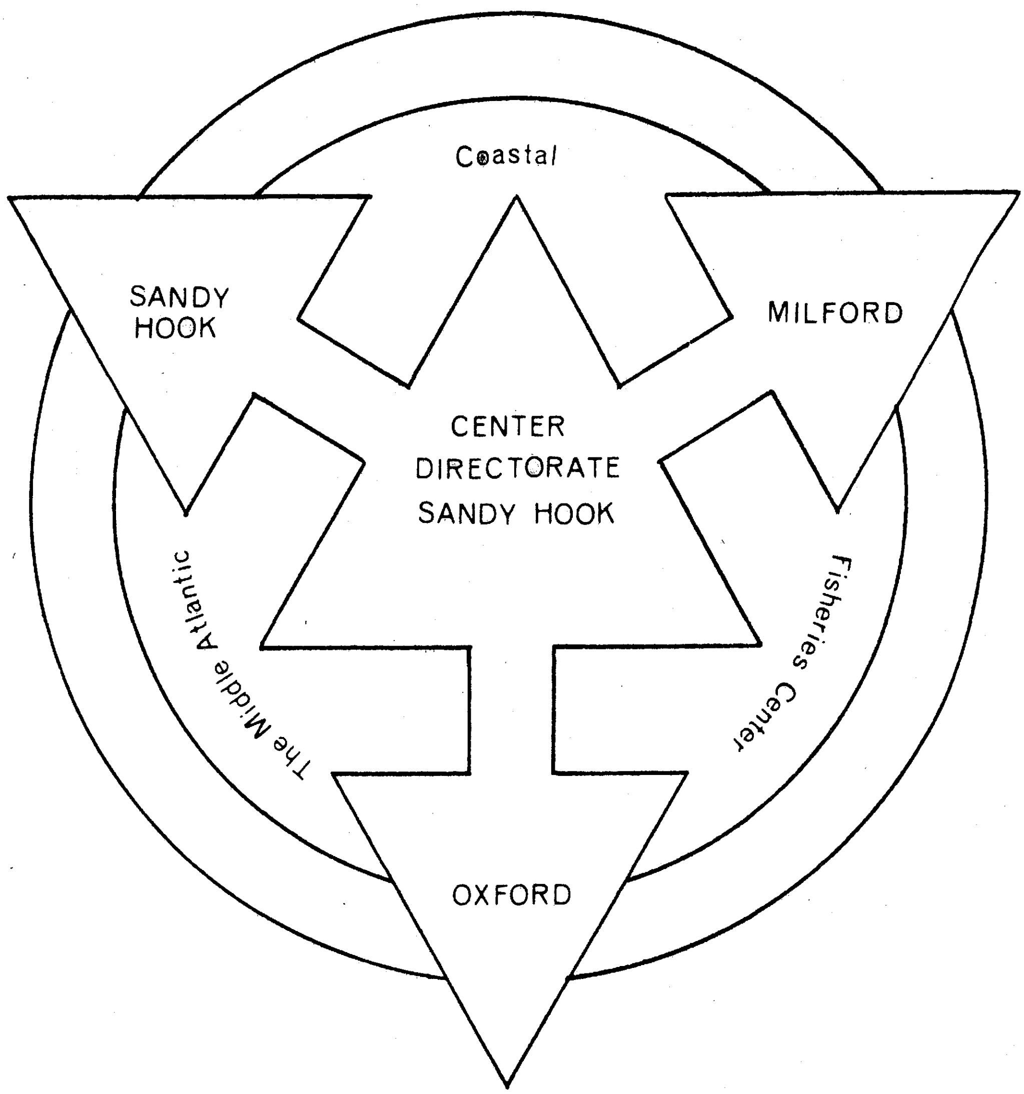
MESA-NYB FUNDED BIOLOGICAL RESEARCH
TRIMESTER PROGRESS REPORT -- NOVEMBER-FEBRUARY 1976

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

MIDDLE ATLANTIC COASTAL FISHERIES CENTER



Informal Report No. 97

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Table of Contents

		Page
I.	Introduction	1
II.	Summary of Accomplishments	2
	Presentations	5
	Publications	6
III.	Detailed Reports of Progress	10
	1. Mutagensis	10
	2. Fin Rot and Invertebrate Disease	17
	3. Benthic Macrofauna and Chemistry	20
	4. Seabed Oxygen Consumption	22
	5. Phytoplankton Primary Productivity	37
IV.	MESA Data Report	38
V.	Appendix	45
	Statistical Analysis of Benthic Sample	46
	Data (Dr. Saila)	47

I. INTRODUCTION

This report summarizes progress by The Middle Atlantic Coastal Fisheries Center in MESA-funded research from 1 November 1975 through 29 February 1976. Section II consists of a summary of accomplishments. Section III is a detailed description of activities and accomplishments of the following individual studies:

1. Mutagenesis,
2. Fin Rot and Invertebrate Diseases,
3. Benthic Macrofauna and Chemistry,
4. Seabed Oxygen Consumption,
5. Phytoplankton Primary Productivity.

The first three studies received direct MESA funding during the reporting period. The last two studies are continuations of formerly MESA-funded research.

Section IV ia a report on data management.

Section V summarizes Dr. Saila's contract research on statistical analyses of benthic sample data.

II. SUMMARY OF ACCOMPLISHMENTS

1. A manuscript on mutagenesis in embryos of fish sampled during the westward cruise of 7 - 18 May 1974 was completed. Evidence is presented of chromosomal abnormalities in excess of background levels together with statistical tests of significance of the results. The manuscript includes a review of mutagenicity in a variety of organisms that is associated with heavy metals and pesticides.
2. About 3,000 fish embryos, mostly mackerel, from The New York Bight, have now been processed for chromosome study, and more are being prepared by three technicians.
3. A method of scoring chromosome damage that is consistent with ADP needs is in use. Embryos in a sample are classified within seven developmental stages and are then rated for severity of chromosomal damage in nine categories. Scoring is numerical whenever possible.
4. Weakfish averaged 11.9% prevalence of fin rot, the highest recorded this trimester, on 10 cruises in Sandy Hook-Raritan Bay. Seasonally low prevalence in winter flounder, 2.8%, and in windowpane flounder, 0.45%, were also recorded.
5. Condition indexes of winter flounder held in cages at the sludge dump site in November and December averaged lower than indexes of fish held at the control site, but the differences were not statistically significant. A February - March experiment is in progress.
6. Discolored gills were found in about 70% of the rock crabs trawled last fall in Sandy Hook Bay and The New York Bight Apex, but after the winter melt, gills were about 90% clean. Collections continue.

7. Phagocytic nodules were present in tissue sections of 80-100% of lobsters and about 50% of rock crabs sampled in Sandy Hook Bay and the Apex during July - October 1975. Causes are being sought.

8. An indicator of high benthic protozoan-bacterial populations inhabits the gill lamellae of rock crabs and lobsters. It is Ephelota sp., a suctorian ciliate which feeds on other free-swimming protozoa which in turn feed on bacteria. It was present on the gills of 20% of the animals sampled last fall and early winter in Sandy Hook Bay and the Apex.

9. We gave Dr. Rozett, through Dr. Jalikee, and Dr. Saila a tape and listing containing data with which to perform multivariate analyses of animal-sediment-water column relations. The data consist of species abundances of macroinvertebrates, diversity and equitability of species, grain-size parameters of sediments, and heavy metals content of sediments at 64 stations in the Apex for the 1st, 3rd, 4th, and 5th quarterly cruises. We also gave them a card deck and listing containing bottom water salinity, temperature, sigma-t, dissolved oxygen, and percent saturation of oxygen at all standard MESA grid stations visited on the 1st, 2nd, 3rd, 4th, and 5th quarterly cruises, plus seabed oxygen consumption for the 4th and 5th quarterly cruises.

10. The benthic sorting and identifying group has processed 230 macroinvertebrate samples in this fiscal year. Cumulatively, since MESA began, we have processed 924 samples (see Table 3 below).

11. Cluster analyses of benthic macroinvertebrate data were performed by hand to guide modification of existing computer programs.

12. We analyzed the heavy metals in sediments of the 5th quarterly cruise, and we included the data in the tape given to Dr. Rozett.

13. Dr. Cok's analyses of sediment particle-size parameters of the 5th quarterly cruise were included in the tape given to Dr. Rozett.

14. Construction of the MESA museum began.

15. A paper on seabed oxygen consumption in The New York Bight Apex was submitted to Limnology and Oceanography. Major findings from five seasonal cruises spanning 17 months included: (1) Rates of total oxygen consumption ranged from 1 - 68 ml O_2 m^{-2} hr^{-1}; (2) rates were generally much higher in summer than in winter, with interesting exceptions; (3) highest summer rates occurred at the dredge spoil site and near the site of a municipal sewage outfall off Asbury Park, N. J.; and (4) seabed oxygen consumption was about 5% of the total surface-to-bottom uptake in the Apex, and about 80% of the 12-cm-to-bottom uptake.

16. An abstract entitled "Dissolved organic matter productivity in Raritan-Lower Hudson Estuary" was submitted to The American Society of Limnology and Oceanography for presentation of a paper in June 1976. Selected conclusions based on monthly measurements over 16 months of dissolved organic matter (DOM), nannoplankton, netplankton, and corelative parameters were: (1) DOM ranged from 0 - 155 mg C m^{-3} hr^{-1} C - (71.2% photossimilated carbon released as DOM); (2) DOM percentages were highest in August - September and lowest in March; (3) DOM productivity varied directly with total productivity.

17. Dr. Saila, under contract, made the final revisions to one manuscript, prepared a second manuscript, and investigated the variability of

faunal diversity indices from the RECON cruise data (Appendix 1). The finalized manuscript, "Optimum allocation strategies for sampling benthos in the New York Bight," is scheduled for publication in 1976 in Estuarine and Coastal Marine Science. The second manuscript, "Sedimentation and food resources: Animal sediment relationships," will be published as Chapter 20 of a book, The American Geological Institute Short Course, entitled "The new concepts of continental margin sedimentation, II." Results of calculating The Shannon-Weaver entropy function and its error terms are presented, together with a map of the distribution of e tropy in The New York Bight Apex.

Presentations

1. Sindermann, Carl J. 1975. Effects of Coastal Pollution on Fish and Shellfisheries. ASLO/MESA Symposium on the Middle Atlantic Shelf and the New York Bight. New York City, 3-5 November 1975.
2. Rosenfield, Aaron. 1975. Disease Problems of Shellfish on the Middle Atlantic Coast. ASLO/MESA Symposium on the Middle Atlantic Shelf and the New York Bight. New York City, 3-5 November 1975.
3. Longwell, A. Crosby. 1975. Chromosome Disturbance and Mitotic Errors in Developing Mackerel Eggs Sampled out of the New York Bight. ASLO/MESA Symposium on the Middle Atlantic Shelf and the New York Bight. New York City, 3-5 November 1975.
4. Thomas, James P. 1975. Seabed Oxygen Consumption - New York Bight. ASLO/MESA Symposium on the Middle Atlantic Shelf and the New York Bight. New York City, 3-5 November 1975.

5. Pearce, John B. 1975. The Temporal and Spatial Distribution of Benthic Macroinvertebrates in the New York Bight. ASLO/MESA Symposium on the Middle Atlantic Shelf and the New York Bight. New York City, 3-5 November 1975.

6. Ziskowski, John. 1975. Fish Disease Studies in the New York Bight. ASLO/MESA Symposium on the Middle Atlantic Shelf and the New York Bight. New York City, 3-5 November 1975.

7. Pearce, John B. 1976. Review of MESA-funded Benthic Biological Research. MESA Program Office, Boulder, CO. 27 February 1976.

Publications

Longwell, A. Crosby. 1975. Chromosome Mutagenesis in Developing Mackerel Eggs Sampled out of the New York Bight. (Expanded Abstract) Amer. Soc. Limnology and Oceanography, Special Symposium, The Middle Atlantic Continental Shelf and New York Bight.

Longwell, A. Crosby. 1976. Chromosome Mutagenesis in Developing Mackerel Eggs Sampled from the New York Bight: Development of Rationale, Methods, Initial Data and Discussion of Implications for Fish Populations. MESA Tech. Rept. Ser., Manuscript.

Murchelano, R. and J. Ziskowski. 1975. Fin Rot Disease Studies in the New York Bight. Amer. Soc. Limnology and Oceanography, Special Symposium, The Middle Atlantic Continental Shelf and New York Bight.

Pearce, John B., Janice Caracciolo, Martha Halsey and Leslie Rogers. 1975. The Temporal and Spatial Distribution of Benthic Macroinvertebrates in the New York Bight. Amer. Soc. Limnology and Oceanography, Special Symposium, The Middle Atlantic Continental Shelf and New York Bight.

Rosenfield, Aaron. 1975. Disease Problems of Shellfish on the Middle Atlantic Coast. (Abstract) Amer. Soc. Limnology and Oceanography, Special Symposium, The Middle Atlantic Continental Shelf and New York Bight. pp. 58-59.

Sindermann, Carl J. 1975. Effects of Coastal Pollution on Fish and Fisheries--With Particular Reference to the Middle Atlantic Bight. Amer. Soc. Limnology and Oceanography, Special Symposium, The Middle Atlantic Continental Shelf and New York Bight.

Thomas, J. B., W. Phoel, F. Steimle, J. O'Reilly and C. Evans. 1975. Seabed Oxygen Consumption - New York Bight. Amer. Soc. Limnology and Oceanography, Special Symposium, The Middle Atlantic Continental Shelf and New York Bight.

The ten data reports listed below were revised and resubmitted to The MESA Program Manager, Boulder, CO., for publication in The MESA data report series.

Azarovitz, T. R., M. Silverman, V. Anderson, A. Thoms and C. Aussicker. NOAA Data Report No. Demersal Finfish Catches in the New York Bight by Stations and Species. R/V Atlantic Twin October 31 - December 5, 1972.

Azarovitz, T. R., M. Silverman, V. Anderson, A. Thoms and C. Aussicker. NOAA Data Report No. Demersal Finfish Catches in the New York Bight by Station and Species. R/V Atlantic Twin May 8 - June 4, 1973.

Azarovitz, T. R., M. Silverman, V. Anderson, A. Thoms and C. Aussicker. NOAA Data Report No. Demersal Finfish Catches in the New York Bight by Station and Species. R/V Atlantic Twin October 1 - November 7, 1973.

Azarovitz, T. R., M. Silverman, V. Anderson, A. Thoms, and C. Aussicker. NOAA Data Report No. Demersal Finfish Catches in the New York Bight by Stations and Species. R/V Delaware II and Atlantic Twin April 1 - May 2, 1974.

Azarovitz, T. R., M. Silverman, V. Anderson, A. Thoms and C. Aussicker. NOAA Data Report No. Demersal Finfish Catches in the New York Bight by Stations and Species. R/V Albatross IV and Delaware II September 23 - October 4, 1974.

Azarovitz, T. R., M. Silverman, V. Anderson, A. Thoms and C. Aussicker. NOAA Data Report No. Demersal Finfish Catches in the New York Bight. R/V Albatross IV and Atlantic Twin March 4-24, 1975.

Pearce, John, James Thomas, Janice Caracciolo, Martha Halsey and Leslie Rogers. NOAA Data Report No. Distribution and abundance of benthic organisms in the New York Bight Apex, 2-6 August 1973.

Pearce, John, James Thomas, Janice Caracciolo, Martha Halsey and Leslie Rogers. NOAA Data Report No. Distribution and abundance of benthic organisms in the New York Bight Apex, 26 August - 6 September 1974.

Pearce, John, James Thomas, Leslie Rogers, Janice Caracciolo, Martha Halsey and Knee McNulty. NOAA Data Report No. Distribution and abundance of benthic organisms in the outer New York Bight and proposed alternate dump sites, June 1974 and February 1975.

Ropes, J. W. and A. S. Merrill. NOAA Data Report No. Historical cruise data on surf clams and ocean guahogs.

The two data reports listed below were accepted for publication in the MESA data report series.

Pearce, John, Janice Caracciolo, Ann Frame, Leslie Rogers, Martha Halsey and James Thomas. Distribution and abundance of benthic organisms in the New York Bight, August 1968 - February 197 .

Thomas, James P., William Phoel and Frank Steimle. New York Bight Apex data on total oxygen consumption by the seabed, March 1974 - February 1975.

The two papers listed below were published in 1975, but were not previously cited in the Publications section of a Trimester Report.

Murchelano, Robert A. 1975. The Histopathology of Fin Rot Disease in Winter Flounder from the New York Bight. J. Wildl. Dis. 11(2): 263-268.

Ziskowski, John, and Robert Murchelano. 1975. Fin erosion in Winter Flounder. Mar. Poll. Bull. 6(2): 26-29.

1. MUTAGENESIS

New Work on Atlantic Mackerel Eggs Collected on Westward Cruise, May 1974

About 3,000 fish embryos, largely mackerel, from the New York Bight have now been removed from their eggs and processed for chromosome study, and more are being prepared. All three technicians have now been hired and trained (the last hired in January). Analysis of the first-collected data on mackerel eggs sampled on the Westward cruise is complete. A full report for MESA has been completed on this work and sent to MACFC for review. The next three months are to be spent in intensive, hopefully relatively uninterrupted reading of prepared slides.

Keys have been formulated for scoring. The end result for use in computer programs will be the following sorts of information on each of seven stages of embryo development: early cleavage, morula, blastula, gastrula, early embryo, tail-bud and tail free, with respect to (1) portion of sample alive and dead, and portion normal and abnormal on gross microscopic examination; (2) mitotic index (its depression accompanies the mutation process, and increases risk of predation); (3) percentage eggs with no abnormality scored; percentage eggs with all chromosome division figures abnormal; (4) multiple abnormalities within cells; (5) abnormality by tissue or cell type - insofar as possible; (6) chromosome errors being repeated over embryo sectors; (7) abnormal physiological effects on chromosomes; (8) disturbances of the spinal apparatus, as reflected in abnormal distributions of the chromosomes; (9) breakage and abnormal rearrangements of the chromosomes. Such data should supply a fairly comprehensive picture of the cyto-genetic development of mackerel eggs in the Bight.

Embryos have been prepared from 28 stations, 5 of which are represented in the 14 already being reported. Eggs are available for 40 stations. If one hundred eggs are to be read for each embryo stage at all stations, this will amount to 28,000 embryos studied. After all stages are spot-checked, one or two stages will be concentrated on until enough data are available on these two stages for sound statistical appraisal.

Some scoring details must yet be solved as the scoring is under way.

Samples of eggs from all the stations prepared for study have now been sent to W. Smith for species identification.

Minor Equipment Purchase and Its Use

An inexpensive dissecting microscope had to be purchased as only one was available for use by two technicians. This new scope was equipped with a camera unit for photographing the intact eggs and embryos dissected from them in preparation for chromosome study. A photomicrographic series of the seven early embryo stages of the Atlantic mackerel was made with intact eggs and dissected embryos alongside each other. Already published pictures are invariably drawings, and are not of free embryos.

Completion of Report for MESA on Initial Data on Chromosome Mutagenesis

As the initially collected *Westward* data were being prepared for publication, several important points came into sharper perspective.

Because of the input of heavy metals into the Bight, the MESA report heavily documents their mutagenicity; also that of pesticides. Classic genetic evidence for the dominant lethality of chromosome aberrations in early development is well cited.

In the manuscript, the life history of the mackerel is traced. Fish spawning in the Bight are from the southern contingent of Atlantic mackerel that spends summers in the Gulf of Maine and overwinters just off the continental shelf. With the exception of those that might have lived and spawned in relative proximity to the Toxic Chemical Disposal Site, their background mutation rate should have been uniform as they commenced their spawning migration into the Bight.

The final maturation of eggs involving very genetic-sensitive stages of meiosis, as mackerel and other such fish migrate into the Bight from cleaner waters, provides a means of testing pre- versus post-spawning incidences of cyto-genetic abnormalities. Incidence of chromosome abnormalities in the blood of migrating mackerel before fish reach the most polluted portions of the Bight should further provide a means of estimating the portion of pre-spawned oocyte abnormalities due to Bight pollution from the portion due to body load of pollutants or mutation load existing prior to the spawning migration. Such an analysis might be carried one step further to include studies of the blood of young mackerel (or even post-hatched stages) before they migrate out of the Bight in the fall once critical developmental and juvenile stages are completed. Major Bight influence on the mackerel must be on the eggs and post-hatched young. Blood would be studied for chromosome abnormalities by the micronucleus test as used for mammals.

The MESA report takes up in depth the background rate of chromosome aberrations and mitotic errors in zygotes and natural environmental factors contributing to this. Aside from Russian data on two fish, one viviparous and the other planktonic, data are available on a plant, a mollusk, chickens and humans. Mackerel data were considered in the light of these data, and the portion of abnormalities expected to be recorded in the scoring system used for the stage mackerel embryo studied. The conclusion was that some of the Bight stations have higher incidences of abnormalities than could have been anticipated on background alone. Also, statistically significant station differences were demonstrated. Spawn was presumably from a single contingent of Atlantic mackerel ruling out much pre-spawning variability in adult exposure.

Also taken up in depth in the report was the fate of post-gastrula fish embryos with genetically abnormal cells. Published work on fish (from radiation studies), chickens, mice and man leads to the conclusion that the periods of early cleavage and gastrulation are those of highest genetic risk to the developing mackerel zygotes. Correlation should exist between incidence of microscopically detectable chromosome aberrations in fish embryos at any stage and successful development of a natural spawn. Genetic and other evidence linking abnormal chromosome types to disease and sub-normal vigor is so overwhelming from plant to man that no few references could represent it.

The accumulation of cyto-genetic data on developing fish eggs significant to both regulation of pollution in the Bight and other coastal areas and to assessments of commercial fishery stocks should come simultaneously from three levels of approach. One of these should be experimental and bioassay in nature. The second should be the directed intensive study of eggs from the water columns of site-limited areas relative to some particular pollutant source, as the heated effluent of a power plant or particular barge dumps of toxic chemicals. Lastly, data should come from plankton samples collected over wider areas, as done for purposes of resource assessment. Baselines of chromosome mutation rates can be accumulated, both through study of newly collected field samples and by study of old plankton collections.

Analysis of mackerel data is on eggs collected only for the purpose of making an attempt to extend a genetic method to fishery biology and pollution as studied in the field. Many of the factors complicating analysis of the Westward data (but promoting thought regarding application of the cytogenetic test to a variety of sample collections) can be eliminated in future work through planning of sampling strategy to suit explicit purposes and, of course, through the mere accumulation of data for comparison.

Forthcoming Spring Cruise

No concrete plans have yet been made for the spring cruise to be scheduled in May when mackerel migrate again to the Bight to spawn. Dr. S. Chang will be consulted on sampling procedures. We are open to suggestions based on information presented in the MESA report. Some collections of summer flounder and red hake eggs sampled several years ago have been sent here for study by W. Smith, as specified in our proposal. These are mostly in later stages of development, but trial preparations have demonstrated they can be studied. Possibly, though, more information would be gained by concentrating efforts on the mackerel. Hake spawn near the bottom and mackerel near the surface. Unlike mackerel, flounder live in the Bight the year-round so one might expect a greater impact of Bight pollution on their developing eggs than on those of the mackerel. Both are reasons for initiating their study now or deferring it to later.

Cyto-genetic Bioassays

A cyto-genetic bioassay of early egg stages would eliminate the necessity for much culture at sea. It appears to have considerable potential. Thought is being given to this. (Other biological tests of larvae require artificial culture.)

Informal Cooperation with Other Groups

Dr. R. Edwards of the Northeast Fisheries Center has expressed interest in our work with respect to cooperation with fish culture endeavors at the NMFS Narragansett laboratory. Dr. G. Lawrence there has supplied us with fish eggs on prior occasions. The Smithsonian (Dr. F. Ferrari) will assist us in obtaining old plankton collections from the Bight if we so desire. Since Dr. R. Lasker and we are working at different ends of larval development, no collaborative projects were developed at the Stony Brook meeting of February 9. Dr. Lasker, however, will supply us with early embryos of the west coast mackerel (*Scomber japonicus*) he cultures in the laboratory. They are of interest, as well as embryos of flounder from the Narragansett laboratory. They are not so immediately important though as Atlantic mackerel (*Scomber scombrus*) eggs obtained from old Sandy Hook collections. These were collected at the northern and southern limits of the spawning area of the Atlantic mackerel.

Symposium and Meeting

A talk was presented at the November 3-5 Special Symposium, The Middle Atlantic Continental Shelf and New York Bight - Chromosome disturbances and mitotic errors in developing mackerel eggs sampled out of the New York Bight. An expanded abstract was prepared for a hand-out.

A meeting was attended at the MESA office at Stony Brook for the purpose of reviewing our work to date, and meeting with Dr. R. Lasker.

Manuscripts and Other Communications

Chromosome mutagenesis in developing mackerel eggs sampled from the New York Bight: Development of rationale, methods, initial data, and discussion of implications for fish populations - A. C. Longwell with assistance of: field collection, M. Griben, M. Silverman, J. St. Onge; methodology:

J. Hughes, D. Perry, S. Stiles, S. Assante, G. Carter; egg identification: W. Smith; statistics: S. Chang, J. MacInnes; typing and editorial work: R. Riccio; acknowledgement to J. O'Connor - for MESA Technical Report on Westward cruise - 54 pages, 4 tables, 1 map, 54 photomicrographs with legends, 183 references - submitted to MACFC for review.

Chromosome mutagenesis in developing mackerel eggs sampled from the New York Bight - A. C. Longwell - 7 pages with map - additionally expanded abstract for Limnology and Oceanology. Another short paper to be prepared for Science or Nature.

To W. Hess as requested - February 13 - paragraph description of cytogenetic work, 6 slides and corresponding 6 prints of slides with legends.

Memo regarding chemical requirements of genetics program as requested by H. Stamford, February 9 - forwarded to J. Hanks at Milford, February 17.

Memos to J. O'Connor - February 3 - regarding memo on possible cooperative efforts with R. Lasker; December 22 - regarding earlier memo concerning comments on abstract for meeting in November 1975.

Translations

Plans are being made to have a small collection of foreign literature papers, some Russian, pertinent to our work translated.

2. FIN ROT AND INVERTEBRATE DISEASE

A. Fin Rot Disease

1. Entrapment studies with winter flounder in sewage sludge area.

During the reporting period, traps containing winter flounder were placed at the sludge site on November 3, December 11, and February 11. Traps were recovered at the sludge site on November 11 and December 29. Traps were placed at the control site on November 6, December 11, and February 11. The traps were recovered on November 17 and December 30. Each trap contained ten winter flounder. For the traps at the sludge site, the condition index was 1.65 in November and 2.25 in December. For the traps at the control site, the condition index was 1.85 in November and 2.45 in December. Condition index coefficients were not statistically different between the control and sludge sites. Bottom temperatures and dissolved oxygen concentrations are being determined for each site at the time of trap placement and retrieval. Both temperature and dissolved oxygen are slightly higher at the control site than at the sludge site. Traps will be placed at both sites on a monthly basis.

2. Fin rot prevalence in summer flounder from Sandy Hook Bay and Great Bay, N. J.

Summer flounder are not onshore during the winter months and were not caught in abundance during the reporting period. No charter cruises were made to Great Bay, New Jersey. Ten cruises were made in Sandy Hook-Raritan Bay and 59/2092 (2.8%) fish were noted with fin rot disease. Winter flounder were the most numerically abundant species and 33/1444 (2.2%) exhibited fin rot. Only 2/436 (0.45%) windowpane flounder were noted with fin rot disease. Although only 193 weakfish were examined, 23 (11.9%) had fin rot. Beginning in April two cruises per month -- Sandy Hook-Raritan Bay and offshore in the Bight apex -- will form the basis for assessing the monthly prevalence of fin rot disease in the summer flounder. The prevalence will be determined from April through November 1976.

3. Histologic studies of normal and fin rot flounder epidermis.

Caudal and dorsal fin tissues were excised from five summer flounder and five windowpane flounder. The tissues were blocked in paraffin so that medial and distal sections of both caudal and dorsal fins could be made. All tissues have been sectioned and the resulting slides stained. The initial stains being employed are hematoxylin and eosin (H & E), periodic acid - Schiff (PAS), and Mallory trichrome. The slides are being examined and representative tissues photographed.

4. Fin rot disease progression in laboratory-held winter and summer flounder.

No progress this reporting period.

5. Contagion in laboratory-held winter and summer flounder.

No progress this reporting period.

6. Fin rot disease in pelagic fish from pound and fyke net fishery in Sandy Hook-Raritan Bay.

Commercial fishermen do not use Sandy Hook-Raritan Bay pound and fyke nets during the period October - May.

B. <u>Invertebrate Disease</u>

1. Collections

Rock crabs, lady crabs, and lobsters were collected by otter trawl in Sandy Hook Bay and in the New York Bight apex. Two hundred specimens were collected and examined for histopathology, including 85 rock crabs collected in Delaware and Philadelphia dumpsites and 29 from Montauk Point, Long Island. New collection sites are being sampled in order to obtain data on crustaceans in habitats far removed from the N. Y. Bight. Data from fall and winter sampling showed that, prior to the winter molt, about 70% of rock crabs had discolored gills. Immediately after molt, crabs in Sandy Hook Bay were about 90% clean. Follow-up collections have been scheduled to follow rates of progressive discoloration. New studies are being designed to determine whether the size and color of silt particles in crustacean gills may serve as an indicator of ocean dumping.

2. Epibionts and parasites

Rock crabs and lobsters were found to have a suctorian ciliate, Ephelota sp., on the gill lamellae. The ciliate feeds on other free-swimming protozoa which in turn feed on bacteria. The presence of Ephelota on 20% of the animals studied indicates that high microbial populations are present in sediments of the Bay and the Bight. Lobsters from the Bay and the Bight continue to show high prevalences of phagocytic nodules in tissue sections. Studies are in progress to determine the role of amoebae, Paramoeba, and bacteria, in stimulating the pronounced phagocytic response. During the period July-October 1975 approximately 80-100% of the lobsters had such nodules and about 50% of the rock crabs had similar pathology.

3. BENTHIC MACROFAUNA AND CHEMISTRY

Sorting and identifying has proceeded on schedule. Efficiency of this activity is largely a function of the experience of personnel. At the beginning of the trimester, one-half of the sorters had been working since early summer, and the other half since mid-September. Two experienced sorters from past work-study periods of employment were added to the sorting group over the Christmas holiday to supplement existing manpower and to accelerate progress. The result is that progress has exceeded expectations somewhat. A total of 230 samples has been sorted and identified in this fiscal year.

Multivariate analyses of data by Dr. Rozett of Fordham University working with Dr. Jalacki of NOAA-EDS-CEDDA, and by Dr. Saila of the University of Rhode Island began this trimester. Agreement was reached at a meeting of participants on January 8 that a tape containing the data would be available on January 16. Both Dr. Jalacki and Dr. Saila visited the Sandy Hook Laboratory during the week following January 16 to pick up the tape and to discuss its content with MACFC staff members. The tape contains species and abundance of macroinvertebrates, grain-size parameters of sediments, and heavy metals content of sediments at 64 stations in the apex of the New York Bight for the 1st, 3rd, 4th, and 5th quarterly cruises. In addition, punched cards and a listing of dissolved oxygen, percentage oxygen saturation, seabed respiration, salinity, temperature, and STD data that are supplemental to information on the tape were sent to Drs. Jalacki and Saila. Because Dr. Rozett and Dr. Saila will use different methods of analysis, the similarity or dissimilarity of their conclusions should be extremely interesting.

Cluster analysis of macrofaunal assemblages began this trimester. After reviewing available methods, Dr. McNulty selected the Canberra metric dissimilarity coefficient coupled with flexible clustering (beta = 0.25), and made several desk-calculator runs to guide modification of existing computer programs. Programs which were obtained from Drs. Watling and Boesch are at this writing being modified to include provision for averaging four replicates at 45 stations of the August 1973 cruise and for transforming the resulting averages to the cube root. The effect of replicate grab samples on cluster analyses are being studied, resulting in a finding to date that three and preferably four replicates per station are desirable. The effect of using species which occur at greater than 25 percent of the stations compared with using all species resulted in the finding based on a few based calculations, that both approaches yield useful but somewhat different results. We plan to try both approaches, then compare results.

New abiotic data obtained this trimester consisted of the heavy metals content of sediments from the 5th quarterly cruise, and particle-size parameters of sediments from the RECON cruise and the first through fifth quarterly cruises. The data were punched and included in the tapes being used in multivariate analyses. Dr. Cok is compiling mud-sand-gravel percentages of sediments sampled in the first four quarterly cruises and Dr. Parks is continuing his analyses of particle size distribution and organic carbon content of sediments employed in seabed respiration studies.

Construction of the MESA museum began this trimester. The work consists of GSA-approved modification of an existing small building at the Sandy Hook Laboratory.

Benthic sampling was limited to monitoring the fauna at 13 stations in the Apex in November and again partially in February.

4. SEABED OXYGEN CONSUMPTION

In November 1975 we presented a paper, Seabed Oxygen Consumption, New York Bight Apex, U. S. A.," in New York City at the Symposium on the Middle Atlantic Continental Shelf and New York Bight. That presentation has resulted in a paper submitted to Limnology and Oceanography. The abstract and a few of the more pertinent tables and figures from that paper are presented here.

Seabed Oxygen Consumption: Seabed oxygen consumption rates and related bottom water hydrographic measurements (temperature, salinity and dissolved oxygen) were obtained during five cruises in the New York Bight apex between March 1974 and August 1975. The area sampled included the waste disposal sites for sewage sludge, dredge spoils, and industrial acid wastes (Fig. 1). 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. Four samples per station for each of approximately sixty stations per cruise were collected and processed in this way.

Percent saturation of bottom water dissolved oxygen in the New York Bight apex ranged from near 100% in winter to 13% in summer (Fig. 2). The area of the apex seabed having low percents of saturation can be significant (Table 1) and could affect demersal finfish and the organisms they feed upon.

Rates of total oxygen consumption by the seabed ranged from 1 to 68 ml $O_2\ m^{-2}\ hr^{-1}$ and are comparable to those of other studies in the coastal marine environment, particularly where organic enrichment of the seabed has occurred (Fig. 3). An average of 444 x 10^6 litres O_2 (183 metric tons

Figure 1. SYMAP station numbers and locations of stations sampled for measurements of seabed oxygen consumption rates. Dredge spoils disposal site (large dot) located near station 109 at the center of encircled area. Encircled area affected by dredge spoils, but not synonymous with dredge spoils disposal site. Dredge spoils disposal site is defined as the area within a circle with a radius of 0.6 nautical miles about 40°24'N and 73°51'W (large dot). Cross stippled area bounded by 28 m depth contour and stations 55, 56, 57 is designated Christiaensen Basin. Northwest corner of sewage sludge disposal site is black square located between stations 32 and 33. Sewage sludge drop area is located between 40°22.30'N and 40°25'N and 73°41'W and 73°45'W.

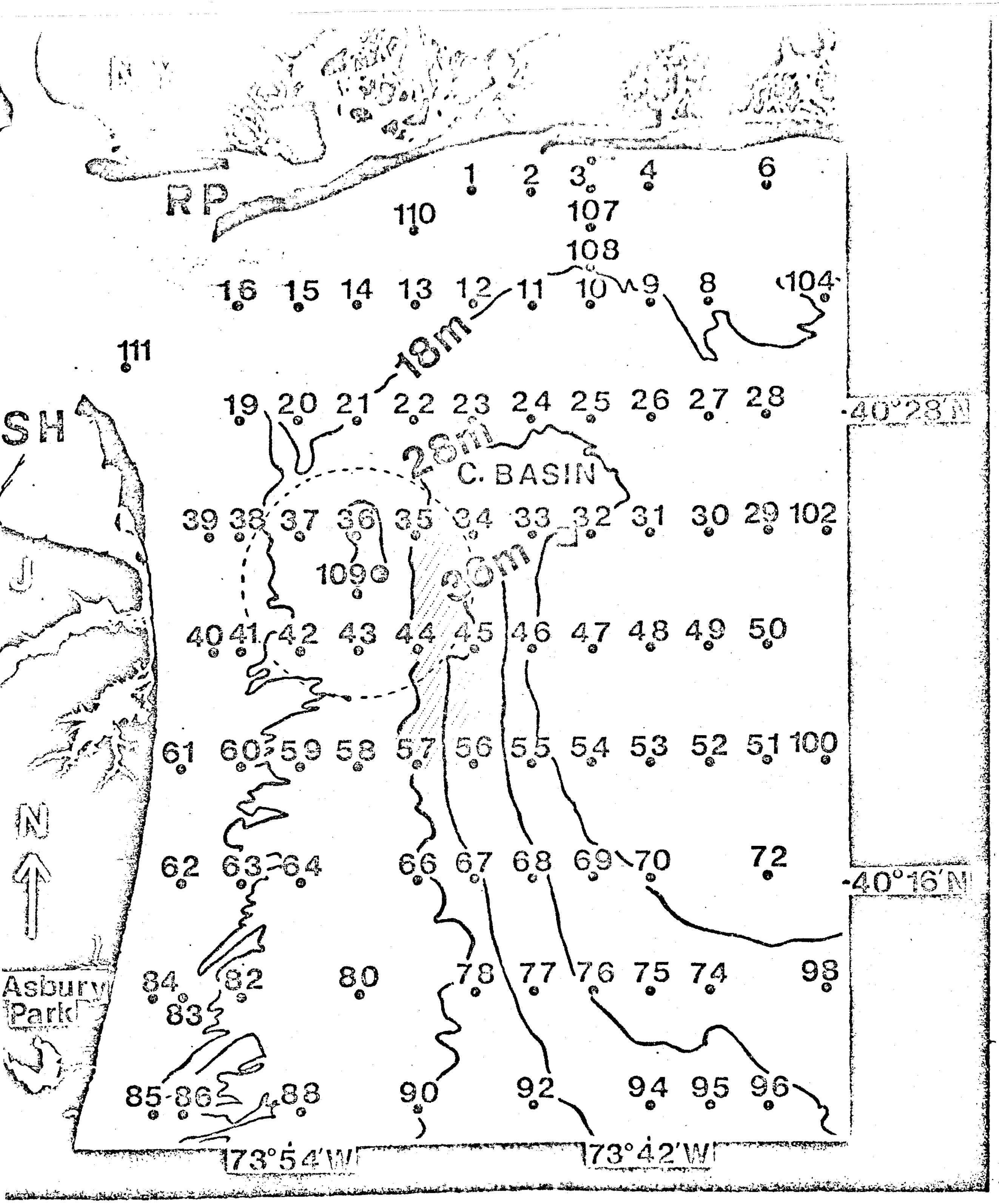
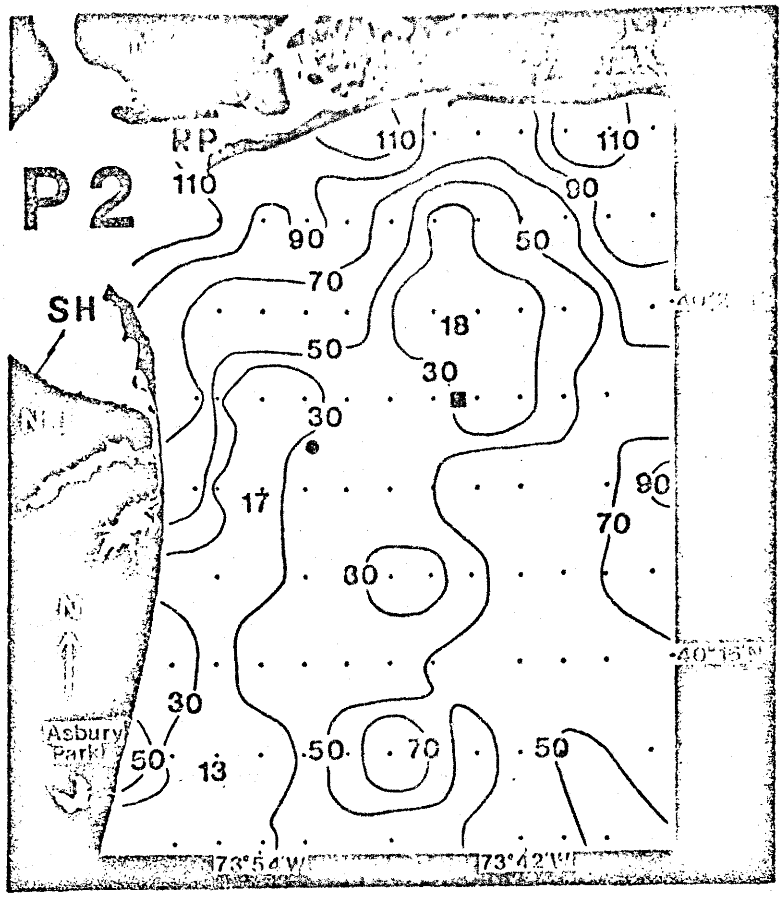

RP
SH
J
N
Asbury Park
C. BASIN
18m
28m
40°28'N
40°16'N
73°54'W
73°42'W
1 2 3 4 6
110 107 108
16 15 14 13 12 11 10 9 8 104
111
19 20 21 22 23 24 25 26 27 28
39 38 37 36 35 34 33 32 31 30 29 102
109
40 41 42 43 44 45 46 47 48 49 50
61 60 59 58 57 56 55 54 53 52 51 100
62 63 64 66 67 68 69 70 72
84 83 82 80 78 77 76 75 74 98
85 86 88 90 92 94 95 96

Figure 2. Percent saturation of bottom water dissolved oxygen for cruise D7409, 26 August - 6 September 1974 (P2) and cruise D7512, 12 - 25 August 1975 (P5).


P2
RP
SH
NJ
N
Asbury Park
110
90
80
70
50
30
18
17
13
73°54'W
73°42'W
40°15'N

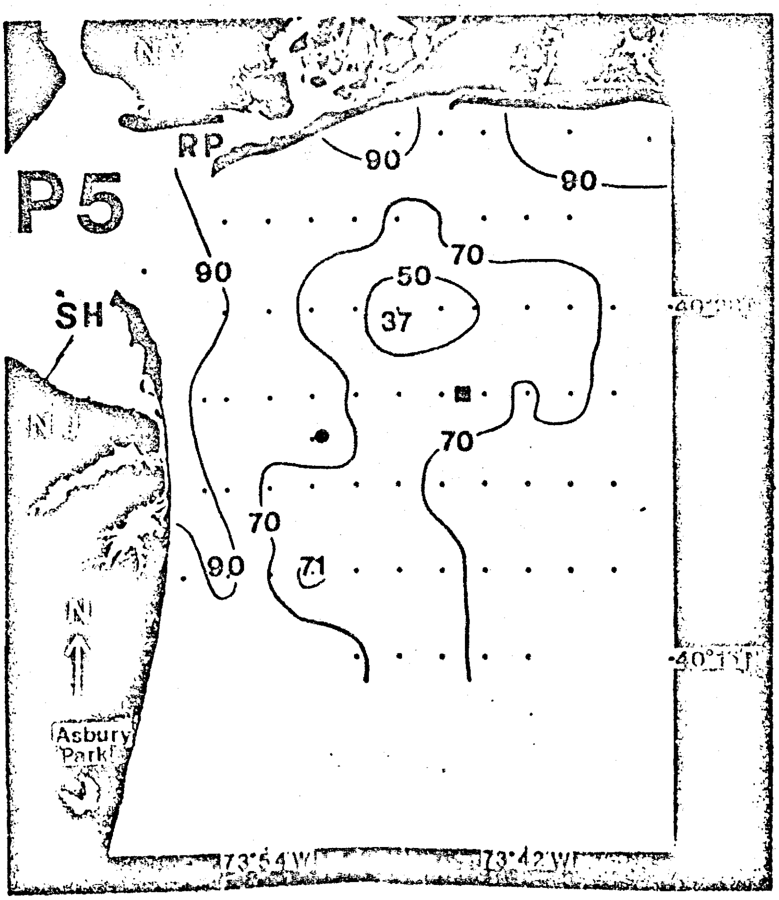

P5
RP
SH
NJ
N
Asbury Park
90
80
70
50
37
71
73°54'W
73°42'W
40°15'N

TABLE 1. Percent area of total apex (1577 km^2) with corresponding values of various levels of percent saturation of bottom water dissolved oxygen for cruise D7409, 26 August - 6 September 1974 and cruise D7512, 12-25 August 1975.

Bottom Water Dissolved Oxygen (% Saturation)	% Area of Total Apex*	
	August 1974	August 1975
30%	18%	0%
50	48	2
70	78	31
90	90	89
110	97	100
120	100	100

* Only 76.6% of the total apex area was sampled during August 1975.

carbon) are estimated to be consumed by the apex (1577 km^2) seabed each day. The annual cycle for the apex ranged from 288 x 10^6 litres O_2 per day in February to 689 x 10^6 litres O_2 per day in August (Fig. 4).

In winter the highest rates of seabed oxygen uptake were measured in the Christiaensen Basin, a topographically low area in the center of the apex adjacent to the sewage sludge disposal site, and in the dredge spoils disposal area, a topographically high area to the west of the Christiaensen Basin. Rates were also elevated in the Hudson Shelf Valley, a topographically low area leading seaward from the Christiaensen Basin.

In summer the highest rates were measured in the dredge spoils area. In contrast, rates in the Christiaensen Basin at this time were low compared with the surrounding areas and were more like rates measured in winter. It is hypothesized that differential sedimentation rates of oxidizable organic carbon to the seabed from barge dumped dredge spoils and sewage sludge as mediated by the presence or absence of a thermocline may have resulted in the phenomenon observed between summer and winter in the Christiaensen Basin. The highest rates measured during the study occurred near the site of a municipal sewage outfall off Asbury Park, N. J. Industrial acid wastes produced no discernible effects on rates of seabed oxygen uptake during the study.

Rates of oxygen uptake by the bottom water (89 stations throughout the year) and by the entire water column (3 stations in August 1975) were measured and compared with oxygen uptake rates by the sediment. It was seen that the bulk (95 to 98%) of oxygen uptake in the apex occurs in the water column and not on the seabed (Table 2). However, oxygen uptake

Figure 3. Seasonal distribution of values for seabed oxygen consumption rates ml 0_2 m^{-2} hr^{-1} (C1-C5), bottom water dissolved oxygen concentrations in ppm (D1-D5) bottom water temperatures in ^oC (T1-T5) and bottom water salinity in o/oo (S1-S5).

C1, D1, T1, S1 represents 21 March - 4 April 1974.

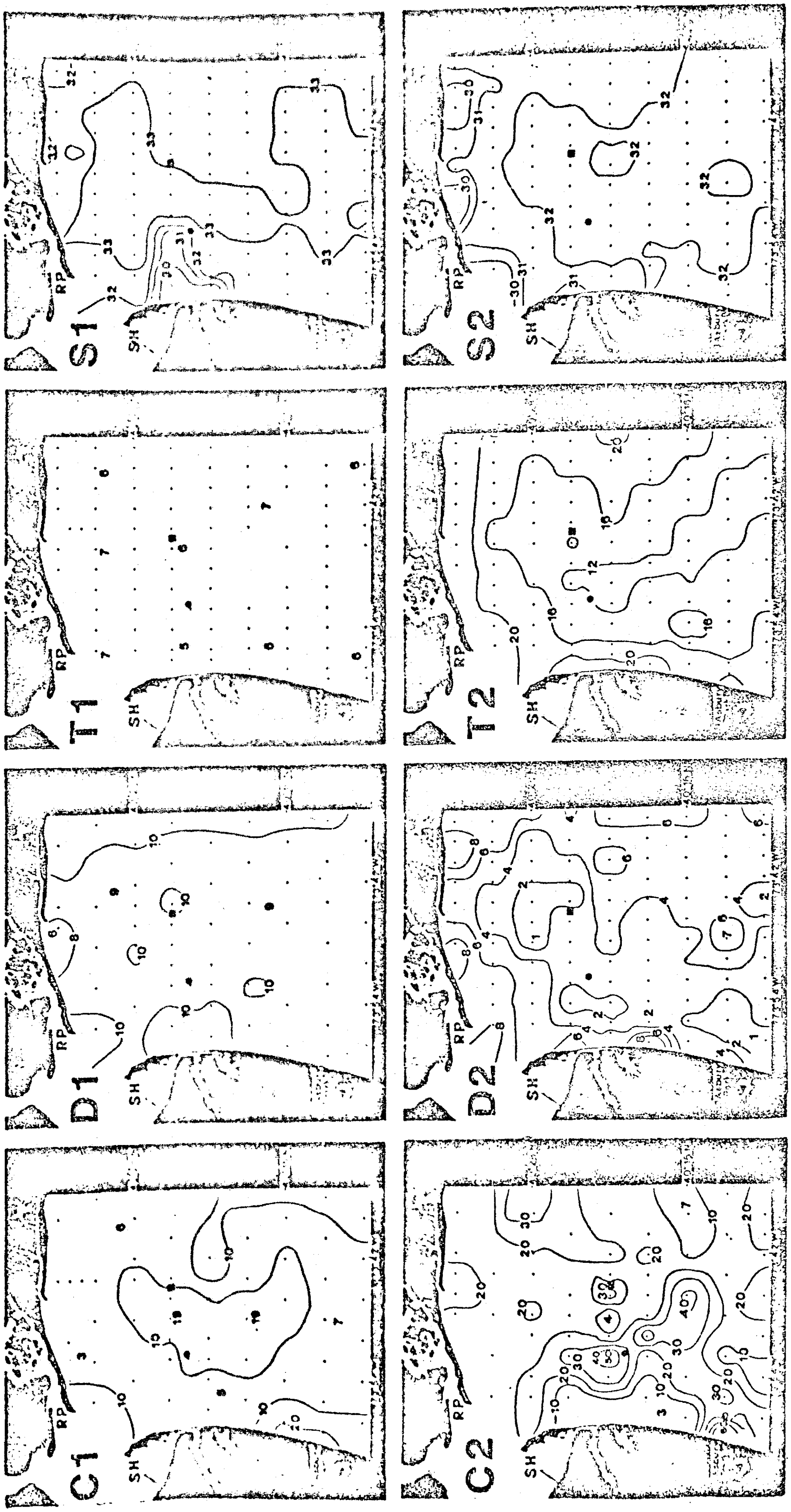
C2, D2, T2, S2 represents 26 August - 6 September 1974.

C3, D3, T3, S3 represents 2-15 December 1974.

C4, D4, T4, S4 represents 12-24 February 1975.

C5, D5, T5, S5 represents 12-25 August 1975.

Black dot located at dredge spoils disposal site. Black square located at NW corner of sewage sludge disposal site.


S1
T1
D1
C1
S2
T2
D2
C2
SH
RP

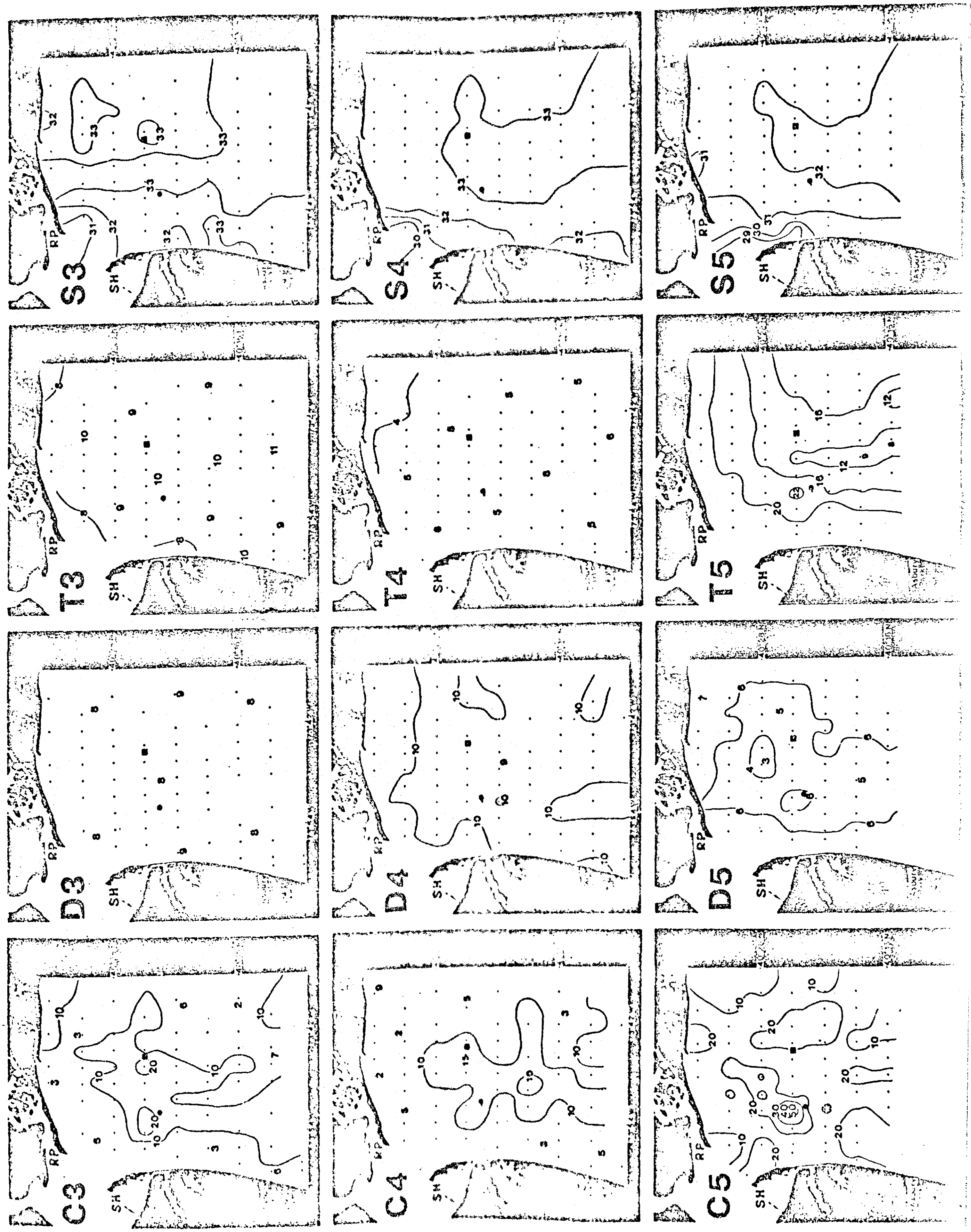

S3
T3
D3
C3
S4
T4
D4
C4
S5
T5
D5
C5
RP
SH

Figure 4. Annual curve of total oxygen consumption by the seabed and the equivalent carbon oxidized for the entire apex ($1577km^2$).

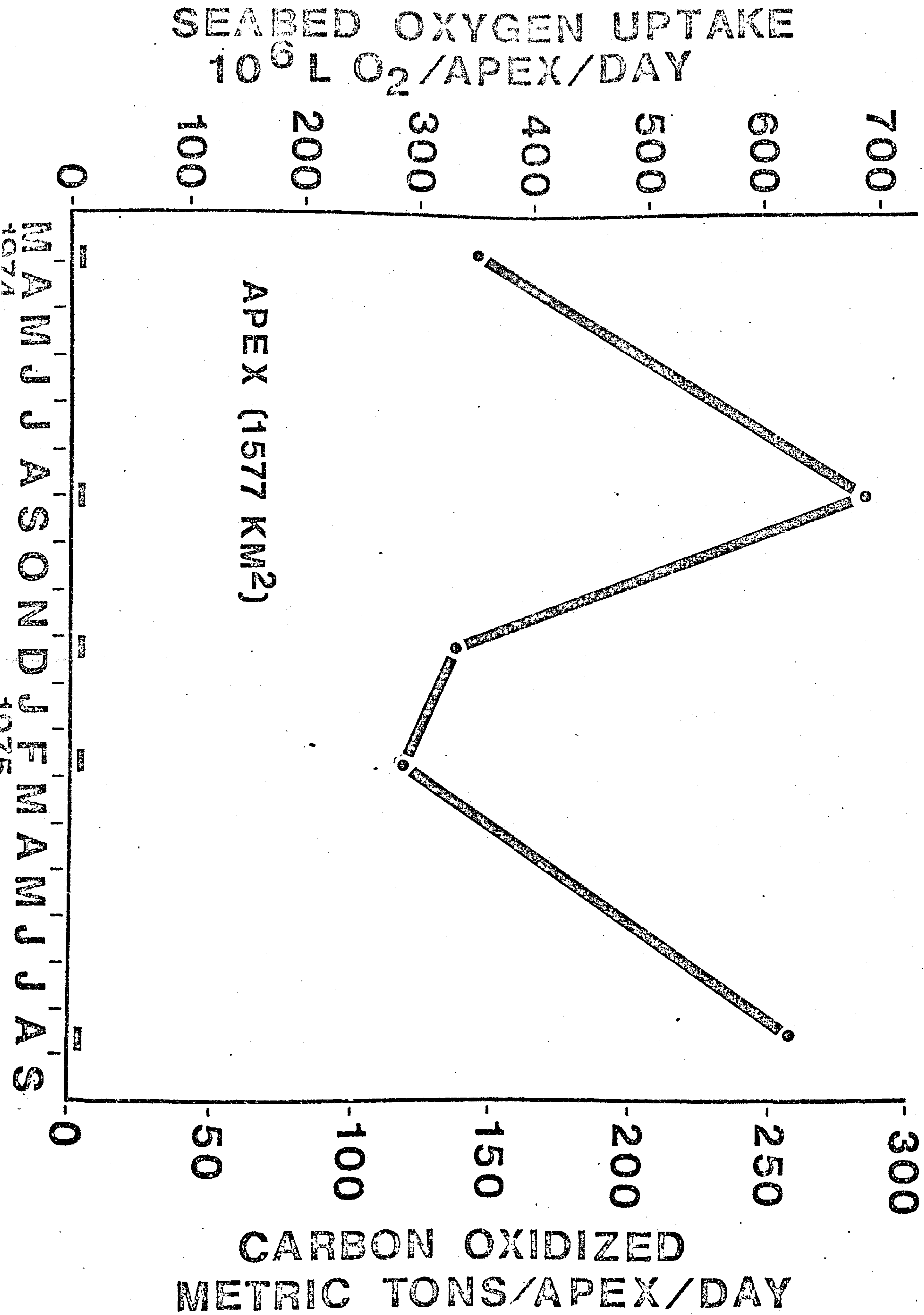

SEABED OXYGEN UPTAKE
10^6 L O_2/APEX/DAY
0
100
200
300
400
500
600
700
APEX (1577 KM^2)
M A M J J A S O N D J F M A M J J A S
0
50
100
150
200
250
300
CARBON OXIDIZED
METRIC TONS/APEX/DAY

Table 2. An organic carbon budget for the New York Bight apex demonstrating the relationship between import and export components.

	APEX (1577 km^2)	
	BULK 10^6 m^3/yr	ORGANIC CARBON* 10^4 mt/yr
IMPORTS		
1. Primary Production		58.3
2. Transect		54.8
3. Dredge Spoils	5.35	13.9
4. Sewage Sludge	4.27	8.6
TOTAL		135.6
EXPORTS		
5. Seabed Oxygen Uptake (Including bottom 12 cm water)**		6.7
6. Sediment Oxygen Uptake (80.5% of Seabed)		5.4
7. Water Uptake (Bottom 12 cm of Column, 19.5% of Seabed)		1.3
8. Water Uptake (Bottom m^3 of Column)		10.8
9. Water Column Uptake (24 m Ave. Depth)		260.0
10. Total Column (Sediment plus Water)		265.4
11. Percent Total Column due to Sediment		2%
12. Percent Bottom 12 cm of Column due to Sediment		80.6%

* 1 ml O_2 = 0.412 mg organic carbon
** average core water height

Sources:
1. Malone (1975).
2. Mueller et al. (1975).
3. Mueller et al. (1975); Gross (1972) Percent total organic carbon.
4. Mueller et al. (1975); Callaway et al. (1975) Percent solids; Smith et al. (1974) Percent organic carbon.

5-12. This study.

by the sediment is still highly significant in terms of energy flow and carbon cycling in the benthic community, accounting for 80.6% of the oxygen uptake in the bottom 12 cm of the water column.

Additionally we have SYMAPed the heavy metal data obtained from samples collected during August and October 1973 and during January, March, and August 1974. These samples were analyzed by Mr. Richard Greig of the Environmental Chemistry Investigation, part of the Middle Atlantic Coastal Fisheries Center, Ecosystems Investigations, located at Milford, Connecticut. A joint paper presenting this data is expected.

Hydrocarbon analyses of the waters of Raritan and Lower Bays are being completed by Exxon Research and Engineering Company and a joint paper is in preparation.

Finally, all hydrographic data (temperature, salinity, signa-T, dissolved oxygen concentrations, and percent oxygen saturation) from MESA quarterly cruises between August 1973 and August 1975 have been SYMAPed and listed. This data will shortly be sent to the New York Bight project office as a Data Report.

5. PHYTOPLANKTON PRIMARY PRODUCTIVITY

Most recently we have submitted an abstract, "Dissolved Organic Matter Productivity in Raritan-Lower Hudson Estuary" to present a paper at the American Society of Limnology and Oceanography meetings to be held in Savannah, Georgia, in June 1976. The submitted abstract follows:

Dissolved Organic Matter Productivity in Raritan-Lower Hudson Estuary: Sixteen monthly cruises were made in the highly eutrophic Raritan-Lower Hudson estuary (New Jersey-New York) between November 1973 and April 1975 to measure three components of total primary productivity (dissolved organic matter, nannoplankton, netplankton) as well as photosynthetically active radiation, light extinction, nutrients, salinity, temperature, dissolved oxygen, pH, chlorophyll, phytoplankton species composition and abundance. Dissolved organic matter productivity, its significance, and its relationship to the structural and functional aspects of the phytoplankton community and environmental characteristics of the estuary will be presented. Percent of photoassimilated carbon released as dissolved organic matter (DOM) range from 0% to 71.2% (averaged 12.4%, n=1308) during the study. The quantity of DOM released ranged from 0 to 155 mg C m^{-3} hr^{-1}. DOM productivity is positively correlated with total productivity (particulate and dissolved). DOM productivity, netplankton and nannoplankton productivity decreased and percent of photoassimilated carbon released increased toward the mouth of the estuary. Surprisingly, percents of DOM released were uniform with depth (100, 47, 30, 11 and 4% surface light). DOM percents were highest in August-September when the nanno-netplankton productivity ratio was 35 and lowest in March when the ratio was 0.4.

IV. DATA REPORT

Accomplishments

Table 3, "Disposition of benthic samples as of 29 February 1976," summarizes the state of processing of each data set of each MESA cruise.

The Center's new terminal, The COPE 1200 Batch-mode Terminal, was described in the November 1975 Trimester Report. Improvement to an interactive, teletype-compatible, time-sharing system is planned as soon as possible.

Data processing efforts have focused on four data sets: (1) benthic macrofauna, (2) sediment grain size, (3) metals in sediment, and (4) fin rot.

We processed the benthic macrofauna data for the 3rd and 4th quarterly cruises from raw data through the tape for CEDDA. We did the same for the raw sediment grain-size data of the 1st, 3rd, 4th, and 5th quarterly cruises, and the sediment heavy metals data of the 5th quarterly cruise.

Fin rot data are being processed by year of collection. The 1973 data are in data report form, lacking only a descriptive text. The 1974 data are ready for key-punching, scheduled for 15-19 March. The 1975 data are being transcribed to data forms for key-punching; most of the transcribing is complete.

TABLE 3. DISPOSITION OF BENTHIC SAMPLES AS OF 29 FEBRUARY 1976

Vessel/Date	Purpose and Location	# Stations	# Grabs/ Station	Total # Grabs	ROSCOP FORM	Investigator or Discipline	# Samples, Subsamples or Cores	# Sorted	# Identified	# Analyzed (Chem. or Sedim.)	First Contract Report Received	Log Sheets Prepared for Keypunching	# Keypunched	Machine Listed	Edited	Data Report	SYMAP	Taped	Tape Edited	Archieved at EDS	Tape to CEDDA[8]	Scientific Publications
Historical Data Aug. 1968- Dec. 1971	Corps Study (Apex)	26	1-23	187		Pearce	187	187	187			x	187	x	x	x		x				
Atlantic Twin 5-14 June 73	RECON (Apex)	8	20	160	x	Pearce	265	265	265			x	265	x	x			x	x[6]			
		21	5	105																		
				265						265[1]		x	246	x	x	x		x	x[6]			
						Grieg	265			265	x	x	x	x	x			x	x[6]			
						Cok	265				x											
						Tietjen	265				x											
						Small																
Albatross IV 2-6 Aug. 73	1st quarterly cruise (Apex)											x	174	x	x	x		x	x		x	
		64	5	320	x	Pearce	320	174	174	107		x	107	x	x	x	x	x	x		x	
						Grieg	320			320	x	x	x	x	x			x	x		x	
						Cok	320				x											
						Tietjen	320				x											
						Small Hydrography[2]				x		x	x	x	x[7]		x					
Oregon II 20-25 Oct. 73	2nd quarterly cruise (Apex)											x	x	x								
		93	5	465	x	Pearce	465	64	64	107		x	107	x	x	x	x					
						Grieg	465			465		x	x	x	x							
						Cok	465				x											
						Small Hydrography[2]				x		x	x	x	x[7]		x					
Albatross IV 22-30 Jan. 74	3rd quarterly cruise (Apex)											x	x	x	x			x	x		x	
		103	5	515	x	Pearce	515	64	64	107		x	107	x	x	x	x	x	x		x	
						Grieg	515			515	x	x	x	x	x			x	x		x	
						Cok	515				x											
						Small Hydrography[2]				x		x	x	x	x[7]		x					

Vessel/Date	Purpose and Location	# Stations	# Grabs/ Station	Total # Grabs	ROSCOP FORM	Investigator or Discipline	# Samples, Subsamples, or Cores	# Sorted	# Identified	# Analyzed (Chem. or Sedim.)	First Contract Report Received	Log Sheets Prepared for Keypunching	# Keypunched	Machine Listed	Edited	Data Report	SYMAP	Taped	Tape Edited	Archieved at EDS	Tape to CEDDA	Scientific Publications
Oregon II 22 Mar.-3 Apr. 74	4th quarterly cruise (Apex)	103	5	515	x	Pearce	515	64	64			x	x	x	x			x	x		x	
						Grieg	515			107		x	107	x	x	x	x	x	x		x	
						Cok	515			515	x	x	x	x	x			x	x		x	
						Small					x											
						Thomas	245[3]			245		x	245	x	x		x					
						Hydrography[2]				x		x	x	x[7]	x		x				x	
Venture 21-30June 74	Alt. Dump Sites (DUPI)																					
	North	33	1	69	x	Pearce	69	69	69			x	69	x	x	x		x	x			
	South	36	1			Grieg	69			69												
						Grain size: AOML	69			69												
Delaware II 26 Aug.-5 Sept. 74	5th quarterly cruise (Apex)	103	5	515	x	Pearce	515	102	78			x	78	x	x	x		x	x		x	
						Lee					x											
						Grieg	515			64		x	x	x	x		x	x	x		x	
						Cok	515			105	x	x	x	x	x			x	x		x	
						Small					x											
						Thomas	300[3]			300		x	300	x	x	x	x					
						Hydrography[2]				x		x	x	x[7]	x		x				x	
Delaware II 2-15 Dec. 74	Seabed O_2 Consumption Apex	63			x	Thomas	241[3]	--	--	241		x	241	x	x		x					
						Hydrography[2]				x		x	x	x	x		x					
Delaware II 12-24 Feb. 75	Sludge dump & vicinity	24	2	48	x	Pearce	48	48	48													
						Heavy metals	48			Storage												
						Parks	48															
		38	1			Foehrenbach	38[4]															
		6	1			Exxon and Duedall	12[5]			x												
						Hydrography[2]				x		x	x	x	x		x	x				
	Alt. Dump Sites (DUPI)																					
	North	6	5	30		Pearce	30	30	6			x	6	x	x	x						

Vessel/Date	Purpose and Location	# Stations	# Grabs/ Station	Total # Grabs	ROSCOP FORM	Investigator or Discipline	# Samples Subsamples, or Cores	# Sorted	# Identified	# Analyzed (Chem. or Sedim.)	First Contract Report Received	Log Sheets Prepared for Keypunching	# Keypunched	Machine Listed	Edited	Data Report	SYMAP	Taped	Tape Edited	Archieved at EDS	Tape to CEDDA	Scientific Publications
Delaware II 12-24 Feb. 75 (continued)	North	6	5	30		Heavy metals				Storage												
						Grain size				Storage												
						Thomas	24			24		x	24	x								
						Hydrography[2]				x		x	x	x								
						Exxon	1[5]			x												
	South	6	5	30		Pearce	30	30	6			x	6	x	x	x						
						Heavy metals	30			Storage												
						Grain size	30			Storage												
						Thomas	24			24		x	24	x								
						Hydrography[2]				x		x	x									
						Exxon	1[5]			x												
	Lower Hudson Estuary	10				Thomas	40			40		x	40	x								
						Hydrography[2]				x		x	x									
	Hudson Shelf Valley & vicinity	7				Thomas	28			28		x	28									
						Hydrography[2]				x		x	x									
Delaware II 23-30 Apr. 75	Outer Continental Shelf (OCS)	60	5	300	x	Pearce	300	60	60			x	x	x	x							
						Heavy metals	300			Storage												
						Grain size	300			Storage												
						Hydrography[2]				x												
	Dredge Spoils	25	2	50		Pearce	50			Storage												
						Heavy metals	50			Storage												
						Grain size	50			Storage												
						Hydrography[2]				x												
Kelez 28 May - 2 June 75	Long Island Near Shore (LINS)	59	5	295		Pearce	295			Storage												
						Heavy metals	295			Storage												
						Grain size	295			Storage												
						Hydrography[2]				x												

Vessel/Date	Purpose and Location	# Stations	# Grabs/ Station	Total # Grabs	ROSCOP FORM	Investigator or Discipline	# Samples, Subsamples, or Cores	# Sorted	# Identified	# Analyzed (Chem. or Sedim.)	First Contract Report Received	Log Sheets Prepared for Keypunching	# Keypunched	Machine Listed	Edited	Data Report	SYMAP	Taped	Tape Edited	Archieved at EDS	Tape to CEDDA	Scientific Publications
Delaware II 12-24 Aug. 75	Seabed O_2 Consumption Apex	69			x	Thomas	276			276		x	276	x	x							
						Hydrography 2/				x		x	x	x	x		x					
	Alt. Dump Sites																					
	North	6				Thomas	24			24		x	24	x								
	South	6				Thomas	24			24		x	24	x								
						Hydrography 2/				x		x	x	x								
	Lower Hudson Estuary	78				Thomas	312			312		x	312	x								
						Hydrography 2/				x		x	x	x								
	Hudson Shelf Valley & vicinity	11				Thomas	44			44		x	44	x								
						Hydrography 2/				x		x	x	x								
Rorqual 11-12 Nov. 75	1st Monitoring Apex	13	2	26		Pearce	26	26	26													
						Heavy Metals	26			Storage												
						Grain Size	26			Storage												
Delaware II 17-19 Feb. 76 (Timoney Cruise)	2nd Monitoring Apex	4	2	8		Pearce	8															
						Heavy Metals	8			Storage												
						Grain Size	8			Storage												

1/ Analyses not funded by MESA.
2/ Temperature, salinity, dissolved oxygen, percent saturation of oxygen and sigma T of bottom water.
3/ Some subsamples delivered 11 Nov. 1975 to Dr. Parks at Lehigh University for organic carbon analysis using the LECO analyzer.
4/ Dr. Foerenbach plans to determine chlorinated hydrocarbon residues such as PCB's and DDT, and possibly other contaminants (information from Dennis Sullivan, 12 Oct. 1975).

5/ Exxon's results in MACFC Informal Report 72-A of 21 July 1975; Dr. Duedall's results in Jour. Water Poll. Control Fed. 47 (11): 2702-2706.
6/ Tape to Dr. Saila.
7/ Cards and listing to CEDDA and to Dr. Saila.
8/ Tape and listing to CEDDA and to Dr. Saila.

An acceptable format for mutagenic data is nearing reality, the crucial element being a scoring system of chromosomal damage that is as quantitative as possible. We are using such a system, and we are incorporating it in the design of an ADP format.

New ADP Personnel

The Center's ADP capabilities were enhanced this trimester by employing Daniel McDonald, computer systems analyst, Mary Duberek, part-time student trainee, and Timothy Wilkinson, work-study programmer-trainee.

Time Devoted to ADP Activities

We have devoted approximately the time indicated below on various ADP activities.

	Person/weeks
Benthos	24
Fin rot	26
Mutagenesis	1
Programming	4
Key-punching	3
ECM operations	1

APPENDIX

PRELIMINARY REPORT

February 25, 1976

STATISTICAL ANALYSIS OF BENTHIC SAMPLE DATA FOR THE NEW YORK BIGHT AREA - PHASE II

by

S. B. Saila
Graduate School of Oceanography
University of Rhode Island
Kingston, Rhode Island 02881

Submitted to: National Marine Fisheries Service
Sandy Hook Marine Laboratory
Highlands, New Jersey 07732
Attn.: Dr. K. McNulty

This preliminary report is presented in a brief narrative fashion. It represents progress made during the second trimester of the total project period.

Manuscript Preparation and Publication

A manuscript entitled "Optimum Allocation Strategies for Sampling Benthos in the New York Bight" was revised into final form and corrected in galley proof during this portion of the project period. This manuscript is scheduled for publication in Estuarine and Coastal Marine Science (1976) 4. Some of the findings from this report are as follows:

(1) With respect to trace elements in the sediments it was found that they were relatively stable, distributed approximately normally and that only a few replicates were required to test hypotheses concerning differences in certain trace metals (Cr, Cu, Ni, Pb and Zn) between stations. It is not believed necessary to perform more statistical analyses for estimates of the variability of trace metal data, since they appear to be quite stable and subject to relatively small analytical error. In general, it appears that only a small number of replicates are required for sampling trace elements. Detailed instructions for determining sample size were provided in this report.

(2) With respect to organisms, seven species were considered in a two-stage optimum allocation strategy. When working with transformed means of abundance, it was demonstrated that the optimum two-stage sampling plan involved relatively few replicates within a station but with a somewhat larger number of stations within a stratum. The importance of having well-defined and homogeneous strata was clearly evident. Thus, further efforts are in progress at this time in order to better define the sample strata. These will be briefly described in

another portion of this report.

(3) A manuscript entitled "Sedimentation and Food Resources: Animal Sediment Relationships" has been prepared as a portion of The American Geological Institute Short Course which has the title of The New Concepts of Continental Margin Sedimentation, II. The manuscript will be published as Chapter 20 of a book with the title mentioned above. This chapter contains a section on sampling problems which describe the results of fitting the negative bionomial distribution to the observed frequency distributions of 22 species of marine invertebrates from the New York Bight. It also describes a method for determining a common value for k, one of the parameters of the negative binomial distribution. The advantages of a common k determined as above is to facilitate sequential sampling, because only one sequential sampling sample size chart is then required.

Analysis of Replicate Sample Data

The replicate station data file has been analyzed with respect to the nature of the variability of diversity indices as a function of replication.

Figure 1 indicates the locations of the replicate bottom grabs used for this analysis. Table 1 describes the results of calculating the Shannon-Wiener entropy function and its error term. Table 1 shows that the error terms associated with the replicate measures of diversity are not extremely high. Also the absolute values of diversity appear to be nicely associated with the polluted versus nonpolluted zones of the New York Bight apex. For example, station 49, with the lowest value of diversity correlates with the area of sludge dumping.

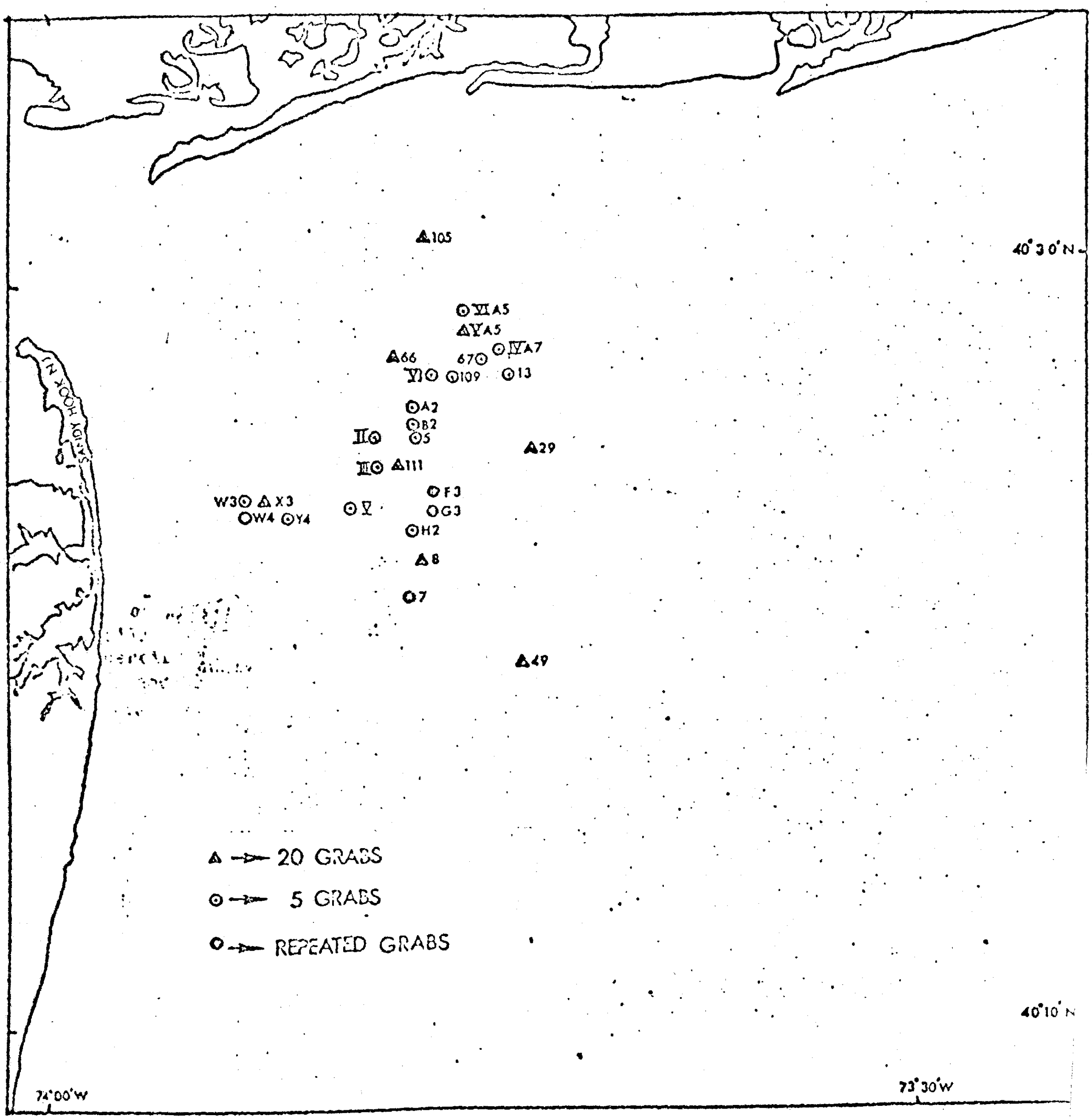


Figure 1. Locations of replicate bottom-sampling stations in the apex area of the New York Bight.

Table 1. Results of computations of the Shannon-Wiener entropy function and its variance for replicate bottom-sampling stations in the apex area of the New York Bight.

Station No.	Sample Size	Diversity	Variance
X3	19	1.900907	0.751502
8	20	1.783849	0.560402
29	19	3.396268	0.077699
49	20	1.651189	0.234357
66	20	1.895403	0.184877
105	20	3.074204	0.104486
111	20	2.191457	0.311278

Entropy Distribution in the New York Bight Apex

The first crude mapping of the distribution of entropy in the New York Bight Apex is shown in Figure 2. This map was plotted by hand. The shaded regions labelled (4 = very low) are the regions of the lowest diversity values. The rank 3 is next followed by 2 and 1, which are the highest values obtained. It should be pointed out that these contours of diversity are statistically significantly different from each other. The mean diversity in each contour in these ranked intervals is separated by at least two times the standard error of the mean from the next contour - suggesting that they are different at the 0.05 probability levels. It is interesting to note that even in this first mapping of entropy the regions of lowest diversity correspond very nicely with regions in which active sludge dumping has taken place. The promise of this technique for mapping multicomponent systems seems to be very high in permitting effective division of the apex region into homogeneous habitat-type strata. Obviously, temporal comparisons of such mappings are possible.

Further work in developing surface plotting programs for the entropy function and data on other variables are in progress. The diversity index values will also be subject to further testing as time permits.

The ultimate objective of this work is to effectively permit more efficient sampling by minimizing the sample size, through better stratum definitions, and a better biological description of habitats.

Fig. 2 - First Mapping of Diversity - 6.