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COASTAL RESEARCH CENTER BUZZARDS BAY STUDY

Site: New Bedford
Break: 19.15
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by

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Introduction:

Buzzards Bay is an important segment of the Massachusetts coast. Yet there have been few systematic studies of this coastal area in comparison to other areas of the U.S. East Coast such as Chesapeake Bay and Narragansett Bay. In part, this latter statement is subjective because we do not even have a comprehensive literature review of research into the many facets of Buzzards Bay ecosystems.

Certain portions of the bay have been studied more than others. For example, there has been extensive research conducted on the Great Sippewissett Marsh ecosystem by researchers from Woods Hole Oceanographic Institution, Boston University Marine Program, and the Marine Biological Laboratory (Appendix I). Some support for this has been supplied by various Sea Grant projects.

The cities of New Bedford and Fairhaven reside on either side of the Acushnet River estuary more commonly referred to as New Bedford Harbor at the

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western end of Buzzards Bay. Sea Grant supported studies by Summerhayes et al. (Summerhayes et al., 1977 and Stoffers et al., 1977) provided an updated assessment of sediment type in the New Bedford Harbor area and parts of western Buzzards Bay. These researchers also found that the sediments of the harbor area were severely polluted with trace metals resulting from discharges from industrial plants over the past 81 years. They determined that the harbor was a leaky sink for trace metal discharges. Trace metals were moving from the harbor to the western part of Buzzards Bay and particulate matter transport was implicated. We know that once material makes it to the sediments of the western part of the bay that tidal resuspension and storm resuspension make the particulates, or some portion of them, available for transport to other areas of the bay (Rhoads, 1973).

PCB Pollution Problem

New Bedford Harbor is also severely contaminated with PCBs. We have studied this problem with support from Sea Grant (July, 1979 - June, 1981), the U.S. E.P.A. Mussel Watch program (1978 - present), and the Coastal Research Center W.H.O.I., Andrew W. Mellon Foundation funds (1980 - present). Detailed accounts of the background to this problem were presented in earlier proposals and are not reiterated here.

Briefly, two electrical component manufacturing facilities discharged PCBs to the harbor area over the past two or three decades. Our measurement of PCBs in cores of surface sediments coupled with those of the survey measurements of grab samples by state agencies have provided a rough estimate of about 110 tons of PCBs in the upper 50 cm of inner harbor (Area I, Figure 1) sediments. Thus, PCB loading in the inner harbor alone is about

equal to the PCB loading of sediments in the upper Hudson River (General Electric) case and that was officially recognized as a severe PCB pollution problem by the state of New York and the U.S. government.

A comparison of data for PCBs in mussels (*Mytilus edulis*) for the U.S. coast shows that *Mytilus* sampled in New Bedford Harbor have the highest PCB values recorded in the U.S. Mussel Watch program (Farrington et al., 1982). Other bivalves (oysters and the hard shell clam from the area) are also severely contaminated (Hatch et al., 1981). A selected set of data for PCBs in mussels and oysters are presented in Table 1 and include our most recent data for Buzzards Bay. These data yield the following major points of interpretation:

1) The concentrations in the New Bedford Harbor area are much higher than the concentrations in the more remote areas of the northeast U.S. coast and even the samples near the Boston sewage outfall and the New York Bight stations.
2) Concentrations have not decreased over the period 1978-1981.
3) Our present interpretations of the elevated PCB levels for East End Beach yield the hypothesis that along shore transport results in movement of PCBs from the harbor area to the area of East End Beach.

The data of Table 2 illustrate that the contamination by PCBs is present in a wide variety of organisms sampled in the outer harbor (Area II, Figure 1). The PCB contamination levels are high enough to result in closure of certain fisheries in the areas indicated in Figure 1 in order to minimize a

public health risk.

The severity of the PCB pollution problem, the attendant potential public health problems, the economic hardship associated with the closure of local fisheries, resulted in the formation of an Ad Hoc Committee of state and local officials, scientists and engineers to deal with these problems and related issues. State Representative Roger R. Goyette of New Bedford chairs the committee. Dr. Farrington of W.H.O.I. is the Chairman of the Technical Data Group of the Task Force. One of the recommendations of the Ad Hoc Committee was to conduct a volunteer survey of concentrations of PCBs in blood residents of New Bedford in order to obtain further information about the potential public health risk for the area. Blood samples taken by the Massachusetts Department of Public Health were analyzed by the U.S. Center for Disease Control (CDC) in Atlanta. Based on previous analyses nationwide, the CDC report an expected 99% of the population will have PCB concentrations in blood at or below 30 ppb (10^{-9} parts/billion). The first survey of the New Bedford area shows greater than the expected concentrations with 10 of 22 people having PCB concentrations in blood ranging from 30-104 ppb. This has stimulated a wider ranging survey and the design of a systematic public health study which has been submitted by the Massachusetts Department of Public Health for funding considerations by a combination of state and federal agencies.

In summary, it is readily apparent from the preceding brief data presentation that New Bedford Harbor has a severe PCB pollution problem which may impact or may have already impacted public health. There are economic impacts on local fishermen. The harbor is probably leaking PCBs to Buzzards

Bay via the mechanism of particulate matter transport proposed for trace metals as previously discussed. Economic development of the harbor area requires dredging to maintain existing port facilities and to expand the harbor. This raises a series of important questions related to methods of dredging, dredge spoil disposal and containment, temporary increased resuspension and transport of polluted sediments as set forth in a recent independent assessment of potential problems for the Massachusetts Department of Environmental Quality Engineering (Malcolm-Pirnie, 1981).

Other Research and Technical Problems

The City of New Bedford has proposed extending its sewer outfall beyond Area III (Figure 1) into Buzzards Bay. This raises the important issue of the general circulation of the bay and the distribution of sewage effluent chemical contaminants to other areas of the bay. The coast of Buzzards Bay continues to be developed for various purposes such as recreational areas, light industry, heavy industry - the range of multiple use pressures found in the heavily populated northeastern U.S. coastal zone. The PCB pollution problem was presented in more detail as an example of the types of problems which are encountered in dealing with coastal zone management in Buzzards Bay.

Proposed Research: Specific Initiatives of the Coastal Research Center

1. Literature Review

The Coastal Research Center will undertake a literature review of scientific and technical papers dealing with Buzzards Bay. Reviews of selected topics already exist in several individual research papers and in the collected papers of the Great Sippewissett Marsh project (Appendix I). This review will be accomplished via the combination of the Coastal Research Center

participants and students in W.H.O.I.-M.I.T. Joint Program and issued as a Technical Report of Woods Hole Oceanographic Institution. The review forms the basis for a reference source for future research in the Buzzards Bay area. We anticipate completion of this phase of the project by January 1, 1983.

2) Sediment Resuspension and General Circulation

The deliberations of the Ad Hoc Committee on the PCB pollution problem identified physical oceanography of Buzzards Bay and in particular the role of near bottom turbulence or physical dynamics as a key information need for the eventual solution of the PCB pollution problem. This is a specific example of a similar set of general problems worldwide which require a better understanding of the role of near bottom turbulence in resuspension and transport of polluted sediments in coastal and open ocean areas. Important scientific questions of a very basic nature must be answered to address the more practical problem of wisely managing the specific polluted sediment problems of the New Bedford Harbor-Buzzards Bay system and the myriad general set of polluted sediment interactions with physical dynamics of coastal areas.

Our first goals are (1) to determine the characteristics of the near bottom flow and its ability to resuspend and transport sediment at various locations in the bay; and (2) to link the near bottom flow to forcing processes in the bay.

Because of the importance of New Bedford Harbor as a source of PCBs, we will concentrate one set of measurements near the harbor. Two other locations will be in the general vicinity of the mouth of the bay at the head of the bay near the Cape Cod Canal. These will be specifically located after a thorough

scrutiny of available data assembled during the literature review process.

We will monitor the near bottom flow using a bottom tripod containing 5 electromagnetic 2-axis current meters. The tripod will also contain (1) a pressure sensor (2) bottom camera and strobe and (3) a transmissometer. During an experiment, we will monitor salinity and temperature for potential stratification, upstream and downstream topography using a high resolution fathometer and bottom conditions and sediments using divers.

We will pick our measurement sites in regions of relatively simple bottom topography which is typical of the bay. Thus, velocity profiles near the bottom will be logarithmic and the profile technique can be used along with the velocity measurements to estimate mean shear stress on the bottom. The current meters and pressure sensor will enable us to estimate waves, currents and wave direction. Much of the bottom in the bay is influenced by surface waves so the ability to resolve waves for estimatng boundary shear stress and roughness is critical. The monitoring of suspended sediment, temperature and salinity will allow us to ensure that the influence of stratification is not influencing our estimates of bottom stress. Monitoring topography will eliminate the possibility of upstream disturbances on the flow confusing the interpretation of the velocity profiles.

To estimate the boundary shear stress in the presence of waves, we will use the Grant and Madsen (1979) combined wave and current model. A stratification correction for suspended sediment has been included in this recently. Grant and Aubrey have extensive experience in boundary layer measurements of the type required in the proposed study.

The tripod system is equipped with a conditional sampling system which can

be set on a threshold velocity. The conditional sampling option will allow us to look at a variety of conditions and deployment lengths. Sampling will be done once per hour for 20 miutes sampled at once per second.

During a tripod deployment, we will also deploy a Neil Brown Acoustic current meter (NBIS) on a separate mooring at mid-water depth. The NBIS will sample continuously and allow us to obtain a long enough time series to resolve tides and low frequency motions. We will deploy the NBIS at mid-water depth.

By moving our tripod and mooring around to selected points in the bay, we can form a rough picture of the near bottom flow, boundary shear stress and circulation pattern. The information is adequate to define a more detailed circulation, transport and resuspension study in the future.

The flow measurements and stress estimates will be used along with existing data from biological and chemical analysis of sediment samples to form an initial estimate of the resuspension and transport of particulate matter, PCBs and heavy metals in the bay.

A number of additional physical measurements are available and should be mentioned. Agrawal and Grant ( ) have a Sea Grant supported project where they will be deploying a LDV in the bay to measure near bottom flow and stress. These measurements will be carried out during the same time as the proposed flow measurements and thus provide additional data points. Ms. Cheryl Ann Hannan has been studying larvae settlement in the bay on a CRC-supported project. Her Ph.D. thesis studies will provide additional information on sediment and fecal pellet distribution in the bay. Current meter tests have been carried out at the mouth of Buzzards Bay by WHOI for

several years. Data from these tests can be used to provide additional data on circulation. Wind and wave meausements were made from the Buzzards Bay tower for many years and provide valuable information on wave climate and winds. In October of 1981, we deployed a sediment trap and NBIS current meter off New Bedford Harbor for 1 week which provides current information at this location and will be used to help design our sampling scheme. Data from that deployment is being evaluated at this time and should be available by February, 1982, to guide our studies.

Other Planned Research and Ongoing Research in Buzzards Bay

1. Marsh-Bay Connection: Dynamics of exchanges of water, particles, nutrients

The previous sections emphasized the importance of physical transport and physical dynamics to the pollution problems associated with New Bedford Harbor. However, there are other aspects of the physical oceanography of Buzzards Bay which are of equal importance. Research in the Great Sippewissett Salt Marsh project has reached a point where a better understanding of exchange of materials between the marsh and the bay is dependent on a better understanding of the physical dynamics of the bay.

Planning for the specific research to be undertaken in regard to the marsh-bay materials exchange will take place during 1982 with research expected to begin in 1983.

2. Comparison of "Assimilative Capacity" of Marsh Ecosystems, Crop Land Ecosystems and Estuarine Ecosystems to Receive Sewage.

The Coastal Research Center has initiated a joint study with Cornell University's Center for Ecosystems Research which will compare the responses

of coastal wetlands, estuaries, and crop lands to sewage input. The project will use the extensive data of the Great Sippewissett Marsh project to provide a basis for a specific example of the long term response of a marsh to years of controlled experimental applications of sewage sludge. The research of several Cornell University scientists has focused on the response of crop lands to sewage sludge disposal. Cornell's Ecosystem Research Center scientists are also working in cooperation with Marine Ecosystems Research Center scientists at the Graduate School of Oceanography at the University of Rhode Island where experimental microcosms are being used in eutrophication studies.

The project at C.R.C.-W.H.O.I. during 1982 will consist of a Post-Doctoral Investigator working under the supervision of Dr. John M. Teal, Senior Scientist, Biology Department, and support for expenses associated with travel to Cornell, writing, library work and data manipulation and interpretation. The initial scientific focus will be comparisons of nutrient and trace metal dynamics (biogeochemistry) in these sewage sludge or sewage stressed ecosystems. The overall goal is to provide a fundamental assessment of how to compare various ecosystem types when considering the multi-media (air, land, water) approach to waste disposal. Several participants in the W.H.O.I. Marine Policy and Ocean Management Program are involved in the policy evaluation aspects of these types of comparisons and will be involved in these projects.

3. PCBs in marine sediments: effects, uptake and metabolism in opportunistic polychaetes.

Dr. Judith P. Grassle of the Marine Biological Laboratory, Woods Hole,

with analytical chemistry assistance from Dr. Farrington's laboratory, is studying the interaction between Capitella species and PCB polluted sediments in the New Bedford Harbor area. This study involves both field observations and laboratory experiments and is funded by N.O.A.A.'s Office of Marine Pollution Assessment as a two-year project - October, 1981-September, 1983.

4. Research and Monitoring for PCB pollution in New Bedford Harbor.

Dr. Farrington has prepared a draft proposal for a five-year research and monitoring program to assist the Massachusetts agencies in monitoring the extent and severity of PCB pollution in New Bedford Harbor and Buzzards Bay. The proposal is designed to provide input to decisions about pollution abation operations before and after dredging of the harbor.

The Massachusetts Department of Environmental Quality Engineering has begun an effort to secure funding for this proposal and coordinate this with the Department of Public Health and Massachusetts Division of Marine Fisheries proposals for studies of the PCB pollution problem.

5. U.S. E.P.A. "Mussel Watch"

Dr. Vaughan T. Bowen, Senior Scientist, Chemistry Department, and Dr. Farrington are conducting "Biogeochemical Research with Mussels and Oysters as Biological Indicators of Pollutant Organic Compounds and Radionuclides in U.S. Coastal Waters" with funding from E.P.A. The New Bedford Harbor and Buzzards Bay area is one of the intensive collection areas and a site for transplantation experiments.

Summary

There is a need for accelerated and coordinated research into the many facets of the Buzzards Bay ecosystem. The PCB pollution problem in the New

Bedford Harbor area on the western shores of the bay and the long-term, very successful Great Sippewissett Marsh research project on the eastern shores of the bay have stimulated an immediate need for a better understanding of the physical dynamics of the bay ecosystem.

There are several ongoing or planned research programs focused in whole or in part on the bay. The Coastal Research Center has initiated an effort to coordinate these efforts and stimulate new critical research programs in Buzzards Bay. The strategy is to combine a mix of individual research projects and strongly focused multidisciplinary projects in order to maximize the input of the wealth of scientific expertise of the Woods Hole scientific community. We plan to cooperate with state agencies in these studies and to involve state college and university scientists as we have done in the PCB pollution research during 1979-1981.

We anticipate submitting a proposal to Sea Grant for a multidisciplinary study of key research problems in Buzzards Bay to begin in July, 1983. Planning for this project as well as ongoing research described above will continue during 1982-1983.

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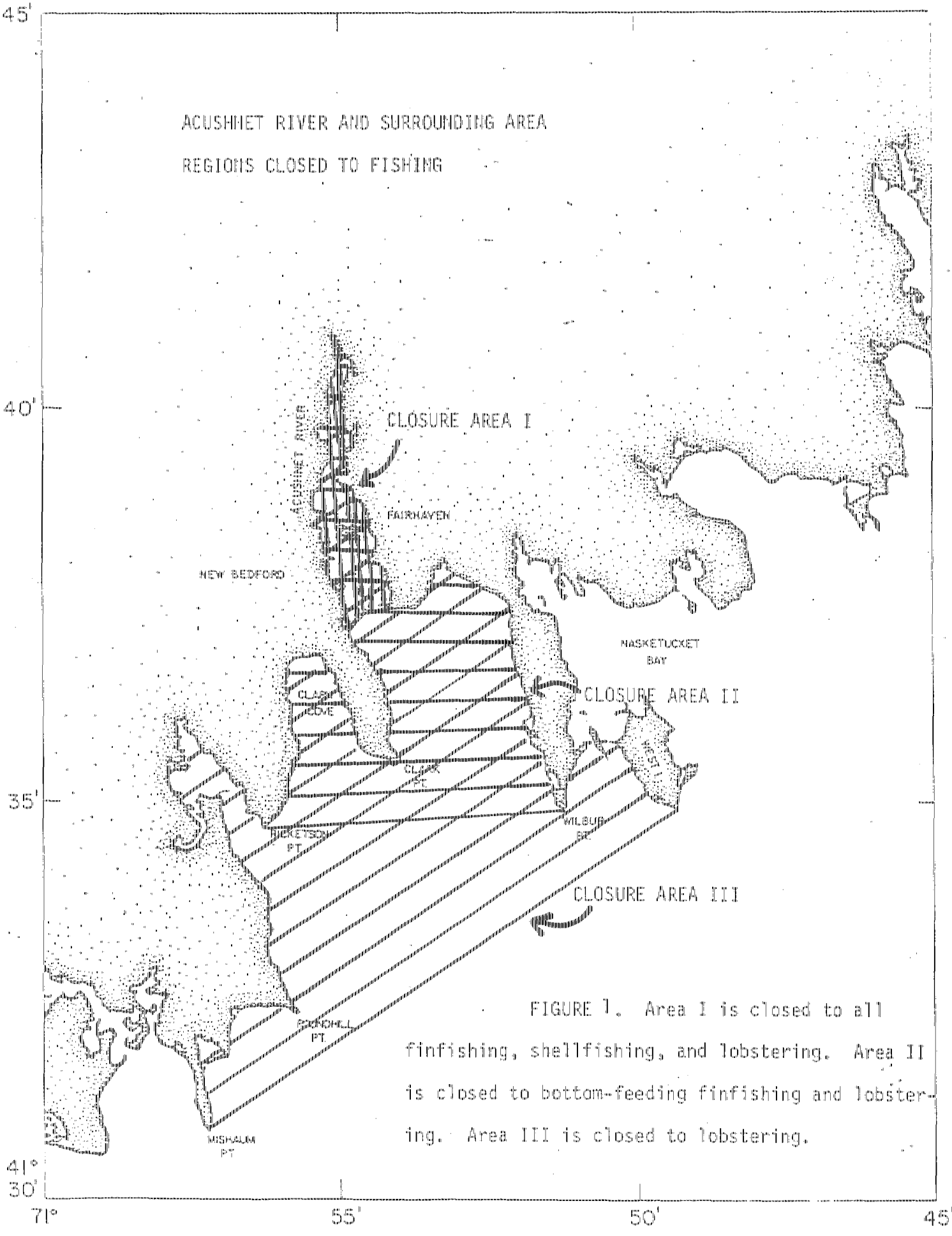

FIGURE 1. Area I is closed to all finfishing, shellfishing, and lobstering. Area II is closed to bottom-feeding finfishing and lobstering. Area III is closed to lobstering.

Table 1

PCB Concentrations in Mussels and Oysters from Buzzards Bay and Nearby Massachusetts Sites.*
10^{-6} g/g dry wt.

Location	Date	Aroclor 1242	Aroclor 1254
New Bedford Harbor Hurricane Barrier	781002	16	15
	800327	39	10
	810504	11	12
East End Beach	800327	1.1	0.9
	810504	0.4	0.9
Slocum River (oysters)	810504	--	0.5
Lloyd Center (oysters)	810504	--	1.0
Cuttyhunk Harbor	791205	0.2	0.6
West End Pond	791205	0.02	0.07
	800626	--	0.03
	800826	--	0.03
	810519	--	0.1
Cape Cod Canal	760925	--	0.2
	770819	--	0.2
	800114	--	0.2
	800214	--	0.3
	800310	--	0.2
	800424	--	0.2
	800522	--	0.2
Vineyard Sound (near Gay Head)	781011	--	0.095
	781026	--	0.096
	790828	--	0.098
	790926	--	0.14
Nantucket Harbor (West Jetty)	800717	--	0.080
	800924	--	0.022
Esther Island	800717	--	0.072
	810519	0.02	0.05

Table 1 (continued)

Location	Date	Aroclor 1242	Aroclor 1254
TRANSPLANT EXPERIMENTS (from Nantucket 810519)			
Outer New Bedford Harbor	810605 (Day 17)	0.98	1.3
	810616 (Day 28)	1.4	1.6
	810715 (Day 57)	1.8	2.8
Cleveland Ledge	810715 (Day 57)	0.12	0.36

*All samples *Mytilus edulis* except two *Crassostrea virginica* samples as indicated.

Table 2. Concentrations of PCBs in selected organisms from New Bedford Harbor and adjacent areas of Buzzards Bay, Massachusetts. (Farrington et al. analyses)

New Bedford (sampled 7/9/79
Outer Harbor, Butler's Flat
light Parallel with channel
or S.E. coast

Species	Aroclor 1254	Wet Wt.	Dry Wt.
Lephopsetta maculata tissue (sand flounder), edible flesh			
3 each (20-28 cm) large	A[a]	7.0	39
	B	6.0	33
3 each (12-15 cm) small	A[a]	3.6	18
	B	3.3	17
Pseudopleuronectes americanus tissue (winter flounder; black back) 3 each (15-49 cm)	A[a]	4.0	18
	B	4.1	18
Stenotorus versicolor tissue (scup)			
3 each (16-24 cm) large	A[a]	2.5	11
	B	2.2	9.9
Mustelus canis tissue (dogfish)			
2 each (35, 33 cm)	A[a]	0.26	1.3
	B	0.24	1.2
Porontus triacanthus tissue (butterfish)			
45 each, small (approx. 8-10 cm)	A[a]	1.8	8.9
	B	1.6	7.8
Tautogolabrus adspersus tissue (cunner)			
11 each	A[a]	2.3	10.4
	B	2.2	10.1
Neopanogoe texons whole (crab)			
16 each		1.4	7
Loligo pealei whole (squid)			
3 each	A[a]	1.3	Not
	B	1.1	Measured

Table 2. (Cont'd.)

		Aroclor 1254	Wet Wt.	Dry Wt.
Westport River, Sampled April 21-29, 1979				
Pseudopleuronectes americanus (black back; winter flounder)	A		.102	Not Measured
	B		.089	

[a]Duplicate analyses of homogenized sample composed of the number of individuals indicated.

APPENDIX 1

Publications of the Great Sippewissett Salt Marsh Project

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