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THE FIRST YEAR OF THE NARRAGANSETT BAY PROJECT: RESULTS AND RECOMMENDATIONS

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THE FIRST YEAR OF THE NARRAGANSETT BAY PROJECT:

RESULTS AND RECOMMENDATIONS

by Eva J. Hoffman

A report submitted to the Narragansett Bay
Project Management Committee

May, 1988

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NOTE

The U.S. Environmental Protection Agency and the State of Rhode Island do not necessarily agree with the results, methodology or conclusions of the health risk section. Publication of this report should not be construed as an endorsement of these methods or conclusions.

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EXECUTIVE SUMMARY

The importance of Narragansett Bay to the citizens of Rhode Island and Southeastern Massachusetts prompted the U. S. Congress to fund a five year study of the Bay. The Congress and the public want to know what are the problems facing Narragansett Bay and what can be done to insure that future generations can use and enjoy the Bay's resources. With ambitious expectations, the Narragansett Bay Project (NBP) was launched in July, 1985.

The Project's first experiment was in the formulation of its own governance structure. Although funding for the Project comes from U. S. Environmental Protection Agency grants and Rhode Island Environmental bonding monies, the governing committees of the Project include not only federal and state governmental representatives but also representatives from the scientific, academic, industry, community, fishing and environmental interests. Therefore the Project depends on the cooperation of all of these elements for its decisions, policies and direction. This first experiment was a success. Because the Narragansett Bay Project committees have proved that diverse interests can work together toward a common goal, two years later the U.S. Congress required that the Narragansett Bay Project governance prototype be used in all future national estuary projects.

During the first year, a number of projects were started and have now reached completion. Some projects were designed to determine where the problems are in the Bay, others were designed to evaluate alternatives to solve known problems, and yet others were simply to discover if the Project itself was heading in the right direction. One of the pleasant side-effects of any study of this type is that more and more is learned about how Narragansett Bay and estuaries in general work and how their resources are affected. However, the purpose of this report is to review the results of the first year's investigations with an emphasis on long term management issues and recommendations for improvement.

The largest freshwater source to Narragansett Bay is the Blackstone River draining an area from Worcester, Massachusetts to Pawtucket, Rhode Island. NBP investigators and state records showed that the Blackstone River is polluted with several metals throughout its entire course both in Massachusetts and Rhode Island. The major source of most of the metals is the Upper Blackstone Treatment Plant in Worcester but the Woonsocket Treatment Plant contributed substantial amounts of organic contaminants and solids. The Blackstone is a major source of lead and cadmium to Narragansett Bay, and there is strong evidence of raw sewage inputs in the lower stretches of the River in Pawtucket. Previous efforts of clean-up have proved successful; the concentrations of most of the metals in the river have decreased over the last decade. Since the results of this study have shown that pollution of the Blackstone is still a problem both in Massachusetts and Rhode Island, both states should work together, first to establish water quality goals for the river and then decide which permits need to be modified to achieve the goals on both sides of the state line.

A large part of the first year's NBP activities involved a study of the water quality in Narragansett Bay itself and the sources of pollution entering the Bay. Over 50 scientists, students, state and federal personnel, volunteers, and treatment plant workers helped in collecting and analyzing the samples. The waters were cleanest in the lower parts of the Bay and dirtiest in the Providence and Seekonk Rivers. The concentrations of copper and nickel in the Providence and Seekonk Rivers consistently violated the EPA saltwater criteria and the bottom waters violated the proposed criteria for shellfish growing waters with respect to lead, cadmium, and nickel. Nitrogen nutrients were also high enough in the Providence River to indicate eutrophication problems.

The major sources of pollution to the Bay are the Fields Point Wastewater Treatment Facility and the Blackstone River. Fields Point was the major source of chromium, copper, nickel, and nitrogen; the Blackstone River was the largest contributor of cadmium, lead, mercury, and phosphorus. Metal loadings have decreased over the last five years due to initiation of industrial pretreatment programs. Further reductions of copper and nickel are needed to achieve high water quality in the Providence River, but these reductions might be achieved with rigorous enforcement of current industrial pretreatment standards particularly by the Narragansett Bay Commission and the Blackstone Valley District Commission. A revision of the standards may be necessary if further enforcement is ineffective in reducing the loads. Lead inputs to the Bay should also be reduced, particularly if the Providence River is ever to be considered for shellfishing. Continuation of EPA's effort to phase out the use of leaded gasolines is strongly advised.

Another part of the water quality studies involved the input, transport and effects of various indicators of pathogenic bacteria and viruses which are discharged into the Bay by sewage treatment plants and combined sewer overflows. Traditionally, fecal coliform has been used by the states and the federal government to determine if the waters are clean enough to allow shellfishing and swimming. But there are other bacterial and viral indicators which also are available. All these indicators were monitored in Narragansett Bay and unfortunately, each had a different pattern. It is still unknown which of these indicators is the best predictor of disease, but when this knowledge is available, state regulators will have some of the data necessary to evaluate the various shellfish regulatory options.

The NBP also developed new alert levels to protect consumers from unsafe metal content in quahogs. Formal adoption of these levels is recommended, particularly for use in opening and closing shellfish beds and for evaluating the suitability of clams for transplant. The proposed alert levels were not violated in open areas of the Bay or in the conditional areas. There were occasional individual violations of the alert level for lead in the presently closed Providence River and for mercury in the presently closed Mt. Hope Bay, although the averages were below the alert level. However, clams in Allens Harbor violated the alert level for lead more frequently and this area should remain closed. The alert levels were then used to generate new proposed metal water quality guidelines for shellfish growing areas. Now there are standards only for fecal coliform. The proposed metal water quality guidelines for shellfish growing areas were violated routinely in the upper Providence River and Seekonk River. This suggests that these areas are inappropriate places to harvest shellfish, at least today. But there is a rich resource of quahogs that live and reproduce in the Providence River suggesting that these areas are potential resource areas especially if lead inputs to the Bay are reduced. There were also some dense patches of quahogs in Mt. Hope Bay, but no smaller quahogs were found in the deeper areas. It is not known whether these quahogs could repopulate themselves if fishing occurs here. In general, the quahogs of the Bay were healthy throughout, but the coloration of some Providence River clams might make them less attractive in the marketplace.

In its first year, the NBP wanted to make sure that the issues it was investigating were the issues of priority interest to RI citizens. Polls, workshops, and surveys, were conducted by NBP and participating Sea Grant investigators. The surveys indicated that NBP committees had identified the priority issues. Water quality concerns and protection of shellfishing resources were especially high priorities for the public. Other issues of interest were shoreline use, enforcement of existing regulations, confusion in governance and health risk concerns. The public was cooperative with the poll takers and representatives of the various user groups demonstrated an ability to work together in an workshop setting. Both are methods that could be expanded and used by the state to examine specific issues. The public is much more willing to participate in environmental decision-making when invited to participate early in the process. Public hearings at the end are much less effective in generating a consensus of thought.

The Narragansett Bay Project has made its first step toward a comprehensive management plan for the Bay. But the journey has begun. Narragansett Bay will ultimately benefit from this partnership of scientists, regulators and the public.

SUMMARY OF RECOMMENDATIONS

MANAGEMENT RECOMMENDATIONS CONCERNING THE BLACKSTONE RIVER:

1. Rhode Island and Massachusetts water quality managers should investigate the feasibility of a joint waste load allocation effort for the entirety of the Blackstone River. The mechanisms for such an effort already exists through the auspices of the New England Interstate Water Pollution Control Commission or the EPA-State Agreement process. Two issues need to be resolved either before the waste load allocation process starts or as a first step; (1) How much of the toxics in the Blackstone River come from point sources, how much from resuspension of contaminated sediments, and how much from non-point sources. Point sources alone cannot account for the concentrations of several metals and contaminants found in the river. It should be certain that placing additional controls on point sources through the waste load allocation process would, in fact, improve water quality. (2) Goals for water quality should be agreed upon by both states. It is clear that, although the EPA criteria are violated, the effluents may be shown in future bioassays to be non-toxic. The states should agree in advance which set of criteria should be used for the process - categorical standards or bioassay testing.

2. The Blackstone River is a significant source of lead to Narragansett Bay. Since lead comes from urban runoff more than from point sources, the most effective way to reduce the lead content of the river (and the Bay) would be to eliminate the use of leaded gasoline. Improvement in water quality may be slow due to contamination of soil in the watershed and sediments in the river.

3. Recent enforcement actions initiated by the State of Rhode Island with regard to Pawtucket and Central Falls combined sewer overflows are particularly timely. There is evidence that combined sewer overflows in Pawtucket cause the coliform content in the Blackstone River to rise as the river flows through Pawtucket. These data were collected in dry weather, suggesting the presence of illegal dry weather overflows. Hopefully, the studies mandated by the enforcement actions will identify these overflows and find the cause.

4. Wet weather sources of contaminants to the Blackstone River should be quantified and their relative impacts to Blackstone River and to Bay water quality assessed.

5. Aggressive water pollution abatement projects in Massachusetts have resulted in measurable water quality improvements for metals in the Blackstone. This activity has been successful and should be continued.

TECHNICAL RECOMMENDATIONS CONCERNING THE BLACKSTONE RIVER:

1. The primary source of solids and most of the metals in the Rhode Island section of the Blackstone River comes from Massachusetts, but discharge records in Massachusetts cannot account for any of the cadmium and only a portion of the nickel and suspended solids. An effort should be made to find these missing sources of contamination in Massachusetts.

2. There is evidence of an unknown source of nickel in the Ashton, Lonsdale, Pawtucket areas of Rhode Island. DEM, BVDC, and Pawtucket should walk the shores of the river in an effort to identify the culprit.

3. Calculations suggest that non-point sources could be a significant contributor of several pollutants to the river during wet conditions. This conjecture must be verified and the importance of Blackstone River pollution during these conditions should be compared to the significance of other wet weather sources of contamination to the Bay. Bacterial and viral contamination from Pawtucket and Central Falls combined sewer overflows should especially be scrutinized.

4. The Blackstone River is a large source of nutrients entering Narragansett Bay. The sources of these nutrients to the River should be studied to determine which abatement techniques are appropriate, should later investigations suggest that loads need to be reduced.

5. The model developed for the Blackstone River should be used by RIDEM to evaluate the effect that water removal from the Blackstone would have on water quality.

6. Three monitoring series on the Blackstone River was sufficient to develop a model of the river, but should not be used as a substitute for routine monitoring of river water quality by Rhode Island and Massachusetts. The data would be more useful if the two states would coordinate their activities in the future.

RECOMMENDATIONS CONCERNING WATER QUALITY OF NARRAGANSETT BAY:

1. In order to achieve water quality goals for acceptable aquatic habitat in the Providence River, it will be necessary to further reduce the loads of copper and nickel entering the Bay. Industrial pretreatment programs have already reduced the loads significantly in the last five years. Continued enforcement of existing pretreatment standards, particularly at BVDC and NBC, is encouraged to further increase compliance and reduce loads. A revision of pretreatment standards may be needed if further enforcement proves ineffective.

2. Vigilance that chromium and mercury levels do not increase in the Providence River is warranted. The pretreatment standards for these elements will not need revision.

3. The sources of lead to the estuary need to be reduced particularly if there are plans to open shellfishing grounds in the Providence River. Since non-point sources appear to be the major contributor, elimination of lead in gasoline additives is suggested. The phase out of these additives already underway through auspices of EPA should continue.

4. The data in these surveys suggest that there are as yet unquantified inputs of nitrogen entering Bay waters. These inputs should be found and their magnitude compared to the point sources before deciding to require advanced treatment for plants along the Bay. This alternative is very costly, and the effectiveness of this option to achieve improved water quality is highly uncertain at present. This does not mean that advanced treatment of wastewater entering Bay tributaries is not justified to improve water quality in the tributaries themselves. Current data are not sufficient to predict whether or not there would be any improvement in the Bay however.

5. EPA and FDA are encouraged to continue their research on fecal indicators and their relationship to human health risks so that the states can make sense of the fecal indicator data now becoming available.

6. When human health risk issues of fecal indicators are clarified, it will be necessary to know a great deal more about the environmental behavior of these indicators in Narragansett Bay before options for regulatory changes can be evaluated. Of particular interest are the distribution of the indicators in the Bay under various environmental conditions, die-off rates of the indicators in the environment, effectiveness of various methods of sewage effluent disinfection, shellfish bioaccumulation and depuration rates and the relationships between water quality and shellfish quality. These data will be needed to evaluate

potential impacts of regulation on the shellfishing industry and to design an appropriate monitoring protocol. The Narragansett Bay Project, EPA, FDA, and the states should work together to provide these necessary data for the Bay.

7. The monitoring data for metals, nutrients, and oxygen suggest that future monitoring efforts can be concentrated in the Seekonk River, the Providence River, and Mt. Hope Bay. The rest of the Bay is relatively clean for these components. Routine monitoring for metals is required only for copper, nickel, and lead, although spot checks of chromium and mercury are advisable. The data are insufficient to design better monitoring protocols for fecal indicators.

RECOMMENDATIONS CONCERNING QUAHOG MANAGEMENT:

1. Narragansett Bay Project guidelines for maximum acceptable metal contents of quahogs should be used by Rhode Island and Massachusetts on an interim basis to evaluate quahogs for suitability for transplanting and to evaluate the feasibility of opening new areas for shellfishing. Formal adoption of these standards would allow the RI shellfishing industry to use these protections as a marketing tool.

2. New Narragansett Bay Project water quality guidelines for seawater designed to protect quahog meats from unacceptable metal content should be used in conjunction with the aquatic habitat standards for future waste load allocation efforts, considered as a part of any reissuance of RIPDES and NPDES permits and considered in the development of industrial pretreatment standards. The formal adoption of these standards would give the state legal authority to require their full usage.

3. Pressure from the State of Rhode Island, the Commonwealth of Massachusetts, their congressional delegations, and EPA should be utilized to encourage the U.S. Food and Drug Administration to issue guidelines the states can use to evaluate the safety of seafood and food products with regard to metal contamination. Even if a few concerned individual states derive their own standards, a national standard is appropriate so consumers will not have to be concerned with the exact origin of their seafood. In the absence of such guidelines, states must adopt their own.

4. Lead inputs to Narragansett Bay should be reduced if the Providence River is to be considered as a future shellfishing resource area. Because lead enters Narragansett Bay primarily from urban runoff and atmospheric deposition due to usage of leaded gasolines, the phasing out of leaded gasoline should be continued by EPA.

5. The sources of mercury contamination entering Mt. Hope Bay - Taunton River should be closely monitored to prevent further insults. More monitoring of this area for the mercury content of clams should be done to determine the extent of the contamination before the area is reopened.

6. Allens Harbor should remain closed due to levels of lead in clams far in excess of proposed standards.

7. Revisions of industrial pretreatment standards to protect quahogs from unacceptable nickel content may be necessary for the Blackstone Valley District Commission, if shellfishing is anticipated in the Seekonk River.

8. A detailed health risk assessment of the hazards of environmental exposure to lead (both dietary and air quality) should be completed using local data. The impact of unacceptable maternal blood lead levels on the development of their fetuses should be particularly investigated. An overall package of lead abatement in the Rhode Island and SE Massachusetts environment may be necessary. In the meantime, continued reductions of the usage of leaded gasolines is highly advisable. If regulation of lead ingested orally is warranted (food and beverage), shellfish products alone should not be targeted. The approach should be holistic.

9. Although quahog growth is slower in the Providence River, and there is some dark coloration of clams near Sabin Point, there is a high standing crop, recruitment of juveniles is taking place, and color is acceptable at Gaspee and Bullock Points. The high potential value of this population as a fisheries resource provides justification for attempts to upgrade the water quality of the lower Providence River. Experiments should be conducted on the causes and remedies of the occasional dark coloration.

10. The quahog population in the deeper areas of Mt. Hope Bay has very few juveniles the causes of which are unknown. This suggests that the quahogs here may not be able to replenish their populations under fishing pressure. The potential productivity of this area should be further evaluated following an experimental harvest to determine the value of this area as a long term resource in Rhode Island waters.

RECOMMENDATIONS REGARDING PUBLIC PARTICIPATION:

1. The state should expand its public participation activities in environmental regulatory affairs.

   The user workshop forum and the user leadership surveys generated hundreds of recommendations for state governmental agencies, all of which were based on perceived problems. Based on the user surveys, there are a number of particular issues which are in dire need of a dialogue between affected parties and state regulators. These include fisheries enforcement issues, pretreatment enforcement issues, and shoreline development issues. Although formal public hearings are required by law, the workshop or task force forum are more effective vehicles for exchange of ideas. Specific, knowledgeable individuals with the respect of their user group community can be specially invited. An agenda with a series of specific trouble spots can be given in advance to both public and regulatory participants so that both sides can be prepared. Both groups should come prepared, not only to participate, but to listen.

It may also be worthwhile to assign a full time public participation coordinator to investigate which public participation form is most useful for given situations, and develop more formal guidelines on methods.

The Bay Project in its short existence cannot be expected to organize and prepare workshops for every issue of environmental interest. The main regulatory agencies should incorporate real public participation programs into their normal business. Full and open discussions of the issues prior to the public hearings or before introduction of proposed legislation will foster the same spirit of cooperation evident with the Bay Project but will last long after the Bay Project is history.

Responsibility for the success of public participation rests both on the public and the state. The public who wishes to participate with the state must make an effort to be an informed participant, and the state must be willing to discuss the issues openly, including not only the technical justifications for proposed action, but also the potential political and economic impacts.

2. Federal and state governmental agencies should pay more attention to health risk. The public is concerned about the quality of the seafood they consume. If federal agencies do not produce national guidelines, the states must act individually in this regard.

3. The Bay Project should make some form of the user workshops a continuing practice with a more limited and specific agenda. The exchange of ideas was useful for the Bay Project and the state. A model for success here can be found, not only in Bay Project efforts , but also in public participation efforts associated with Special Area Management Plans. A basin plan involving the whole of Narragansett Bay will require participation by the public, scientists, regulators, and policy makers. As the drafting of a management plan becomes closer, the forum will be particularly valuable.

4. The state should consider the use of polls to determine in advance the likelihood of passage of proposed bond referenda. The accuracy with which the responses to the Bay Project poll predicted the results of the RI Clean Water Act bonds demonstrates the usefulness of polls. Polling can aid administrators and legislators to judge public sentiment and decide whether the timing of future bond referenda is appropriate or if delay for extensive promotion or education will be necessary. Polling can also help government in

formulation of priorities. Cooperation with various media outlets could help here.

5. Bay Project committee members and scientists should continue their participation in Task Forces on specific issues so that information, expertise, and contacts of the Bay Project can be used by these groups and duplication of effort can be avoided. The Bay Project could also aid in the formation of other task forces or workshops as recommended earlier.

6. Fisheries enforcement activities should be more highly publicized. Inadequate fisheries enforcement was mentioned in workshops as a problem for Narragansett Bay management. Examination of media coverage of this issue showed that very few fisheries enforcement activities were mentioned in the newspaper. It is natural for the public to assume that nothing is happening. Fisheries enforcement officials could easily remedy this misconception by cooperating with media in a fashion similar to other law enforcement agencies. A high-profile in governmental affairs here is warranted because of benefits in discouraging illegal practices. An example of intense media coverage of enforcement activities is evident in industrial pretreatment enforcement actions. The adverse publicity may be even more effective in reducing violations than the enforcement action itself.

7. Should the Bay Project recommend combined sewer overflow abatement in the future, it will be necessary to educate the public about what they are. They are not perceived to be a problem by user group leaders, users themselves, or by the public.

8. The Bay Project should continue to investigate Bay governance issues. There are sufficient data to suggest that the public feels the situation in some agencies could be improved. Other agencies receive high praise from some groups and not from others. Agencies with Bay governance responsibilities should evaluate the results of the Narragansett Bay Project public opinion polling and survey efforts to evaluate their own needs in terms of scientific informational needs, and agency needs in terms of public education.

CHAPTER 1

INTRODUCTION

THE NARRAGANSETT BAY PROJECT -- WHY?

Narragansett Bay (Figure 1-1) has served a vital role in the cultural, social, and economic development of its watershed since man first settled along its shores. The Narragansett Indians built camps along its shores, sustaining themselves by fishing, hunting, and farming. The first European colonists also built towns along its shores using the waters of the Bay to transport their agricultural products to markets. The industrial revolution in the United States began here where water power from Narragansett Bay tributaries was used first to power grist mills and then to power textile looms. A lively shipping industry developed to transport these products to world markets. Soon ships from Narragansett Bay, already involved in the colonial triangle trade, began to travel even to China. Towns grew into cities. Immigrants came in waves to labor in the industries. Narragansett Bay became a recreational outlet for the rich and the laborers. And the traditional uses of the Bay for fishing continued by the full time fishermen and also by ordinary seafood loving citizens.

Therefore, today's usages of Narragansett Bay are continuations of uses begun long ago. The Bay still serves as a transportation route, a productive fishing ground, and a recreational playground. Unfortunately, with all the uses came abuses as well. Industrial, economic and population growth around the Bay led to pollution of the Bay. The Bay became a convenient disposal area for the wastes of people and their industrial pursuits. Today's challenges are clear. How can we continue to live, play and work along the shores of the Bay and yet avoid injuring it in the process. The people love this Bay. It's a part of their cultural, social, and economic heritage they want to enjoy and they want their descendants to enjoy. They demanded action of their political leaders.

The political leaders of the region consulted with the scientific experts of the area. They discovered that scientists had already been studying Narragansett Bay. In fact, Narragansett Bay had been used as a laboratory for many years. The scientists had found that, because the pollutants in the Bay varied considerably, they could use the Bay to test theories about the impacts of pollution in estuaries generally. The knowledge was extensive but it was fragmented and wasn't Figure

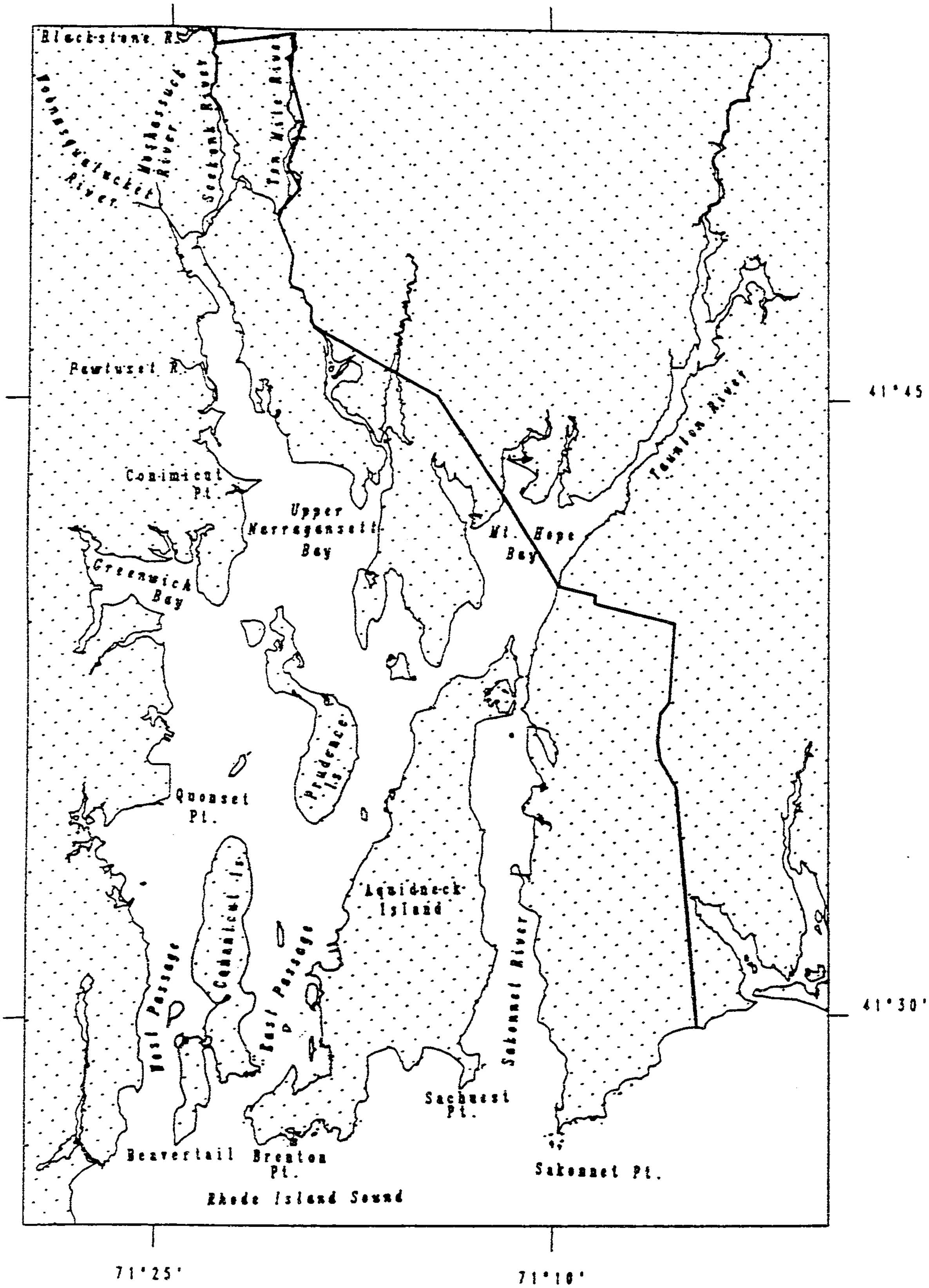

Figure 1-1. Narragansett Bay.

designed to address directly Bay management issues. This pattern was not unique to Narragansett Bay but existed in other estuarine areas too. Congress had already responded to this dilemma in the Chesapeake Bay area by initiating a comprehensive investigation of the water body. After expending $27 million over a seven year period, the Chesapeake Bay Project had discovered the major problems of the water body and recommended actions designed to address these problems. If this approach was successful in the Chesapeake Bay area, perhaps it would also work elsewhere. The seeds of the National Estuaries Program were planted when a special appropriations bill from Congress in June 1984 allocated $4 million for the first year of investigations into four estuaries. Because Narragansett Bay area political leaders introduced, sponsored, and nurtured this legislation, it was not surprising that Narragansett Bay was specifically mentioned in the legislation.

So why a Narragansett Bay Project? The people of Narragansett Bay wanted to preserve this water body which played such an important role in their past and present for future generations. They felt that a water quality management plan based on state-of-the-art scientific investigations could help resolve conflicts and direct monies to provide solutions to the most critical problems. The Narragansett Bay Project structure was designed to provide a mechanism by which the politicians, managers, scientists and the public could work together developing a consensus on how this could be done.

Water quality management plans were not a new concept in the Narragansett Bay region. The first attempt was made in the 1880s in conjunction with the planning for the Providence sewerage system. In the 1950s, the New England River Basin Commission examined the status of several Narragansett Bay tributaries. In the 1970s, the original federal Clean Water Act of 1972 required regional water quality management plans. The "208 plan" made a number of recommendations which are still being implemented. The Coastal Resources Management Council further expanded the concept, particularly with regard to coastal land use along several sections of the Bay, e. g., the Providence and Newport harbor areas, and also developed a plan which stated which kinds of land uses were acceptable along each stretch of shoreline.

Each of these previous plans was developed using data existing at the time they were developed. Sufficient monies to conduct research on the knowledge gaps did not exist. The plans were full of recommendations for the scientific community to conduct the needed research on these knowledge gaps. The Narragansett Bay Project began where previous plans left off. With sufficient funds to conduct the research necessary to fill the knowledge gaps in high priority areas, the water quality planning effort could continue, and address problems previously untouchable because of lack of information. In some ways, the Narragansett

Bay Project is only another step toward insuring the future of the Bay. But this time, the full force of the scientific community and the public could be involved.

STRUCTURE OF THE PROJECT

The governance of the newly founded Narragansett Bay Project was patterned after the earlier Chesapeake Bay Project with a few innovations. The governance structure included an executive committee composed of Michael Deland, the regional EPA administrator, and Robert Bendick, the director of the Rhode Island Department of Environmental Management. The participation of high level state and federal administrators was designed to insure state and federal cooperation in the effort. The executive committee was the final authority of the Project affairs. Advising the executive committee was a management committee composed of representatives of other state and federal agencies with Bay management responsibilities, and representatives of the public, industries and scientific community. The Management Committee formed committees to provide technical advice from the scientists and educators. The Narragansett Bay Project had two such committees originally; the Science and Technical Committee and the Public Education Committee. Later a policy committee was also formed. A description of these committees and their membership is given in Appendix 1.

GOALS OF THE NARRAGANSETT BAY PROJECT

The first listing of goals for the Narragansett Bay Project was compiled and adopted locally by the Bay Project Management Committee in March, 1986. The Project goals were framed in the form of management questions (Narragansett Bay Project Management Committee, 1986):

(1) What are the goals of the public user groups, and government agencies, and how are they incorporated into management goals and strategies for Narragansett Bay?

(2) What are the impacts of point source pollution on the water quality of Narragansett Bay?

(3) What are the impacts of non-point source pollution on the water quality of Narragansett Bay?

(4) What are the impacts of water quality on the health of living marine resources in Narragansett Bay?

(5) What are the levels of toxics and pathogens in living resources to which consumers are exposed? What are the risks and are they acceptable to the public?

(6) How does sediment composition and contamination affect water quality (dredging, resuspension, etc.) and living resources in Narragansett Bay?

(7) What are the present and future goals of recreational resource management for Narragansett Bay and how are they influenced by water quality?

(8) In order to achieve the management goals identified for Narragansett Bay, what regulatory and management structures would be most effective, how can implementation processes be structured most efficiently, and how can the system be evaluated for compliance with the management goals?"

In addition to adherence to the policies and funding principles practiced by EPA and DEM, the Narragansett Bay Project committees developed policies to provide operational mechanisms for the project. A description of these operational details is given in Appendix 2.

The Five Year Plan

When the first year research activities were barely underway, the Management Committee was informed by the EPA National Estuaries Office that a five year plan would be required before any further funding would be granted. Although this development certainly meant that all the Committees and staff would have lots of additional work to do during the first year, the mandate of the administration was received with a positive attitude. It was the first time that anyone had even hinted that the project might indeed proceed for 5 years, so the announcement was good news. Additionally, the Management Committee knew that a long term plan for the project was a good idea, even if not required by the national office.

The five year plan was developed in a series of workshops conducted by the various committees of the project. Advice from scientists, managers, planners, industrialists, environmentalists, fishermen and educators was solicited by the committees. Their suggestions were prioritized, evaluated for consistency with the goals of the project, and the elements were scheduled over a five year period.

The five year plan was adopted in April 1986 by the Management Committee with the understanding that each year the five year plan would be reviewed and modified should new findings or developments warrant a change. The five year plan primarily addressed science and technical issues. The Public Education Committee and the Ad-Hoc Policy and Management Issues Review

Committee were encouraged to fill in details concerning their areas of concern.

In general, point source pollution issues were to be examined first with monitoring and modelling efforts. Later this baseline would be expanded to include non-point issues. One living resource use was to be examined each year, the first one being an examination of quahog issues, and then flounder issues. Health risk issues, eutrophical problems, governance issues and an assessment of public concerns were to be examined early in the project. An outline of the five year plan adopted during this first year is given in Table 1. Subsequent changes are noted. Details of the first year efforts and the justification for them is given in Appendix 3.

THIS REPORT

The first year's work plan was finalized in April, 1985; requests for proposals were distributed; the proposals were submitted and reviewed; the contractors were selected; and the grant proposal was submitted. The first year of the Bay Project started with great fanfare on July 12, 1985 at a celebration hosted by the URI Foundation on board the URI research ship Endeavor. After speeches by Senator John Chafee and Senator Claiborne Pell, Michael Deland, and Robert Bendick, Senator Chafee hand delivered the EPA letter of credit to Robert Bendick. Principal investigators changed from their party clothes, rolled up their sleeves and soon the Bay was filled with university and state boats carrying investigators to all parts of the Bay.

The remainder of this report contains the results of the first year's studies of the Narragansett Bay Project and any recommendations for improved Bay management where the information is sufficient. The studies of the first year, the principal investigators, and the location of their results in this report are given in Appendix 3.

Emphasis of later chapters in this report will be placed on the results which have Bay management implications. Often the final reports of the individual principal investigators include data or results which have added significantly to the basic scientific knowledge of the Bay; however, these are not fully discussed in this report unless management conclusions can be drawn without further research. Readers with specialized interests are referred to the individual final reports. Each chapter describes the results and implications regarding a series of issues and presents action recommendations for discussion by the Management Committee.

TABLE 1-1

Highlights of the Five Year Plan

1985

Development of water quality models
Monitoring of water quality Bay-wide
Impacts of water quality on quahogs
Impacts of water quality on plankton
Public attitudes about Bay management
Governmental structure for Bay Management

1986

Continued development of water quality models
Monitoring of water quality in upper areas of the Bay
Impacts of water quality on winter flounder
Historical trend assessments
Governmental structure for non-point control
Water quality at beaches
Impacts of sewage inputs on Bay ecosystems
Recreation assessment for upper Bay

1987

Estimation of combined sewer overflow in Pawtucket and Central Falls*
Pollutant discharges of rivers following rain events#
Geology, chemistry and biology of Narragansett Bay sediments
Nuisance algae and its effects
Assessment of impact of sediment characteristics on quahog settlement and growth, and dredge spoil disposal options#

1988

Integration of combined sewer overflow models
Impacts of wet weather on the water quality of the Providence River and upper Bay
Impacts of marinas on surrounding water quality
Land use trends
Economic impact of point source management alternatives
Calibration of a water quality model for rain events

1989

Water quality monitoring and modelling for Mt. Hope Bay*
Impacts of septic systems on water quality
Impacts of coastal land use on water quality
Evaluation of alternatives for combined sewage overflow abatement

Evaluation of remedial alternatives for shellfish cleansing
Economic impacts of non-point source pollution management
Creation of a Narragansett Bay library
Comprehensive management plan

***funded through other sources**
#postponed

CHAPTER 2

DO INPUTS OF POLLUTANTS FROM THE BLACKSTONE RIVER POSE A CONCERN FOR BAY WATER QUALITY?

EXECUTIVE SUMMARY

The Blackstone River is the largest freshwater input to Narragansett Bay. A survey of pollutant concentrations of the Rhode Island section of the Blackstone River by the Narragansett Bay Project determined the degree of contamination of the river and developed a water quality model for the river. The survey and model clearly demonstrated that many of the organic and metal contaminants largely originate on the Massachusetts section of the river. Massachusetts discharge records confirm that the wastewater treatment plant of the Upper Blackstone serving Worcester contributes most of the pollutants currently entering the river. Mass balances suggest that additional sources of pollution could arise from resuspension of toxic materials from the river bed which were deposited during previous years.

A number of metals in the Blackstone are present in concentrations in excess of the EPA freshwater quality criteria throughout the entire course of the river from Worcester in Massachusetts to tidewater in Rhode Island. For this reason, waste load allocation on the Blackstone is warranted but must be a joint effort with Rhode Island and Massachusetts to achieve any water quality improvement. Previous water pollution abatement activities have been successful. Comparison of the Narragansett Bay Project survey results (1985) with previous studies (1978-1982) suggest an improvement in water quality in terms of metal concentrations.

The fecal contamination as measured by fecal coliform which enters the tidal waters of the Seekonk River apparently originates in the lower stretches of the Blackstone in the Pawtucket, Rhode Island area. Fecal coliform from other sources have died off by the time the river reaches estuarine waters.

During dry weather conditions, the Blackstone River is a large source of both cadmium and lead to Narragansett Bay, relative to other pollutant sources to the Bay in dry weather. Because the lead concentration in the Bay quahogs are a potential human health concern, waste load allocation on the Blackstone should consider reduction of lead inputs to the Bay in addition to the protection of the Blackstone River itself. Calculations suggest that wet weather conditions may cause significant degradation of river water quality and Bay water quality for a number of chemical and microbiological contaminants.

MANAGEMENT RECOMMENDATIONS:

1. Rhode Island and Massachusetts water quality managers should investigate the feasibility of a joint waste load allocation effort for the entirety of the Blackstone River. The mechanisms for such an effort already exists through the auspices of the New England Interstate Water Pollution Control Commission or the EPA-State Agreement process. Two issues need to be resolved either before the waste load allocation process starts or as a first step; (1) How much of the toxics in the Blackstone River come from point sources, how much from resuspension of contaminated sediments, and how much from non-point sources. Point sources alone cannot account for the concentrations of several metals and contaminants found in the river. For example, an extensive assessment of non point sources as an input mechanism for contaminants in the river should be made before wasteload allocations for wastewater treatment facilities are undertaken. It should be certain that placing additional controls on point sources through the waste load allocation process would, in fact, improve water quality. (2) Goals for water quality should be agreed upon by both states. It is clear that, although the EPA criteria are violated, the effluents may been shown in bioassays to be acutely non-toxic. The states should agree in advance which set of criteria should be used for the process - categorical standards or bioassay testing. Recent data for use in comparison of the river with categorical standards on a chemical by chemical basis are now available for both the Rhode Island and Massachusetts sections of the river. Bioassay testing of effluents and sediments will begin shortly in Massachusetts.

2. The Blackstone River is a significant source of lead to Narragansett Bay. Since lead comes from urban runoff more than from point sources, the most effective way to reduce the lead content of the river (and the Bay) would be to eliminate the use of leaded gasoline. Improvements in water quality may be slow due to contamination of soil in the watershed and sediments in the river.

3. Recent enforcement actions initiated by the State of Rhode Island with regard to Pawtucket and Central Falls combined sewer overflows are particularly timely. There is evidence that combined sewer overflows in Pawtucket cause the coliform content in the Blackstone River to rise as the river flows through Pawtucket. These data were collected in dry weather, suggesting the presence of illegal dry weather overflows. Hopefully, the studies mandated by the enforcement actions will identify these overflows and find the cause.

4. Wet weather sources of contaminants to the Blackstone River should be quantified and their relative impacts to Blackstone River and to Bay water quality assessed.

5. Aggressive water pollution abatement projects in Massachusetts have resulted in measurable water quality improvements for metals in the Blackstone. This activity has been successful and should be continued.

TECHNICAL RECOMMENDATIONS:

1. The primary source of solids and most of the metals in the Rhode Island section of the Blackstone River comes from Massachusetts, but discharge records in Massachusetts cannot account for a portion of the solids. An effort should be made to find these missing sources of contamination in Massachusetts.

2. There is evidence of an unknown source of nickel in the Ashton, Lonsdale, Pawtucket areas of Rhode Island. DEM, BVDC, and/or Pawtucket should walk the shores of the river in an effort to identify the culprit.

3. Calculations suggest that non-point sources could be a significant contributor of several pollutants to the river during wet conditions. This conjecture must be verified and the importance of Blackstone River pollution during these conditions should be compared to the significance of other wet weather sources of contamination to the Bay. Bacterial and viral contamination from Pawtucket and Central Falls combined sewer overflows should especially be scrutinized.

4. The Blackstone River is a large source of nutrients entering Narragansett Bay. The sources of these nutrients to the River should be studied to determine which abatement techniques are appropriate, should later investigations suggest that loads need to be reduced.

5. The model developed for the Blackstone River should be used by DEM to evaluate the effect that water removal from the Blackstone would have on water quality.

6. Three monitoring series of the Blackstone River was sufficient to develop a model of the river but should not be used as a substitute for routine monitoring of river water quality by Rhode Island and Massachusetts. The data would be more useful if the two states would coordinate their monitoring activities in the future.

INTRODUCTION

When considering the source of pollutants to Narragansett Bay, it is necessary to include tributaries in the assessment. Some pollutants can enter Narragansett Bay that were originally discharged many miles away. The States of Rhode Island and Massachusetts have started an aggressive campaign to study a number of tributaries to the Bay. Massachusetts has studied the Ten Mile River and has issued new permits to reduce loadings. Rhode Island has studied the Pawtuxet River and new permits are being developed.

Therefore, a water quality survey of the Blackstone River was funded by the Narragansett Bay Project because this river is the largest freshwater source to the Bay, it drains sections of two states, and it has had a long history of water pollution problems. The primary management questions were: (1) what is the current status of water quality in the Blackstone River? (2) are further reductions in pollutant loadings necessary to achieve water quality goals for the river? (3) is the Blackstone River a significant source of pollutants to Narragansett Bay? (4) are reductions of pollutant loadings entering the Blackstone River necessary to protect uses of Narragansett Bay? (5) what is the relationship between pollutant loadings from point sources and the pollutant concentrations in the river? and (6) are there indications of unknown sources of pollution to the river which warrant further investigation?

The Blackstone River has a drainage area of 478 square miles, comprised of 373 square miles in Massachusetts and 105 square miles in Rhode Island (Figure 2-1). The basin is 46 miles long, stretching from its headwaters in the vicinity of Worcester southeasterly to tidewater in the Providence-Pawtucket area. There are several cities along the river, Worcester in Massachusetts and Woonsocket and Pawtucket in Rhode Island. The river is lined with several smaller communities. Development of the area began in the late 1700s at the beginning of the industrial revolution since the area had availability of water power and access to transportation routes. Today, the location of the Blackstone Valley close to metropolitan areas of Boston and Providence has led to renewed development in the valley during the recent economic resurgence of the area.

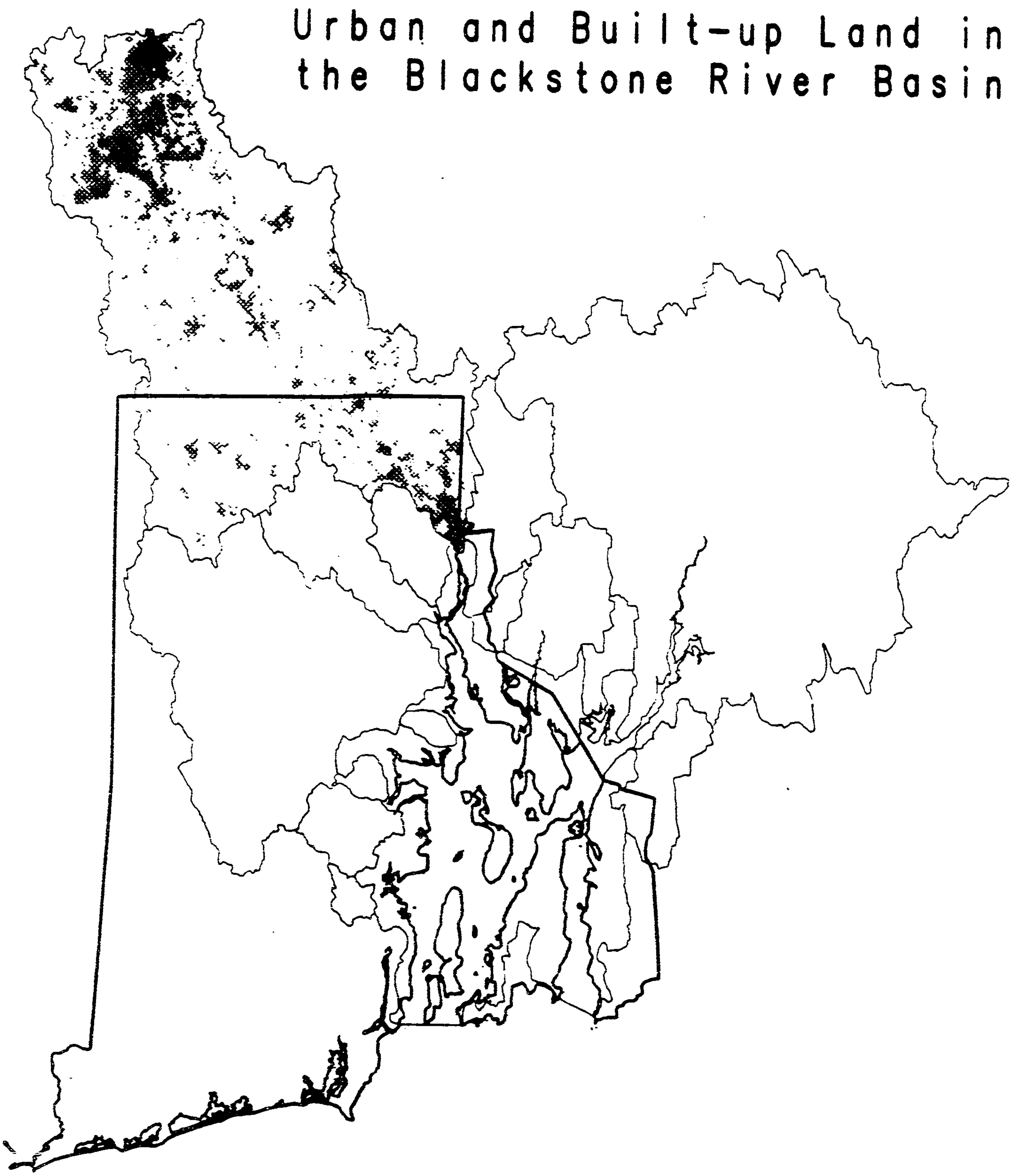

Figure 2-1. Urban and built-up areas in the Blackstone River watershed. (from USGS 1974 GIRAS data).

POINT SOURCES OF POLLUTION TO THE BLACKSTONE RIVER

An inventory of suspended solids and metals inputs to the Blackstone River is given in Table 2-1. The largest point source in Massachusetts is the Upper Blackstone Water Pollution Abatement District (UBWPAD) which serves the City of Worcester and surrounding communities. In fact, this sewage treatment plant accounts for 79% to 96% of the metals and solids entering the river from point sources in Massachusetts. The largest point source in Rhode Island is the Woonsocket Wastewater Treatment Plant, but, except for solids, contributes only 40% or less the amounts of UBWPAD.

The inventory for organic contaminant entry to the river is given in Table 2-2. Both Rhode Island and Massachusetts contribute organic pollutants to the river. Massachusetts contributes the most polycyclic aromatic hydrocarbons (which largely come from petroleum products and the burning of fuels) and the most polychlorinated biphenyls (which come from electrical transformer oils). Rhode Island point sources, especially the Woonsocket Treatment Plant, contribute most of the phthalates (plastics additives). Polluters from both states contribute petroleum hydrocarbons (oil products) and coprostanol (sewage indicator) to the river.

This mass balance also produces some puzzlements. The actual suspended solids load crossing the Massachusetts border into Rhode Island is considerably larger than can be accounted for by current point sources. This imbalance can be explained by resuspension of river sediments in Massachusetts, non-point pollution and erosional inputs. Rain had occurred in the previous week before sampling took place on two of the three sampling periods, and inputs resulting from these events could still have been in the river. The mass balance also show that, at least during dry weather, pollutants entering Rhode Island sections of the Blackstone do not make it all the way to the estuary. Losses could occur through sedimentation in the river. In addition, organic contaminants could degrade or be lost through volatilization during transport.

Table 2-1

Point Sources of Metals and Solids to the Blackstone River

(units in kg/day)

Massachusetts*	**TSS**	**Cd**	**Cr**	**Cu**	**Ni**	**Pb**
Worcester Spinning	5.5	<0.005	0.009	0.09	-	<0.009
NE Plating	5.2	-	-	0.22	0.18	<0.03
Upper Blackstone TP	1612	3.2	9.1	6.3	13.2	<4.1
Millbury WWTP	18.6	-	0.10	0.28	<0.13	-
Grafton WWTP	20.0	<0.05	<0.045	0.31	<0.11	<0.009
Northbridge WWTP	9.9	-	<0.06	0.26	<0.16	<0.29
Uxbridge WWTP	53.2	-	-	0.43	-	<0.082
E. Douglas WWTP	10.5	<0.009	-	0.02	<0.02	0.014
Guilford Industries	82.2	-	-	0.05	1.4	<0.095
Rhode Island#						
Woonsocket WWTP	1605	0.017	0.55	3.3	1.0	0.43
Okonite	0.72	0.0002	0.00054	0.036	0.0023	0.0069
SAB Nife	2.7	0.00003	-	0.0003	0.0004	-
GTE	68.2	0.0001	0.045	0.015	0.0045	0.0005
Sum MA dischargers	1817	3.2	9.2	8.1	14.7	<4.1
Transport over line#	6000	1.0	10.9	11.4	21.4	4.1
Sum RI dischargers	1673	0.017	0.59	3.4	1.05	0.44
RI+MA dischargers	3107	<0.05	9.8	11.4	15.8	< 4.5
Enters tidewater#	7318	0.56	4.5	8.2	15.3	4.0

***Hogan, Mass. DEQE, 1987**
#Quinn, et al., 1987

Table 2-2

Point sources of organic contaminants to the Blackstone River#

	hydrocarbons (kg/d)	PAHs (gm/d)	Coprostanol (gm/d)	Phthlates (gm/d)	PCBs (gm/d)	HCH (mg/d)
Massachusetts (no data)						
Rhode Island						
Woonsocket WWTF	32.	24.	381	8540	-	568
Okonite	12.	0.24	-	71	0.003	0.53
SAB Nife	0.53	0.32	0	0.47	-	0.61
GTE	18	0.46	0.07	8.6	0.004	0.01
Sum MA dischargers	-	-	-	-	-	-
Across MA line	94	277	418	3920	34.4	2141
Sum RI discharges	63	25	381	8620	0.007	569
Enters tidewater	72	306	224	2200	23	-

#Quinn, et al., 1987

WATER QUALITY OF THE RHODE ISLAND SECTION OF THE BLACKSTONE RIVER

The water quality of the Blackstone River was monitored on three separate occasions during the summer and fall of 1985, with emphasis on dry weather conditions during periods of low flow which would maximize the influence of point source discharges on the river (Quinn, et al., 1987). In all, 3666 analyses were completed in this effort, including suspended solids, 6 metals, and 27 organic contaminants at 9 river stations and 4 point sources, all in the Rhode Island section of the river (the lower Blackstone).

The river water routinely violated the acute fresh water quality standards during its entire course through Rhode Island for copper and occasionally for cadmium. The chronic freshwater standards were violated throughout the Rhode Island section of the river for cadmium, copper, lead, PCBs, and perhaps silver. The violations for these contaminants start somewhere in Massachusetts and continue throughout its course through Rhode Island (see Table 2-3). Massachusetts monitoring data (Massachusetts Department of Environmental Quality Engineering, Westborough, MA., 1986) indicate that violations for cadmium and copper start downstream of the Upper Blackstone treatment plant at Worcester. Occasional violations of the chronic standard for bis-2-ethylhexylphthalate (BEHP) occurred in the stations immediately downstream of the Woonsocket Treatment Plant. Although there were no violations of the freshwater quality standards for nickel, vigilance for this element is also warranted since levels often approached the criteria especially near the Massachusetts border.

The water quality of the Blackstone River with regard to toxic contaminants was relatively constant throughout the Rhode Island section of the river. The water quality model generated with these data confirmed that "the water quality of the Blackstone River as it leaves Massachusetts is clearly the controlling factor governing the water quality of the river in Rhode Island" (Wright, 1987).

The importance of Massachusetts pollution loads has already been demonstrated. The water quality criteria violations are already evident for the above metals and PCBs as the river flows into Rhode Island from Massachusetts. The phthalate violations in the river, however, begin downstream of the Woonsocket Treatment Plant. The pollution inventory for phthalates confirms that the Woonsocket Treatment Plant is a major source of these compounds to the river. There is another way to evaluate the water quality of river waters through bioassay techniques. Both Rhode Island and Massachusetts require their major dischargers to test prechlorinated effluents for acute toxicity to two aquatic organisms. Neither state have conducted such tests on the river water itself yet, and each continue to use individual chemical criteria values to evaluate water quality at present.

Because there are numerous violations of the freshwater aquatic habitat criteria in the Blackstone River, it will be necessary to reduce loads of these toxic materials, if Rhode Island and Massachusetts want the Blackstone River to serve as a high quality aquatic habitat.

Fecal coliform was determined by the State of Rhode Island Department of Health Laboratory in cooperation with the URI studies (see data in Appendices of Quinn, et al., 1987). All three sampling periods showed the same pattern of fecal coliform in the river. As the river crossed the Massachusetts-Rhode Island border, the fecal coliform concentrations ranged between 93 - 150 counts/ 100 ml., beneath the Massachusetts water quality standard of 200 counts/100ml. Downstream of the Woonsocket Treatment Plant, the concentrations rose to 430 to 36,000 counts/100 ml. The concentrations then began to decrease reaching a minimum at Ashton where the concentrations ranged between 39-230 counts/100 ml. Once again, through Pawtucket the fecal coliform concentrations rose to concentrations of 430-9300 counts/100 ml., presumably due to dry weather combined sewer overflows. In summary, the fecal coliform responded directly to the sewage inputs from the Woonsocket Treatment Plant and dry weather combined sewer overflows in the Pawtucket area. Upstream Massachusetts inputs are overwhelmed by local Rhode Island sources of this bacterial indicator.

The Blackstone River in Rhode Island is classified as a "Class C" waterbody. "Class C" water is suitable for boating, fish and wildlife habitat and industrial processes. It is not good enough for drinking or swimming. The median value for fecal coliform in "Class B" water is 200 counts/100 ml. The survey data indicates that only at the Rhode Island border and at Ashton is the water clean enough to be upgraded from "Class C" to "Class B". The rest of the Rhode Island sections are properly classified with regard to the coliform criteria.

Table 2-3

Comparison of Blackstone River Water Quality with state and federal standards

	Standard (ug/l)@ Acute EPA(86)	Chronic EPA(86)	mean RI Blackstone#	mean exceeds criteria? Acute	Chronic
As	360	190	<5.*	no	no
Cd	1.31	0.52	0.78±0.43	no	yes
Cr(6)	16	11	8.35±8.31	no	no
Cu	7.09	5.15	10.6±3.5	yes	yes
CN	22.	5.2	<10*	no	?
Pb	23.7	0.92	4.35±3.13	no	yes
Hg	2.4	0.012	<1*	no	?
Ni	881.	45.6	22.3±7.68	no	no
Ag	0.76	0.12	<0.36	no	?
BBP	940	3.	0.42	no	no
DEHP	940	3	5.6	no	no
Acenap	85&	1.9&	0.036	no	no
Fluora	199&	4.4&	0.082	no	no
lindane	2&	0.08&	<0.01	no	no
PCBs	2	0.014	0.021	no	yes

**@dependent on hardness. The hardness used for values in this table was 37.8 mg/
l (US Geological Survey mean for 1986)**

#Quinn, et al., 1987

***RI Department of Health as cited in Quinn, et al., 1987.**

&EPA - 1980 criteria, none given for 1986.

POSSIBILITY OF UNKNOWN POINT SOURCES

There are two ways these data can be used to discover if there are significant unknown or unmonitored sources of toxic contamination to the river. The water quality model generated with the monitoring data (Wright, 1987) found, for example, that there was an unexplained rise of soluble nickel concentrations in the Ashton-Lonsdale- Pawtucket region of the Blackstone. Of course, sometimes, extra metals in rivers can come from resuspension of contaminated sediments, but these excesses usually show up in the particulate fraction of the metals. The extra nickel in the river in this section of the river could come from an unknown source.

It is also clear that the inventory of point sources in Massachusetts (Hogan, 1987) do not account for several constituents crossing the border into Rhode Island. The suspended solids crossing the border is much larger than the sum of the point sources in Massachusetts. However, there are many sources of suspended solids into and within the river from non-point sources and sediment resuspension. Imbalance in inventories is possible also when the point source monitoring was done at a different time than when the river was monitored and one or the other was not a typical situation. The inventory imbalance does, however, suggest that contribution from unknown sources of pollution from Massachusetts may be one possibility.

The modelling method for finding unknown point sources is a great deal more specific than using imbalances in inventories, because it also identifies the possible location of the source. This technique was used successfully in the past to discover additional sources of contamination in the Pawtuxet River. One of the sources was an abandoned treatment lagoon for wastewater of a closed manufacturing plant. Another was contamination from leachate of a landfill adjacent to the river.

Even though there is a suggestion of additional sources of toxic pollution entering the river, there is also evidence that during dry weather low flow conditions toxic materials are settling out in the river. While this suggests that the river has a self-cleansing mechanism during low flow conditions, it is probable that these particulate-bound contaminants could became re-entrained into the water column during periods of higher flow. Additional monitoring will be necessary to assess the seriousness of this problem.

TRENDS IN RIVERINE WATER QUALITY OF THE BLACKSTONE

The U.S. Geological Survey has analyzed Blackstone River water quality at the Manville Dam (Narragansett Bay Project Station 4) since 1978 (Briggs and Feiffer, 1986). A summary of their analyses between 1978 and 1982 can be compared with the results of the Narragansett Bay Project survey in 1985 (see Table 2-4). For most of the metals, there has been an improvement in water quality, most likely due to aggressive water pollution abatement programs in Massachusetts. This program has been successful and should be continued.

Table 2-4

Trends in water quality of the Blackstone River at Manville, RI (Narragansett Bay Project Station 4)

ug/l	Range 1978-1982#	Mean 1978-1982#	Range 1985*	Mean 1985*
Cd	0 - 4.0	1.6±1.5	0.73 - 1.31	0.95±0.31
Cr	10 - 50	20±14	5.7 - 9.2	7.8±1.9
Cu	16 - 42	24±12	10.2 - 12.8	11.7±1.4
Pb	6 - 45	16±14	2.0 - 7.6	4.4±2.9
Ni	2 - 65	36±21	22.6 - 26.4	24.1±2.0
Ag	0 - 1	<0.3	0.09 - 0.12	0.10±0.01

#Briggs and Feiffer, U.S. Geological Survey, 1986

***Quinn, et al., 1987**

THE BLACKSTONE RIVER AS A SOURCE OF CONTAMINANTS TO NARRAGANSETT BAY

In addition to the Narragansett Bay Project Blackstone River survey completed by Quinn and Wright, the Blackstone River at Slaters Mill in Pawtucket was also monitored on four other occasions during 1985 and 1986 as a part of the Narragansett Bay survey (Hunt, et al., 1987). The Blackstone River was found to be a source of many contaminants to Narragansett Bay, but during dry conditions, the Blackstone is a important source for only a few relative to other sources (see Table 2-5). The Blackstone

River is a major source of cadmium and lead to the Bay during dry weather conditions. Therefore, if reductions of loads for these elements is needed in Narragansett Bay, the waste load allocation effort on the Blackstone should incorporate these goals in addition to protection of only the river itself. The data available to date indicates that lead poses potential human health threat in terms of affecting the edibility of quahogs in the Providence River. Reduction of lead levels in the Blackstone and throughout the whole basin may be needed before considering the possible opening of this area to shellfishing.

Table 2-5

Importance of Blackstone River contaminants to Narragansett Bay (% of total Bay input rate)*

	Oct 85	Nov 85	April 86	May 86	Mean
Cd	13.7	70.6	37.9	58.2	45.1
Cr	22.2	24.0	14.4	3.8	16.1
Cu	7.0	26.1	13.7	7.2	13.5
Pb	2.8	40.3	42.8	57.9	36.0
Ni	7.9	41.9	17.3	9.6	19.1
TP	14.7	30.2	20.8	23.3	22.3
TN	14.1	30.6	31.0	15.9	22.9

***calculated from Hunt, et al., 1987**

#atypical

It is unknown how fecal material from the Blackstone River affects the distant areas of Narragansett Bay. Fecal coliform must travel another 5 miles through the Seekonk River before joining with other rivers and point sources in the Providence River. Substantial die off of sensitive indicators would be expected during this time. However, the selection of fecal coliform as the indicator of potential sewage-borne pathogens for regulatory purposes is undergoing intense scrutiny. The transportation behavior of other indicators may be very different than fecal coliform. Additional data on these other fecal indicators in the Blackstone River will be necessary if a regulatory change is anticipated. The two fecal indicators monitored in the Blackstone River surveys, coprostanol and fecal coliform, did not correlate even in the river itself. This suggests that differences in longevity of the various bacterial and viral indicators during transport could be substantial. As discussed in a later chapter, the Blackstone River is only a part of this larger controversy involving selection of indicators for use in regulations, a controversy which affects the whole of Narragansett Bay and its drainage basin.

POTENTIAL INFLUENCE OF NON-POINT SOURCES

There is evidence that the water quality of the Blackstone River will degrade substantially during wet weather conditions. Additional inputs from combined sewer overflows, re-entrainment of sediments into the water and urban runoff are expected. Monitoring of the Blackstone during these conditions is currently underway by the Narragansett Bay Project, and the Cities of Pawtucket and Central Falls will evaluate the seriousness of their combined sewer overflow situation. There are earlier calculations which estimate the potential seriousness of urban runoff inputs relative to the point source loadings studied by the Bay Project (Hoffman and Quinn, 1984). A comparison of these point loads and the estimated non-point loads is given in Table 2-6. This comparison suggests that point sources in Rhode Island and Massachusetts are the culprits for copper contamination. However, urban runoff overwhelms point source inputs of lead and makes a major contribution to the petroleum hydrocarbon and polycyclic aromatic hydrocarbon inventory in the river. Thus the total picture for contaminants, such as hydrocarbons, PAHs and lead, could change radically during and following rain events.

Table 2-6

Potential significance of non-point source pollution in the Blackstone River (units in metric tons/year)

	Sources of pollution in RI section of the Blackstone			Pollution entering RI from Massachusetts*
	Urban runoff#	CSOs#	point sources*	
Hydro-carbon	98.2	22.5	22.8	34.3
PAHs	0.0786	-	0.009	0.101
Cu	0.569	0.164	1.227	4.124
Pb	4.953	0.861	0.159	1.492

#Hoffman and Quinn, 1984.

*Quinn, et al., 1987.

Waste load allocation for point sources alone, even as a joint effort by Massachusetts and Rhode Island, is unlikely to achieve a significant reduction in total loading for contaminants which have large non-point source contributions; in this case, non-point source abatement measures would be more effective. Since the full significance of wet weather inputs to the Blackstone River is the subject of a Narragansett Bay Project study this year, waste load allocation efforts should be postponed until the seriousness of the situation for a variety of contaminants is quantified and effectiveness of point source abatement controls can be judged in context of the whole picture. Such an effort could start as early as 1990.

SUMMARY OF BLACKSTONE RIVER WATER QUALITY ISSUES DURING DRY WEATHER

A summary of water quality issues regarding the Blackstone River is given in Table 2-7. The contaminants which are of concern in the Blackstone itself or of concern because of Blackstone inputs to Narragansett Bay include: cadmium, copper, lead, nickel, bis(2-ethyl)hexylphthalate, and polychlorinated biphenyls. Water quality improvement will require the participation of both Massachusetts and Rhode Island in any point source waste load allocation effort. Joint non- point source abatement programs may also be necessary to achieve reduction of lead loads.

Table 2-7

Summary of water quality concerns in the Blackstone River

	Water Quality Violations in the River Acute?	Chronic?	Significant MA contri- butions ? (>50%)	Significant RI contri- butions? (>50%)	Major input to N. Bay? (>30%)	Concentrations a concern in N. Bay?	Potential non-point inputs?
Cd	occasional	yes	yes	no	yes	yes	yes
Cr	no	no	yes	no	no	no	no
Cu	yes	yes	yes	no	no	yes	yes
Pb	no	yes	yes	no	yes	yes	yes
Ni	no	no	yes	no	occasional	yes	no
Ag	no	yes	yes	no	?	?	no
BBP	no	occasional	no	yes	?	?	no
DEHP	no	no	yes	no	?	?	no
Acenap	no	no	yes	no	?	?	yes
Fluora	no	no	yes	no	?	?	yes
Lindane	no	no	yes	no	?	?	yes
PCBs	-	occasional	yes	no	?	?	yes
TP	-	-	?	?	occasional	?	yes
TN	- - ?	? occasional ?	yes				

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CHAPTER 3

WHAT IS THE CURRENT STATUS OF WATER QUALITY IN NARRAGANSETT BAY? WHAT FACTORS CONTROL BAY WATER QUALITY?

EXECUTIVE SUMMARY

Water quality surveys of Narragansett Bay during the first year of the Narragansett Bay Project examined the content of metals, nutrients, oxygen, and fecal indicators in Bay waters. Concentrations of nickel and copper routinely violate water quality standards in the Seekonk River and the Providence River. Concentrations of lead in the Seekonk and Providence Rivers routinely violated the standard proposed to protect quahogs from unacceptable lead content. Occasional violations of this proposed lead standard were found in Greenwich Bay, the upper Bay, and Mt. Hope Bay. Occasionally, the nitrogen content of the Providence River water exceeded concentrations which have been shown to produce eutrophic conditions in nutrient addition experiments. Low oxygen concentrations were limited to the Fox Point area of the upper reaches of the Providence River during these surveys which, however, were not conducted under worst case conditions.

One survey of fecal indicators conducted when the upper Bay was closed to shellfishing found fecal coliform concentrations in excess of the shellfishing standard throughout the Providence River and in a few locations in the upper Bay. During the summer when the upper Bay was open, violations of the fecal coliform shellfishing standard were limited to the Providence River north of Gaspee Point.

During the surveys, the largest contributors of metals and nutrients to Bay waters were the Fields Point Wastewater Treatment Plant and the Blackstone River. Fields Point was the largest contributor of Cr, Cu, Ni, and N; the Blackstone River was the largest contributor of Cd, Pb, Hg, and P. The majority of all the metals and nutrients enter the Bay by way of the Providence River, which explains the poorer water quality observed there. Comparison of metal loading rates today (1985-1986) with a similar survey in 1980-1982 showed that metal loadings have decreased over the last 5 years. Fecal indicators known to be resistent to chlorination had their largest source from Fields Point; whereas, the indicators affected by chlorination had their largest sources from the rivers.

RECOMMENDATIONS:

1. In order to achieve water quality goals for acceptable aquatic habitat in the Providence River, it will be necessary to further reduce the loads of copper and nickel entering the Bay. Industrial pretreatment programs have already reduced the loads significantly in the last five years. Continued enforcement of existing pretreatment standards, particularly at BVDC and NBC, is encouraged to further increase compliance and reduce loads. A revision of pretreatment standards may be needed if further enforcement proves ineffective.

2. Vigilance that chromium and mercury levels do not increase in the Providence River is warranted. The pretreatment standards for these elements will not need revision.

3. The sources of lead to the estuary need to be reduced particularly if there are plans to open shellfishing grounds in the Providence River. Since non-point sources appear to be the major contributor, elimination of lead in gasoline additives is suggested. The phase out of these additives already underway through auspices of EPA should continue.

4. The data in these surveys suggest that there are as yet unquantified inputs of nitrogen entering Bay waters. These inputs should be found and their magnitude compared to the point sources before deciding to require advanced treatment for wastewater facilities along the Bay. This alternative is very costly, and the effectiveness of this option to achieve improved water quality in the Bay is highly uncertain at present. This does not mean that advanced treatment of wastewater entering Bay tributaries is not justified to improve water quality in the tributaries themselves. Current data are not sufficient to predict whether or not there would be any improvement in the Bay through this action however.

5. EPA and FDA are encouraged to continue their research on fecal indicators and their relationship to human health risks so that the states can make sense of the fecal indicator data now becoming available.

6. When human health risk issues of fecal indicators are clarified, it will be necessary to know a great deal more about the environmental behavior of these indicators in Narragansett Bay before options for regulatory changes can be evaluated. Of particular interest are the distribution of the indicators in the Bay under various environmental conditions, die-off rates of the indicators in the environment, effectiveness of various methods of sewage effluent disinfection, shellfish bioaccumulation and depuration rates and the relationships between water quality and shellfish quality. These data will be needed to evaluate

potential impacts of regulation on the shellfishing industry and to design an appropriate monitoring protocol. The Narragansett Bay Project, EPA, FDA, and the states should work together to provide these necessary data for the Bay.

7. The monitoring data for metals, nutrients, and oxygen suggest that future monitoring efforts can be concentrated in the Seekonk River, the Providence River, and Mt. Hope Bay. The rest of the Bay is relatively clean for these components. Routine monitoring for metals is required only for copper, nickel, and lead, although spot checks of chromium and mercury are advisable. The data are insufficient to design better monitoring protocols for fecal indicators.

WHAT IS THE CURRENT STATUS OF WATER QUALITY IN NARRAGANSETT BAY? WHAT FACTORS CONTROL BAY WATER QUALITY?

INTRODUCTION

Water quality can be viewed in a number of different ways. Traditionally, the state and EPA have been concerned about only two parameters in estuarine waters --oxygen and coliform. Oxygen is essential to estuarine aquatic life. Massive fish kills occur when the oxygen gets too low. Excessive nutrients and organic matter entering an estuary can trigger low oxygen events and, therefore, the State of Rhode Island issues permits to sewage treatment plants which regulate the amount of organic carbon entering the waterbody. In addition, nutrient regulation is also pursued in the State of Massachusetts, especially for effluents entering freshwaters. Coliform is measured and regulated because it is the traditional indicator of fecal contamination. Human fecal material is known to contain human pathogens. For example, a person who has a viral disease will pass along that virus in his fecal matter which travels from the infected person's toilet to the local sewage treatment plant. The treatment plants try to kill the viruses, but some survive and enter the waters of the estuary usually attached to organic matter. The quahogs and shellfish eat the organic matter for food and, if it contains a virus, the virus will enter the gut of the clam. Traditionally coliforms have been used as a indicator of these pathogenic bacteria and viruses. Both the coliform content of effluents are regulated and the coliform content of the receiving water has been used traditionally to determine if the area is suitable for shellfishing and swimming.

But with the advances in the field of environmental sciences, it is now evident that other components of the water are important too and the states and federal government are already reacting to these new findings by monitoring and regulating these new components as well. Several metals have been shown to be toxic to marine life and can also be incorporated into fish flesh. Industrial pretreatment standards have been issued to reduce this contamination. Also new tests have been found which also estimate fecal contamination of the water. Some of these new tests may be more appropriate as indicators of potential human pathogens than the traditional tests for coliform.

The state regulators of today are faced with many questions: What is the water quality of Narragansett Bay? How much is too much of each contaminant? Where do these contaminants come from? Are the appropriate components being monitored and regulated? Is further abatement necessary? What are the abatement priorities? How much will it cost? What will happen if we do nothing? How much will water quality improve with each abatement alternative? What goals do we wish to achieve? One of the main reasons that the Narragansett Bay Project was conceived was to provide the resources necessary for the scientific and regulatory communities to work together to answer these questions.

There are a number of unresolved questions concerning the processes which occur in the Bay which can result in pollutants being lost from the water column during transport, and can transform pollutants into different phases and species than what they were when they first entered the Bay. These issues are particularly interesting to the scientific community in their efforts to understand how the Bay works. These issues are not discussed fully in this chapter, but have been examined in some detail by Pilson and Hunt (1988).

WHAT IS THE CURRENT STATUS OF BAY WATER QUALITY?

The Narragansett Bay Project in its first year funded surveys of the metals, nutrients, oxygen, and fecal indicators throughout Narragansett Bay. The metals, nutrients, and oxygen were determined during four surveys of the Bay where each of 22 stations were visited at high tide. The principal investigators of this effort were Michael Pilson, Candace Oviatt, Scott Nixon, and Carleton Hunt of the Graduate School of Oceanography at URI. In addition, organic contaminants in the upper reaches of the Bay were collected for later analyses by a team led by James Quinn, Oceanography, URI. Participating in the water quality survey portions of these efforts were over 50 university, state, federal, and project personnel. These four cruises were called "SINBADD" cruises for short (Sampling In Narragansett Bay All D--- Day) and were conducted in October (1985), November (1985), April (1986) and May (1986). The fecal indicators were determined (at stations and times different than the SINBADD series) at 21 different stations located in the Providence River and upper Bay during three surveys at low tide. These surveys were conducted by a team for the microbiology department at URI lead by Victor Cabelli using a state boat from the Division of

Fish and Wildlife. Following extensive and labor intensive analyses of the samples, the Environmental Data Center of URI provided maps of bay water quality from the analytical and microbiological data provided by these principal investigators. The original metal, oxygen, and nutrient data assessed in the remainder of this chapter come from Hunt, et al., 1987; the original microbiological data come from Cabelli, 1987.

Oxygen

Oxygen in estuarine waters is an essential element for marine life and the state recognizes its importance in its classification criteria for marine waters. To classify as SA water (suitable for aquatic habitat, swimming and fishing), the concentration of oxygen cannot fall below 6 mg/l at any time; for SB waters (suitable for aquatic habitat), the concentration cannot fall below 5 mg/l at any time; and for SC waters, the concentration cannot fall below 4 mg/l at any time. The surveys conducted by the Bay Project found that any violations of these standards occurred only in the Providence River and then only during the early fall cruise. At all other times, the oxygen levels met SA specifications for oxygen. During the October 1985 cruise, however, Fox Point bottom waters fell below 4 mg/l, and the other levels of waters at Fox Point fell below 5 mg/l. The waters immediately downstream of Fields Point also violated the 5 mg/l standard. Oxygen is depleted whenever there is an overload of organic carbon and nutrient inputs at some time prior to the occurrence. Therefore, oxygen depletion can be minimized through control of organic carbon inputs such as reduction of the BOD (biological oxygen demand) components of sewage and by control of nutrient inputs. Low oxygen in sections of the Providence and Seekonk Rivers has been documented before and is particularly severe in the summer months (Nixon, 1986). None of the SINBADD cruises took place in the summer, so it is likely that the extent of low oxygen conditions in the Bay could be worse than this particular series would indicate. The second year's monitoring activities in the Providence River, which will have two summer cruises, will be much more useful in examining the extent of low oxygen in this area and what concentrations of BOD and nutrients are associated with these observations. Conclusions regarding the status of the oxygen content in the Providence River and possible remedies must await the second year results.

Nutrients

There are no official standards for nutrients in seawater or estuarine waters. However, a proposed guideline for inorganic nitrogen was recently derived for Narragansett Bay by Candace Oviatt of URI's Marine Ecosystem Research Laboratory based on a series of nutrient addition experiments using Narragansett Bay water and Narragansett Bay biota. In these experiments, the 8x tank (where the dissolved inorganic nitrogen averaged 550 ug/l) exhibited abnormally high productivity and routine episodes of low oxygen. These experiments suggested, therefore, that whenever inorganic nitrogen concentrations exceeded 550 ug N/l, eutrophic conditions could result. The eutrophic conditions would lead to an abnormally high growth of plankton which would then result in low oxygen conditions especially during the night. This guideline may also be an underestimate of eutrophication potential in the Bay since the experiments were conducted in a well mixed system and the Providence River is known to be stratified (the bottom waters are not well mixed with surface waters cutting off efficient exchange with the atmosphere). When Narragansett Bay waters were compared to this proposed, perhaps underestimated, guideline, routine excesses of inorganic nitrogen occurred in the Providence River especially in the area immediately downstream of Fields Point (see Figure 3-1). In this area, the inorganic nitrogen concentrations were 670, 880, 110, and 560 ug N/l,and the violations ranged from slight to 50% higher than the experimental guideline. The variability was large in this data set; it is well known that nutrient concentrations have a seasonal functionality in Narragansett Bay (Pilson, 1986). It is possible that some seasonal reductions of nutrients may be required in the future, but further information on source strengths is needed before the effectiveness of this recommendation can be estimated. In addition, a better guideline is needed. Perhaps a correlation of nutrient concentrations with observed eutrophic conditions in the Bay during various seasons can provide further insight.

Metals

In general, the metal content of Narragansett Bay water decreased from the Providence River down Bay. An example of this can be seen in Figures 3-2 and 3-3, which illustrate copper and nickel in Bay surface waters. The highest concentrations are found in the Providence River decreasing down Bay. All of the metals had similar patterns in this regard. The distributions are consistent with the multiplicity of sources entering the Providence River with relatively minor sources down Bay.

Segments where at least one sample exceeded the nitrogen levels associated with eutrophication

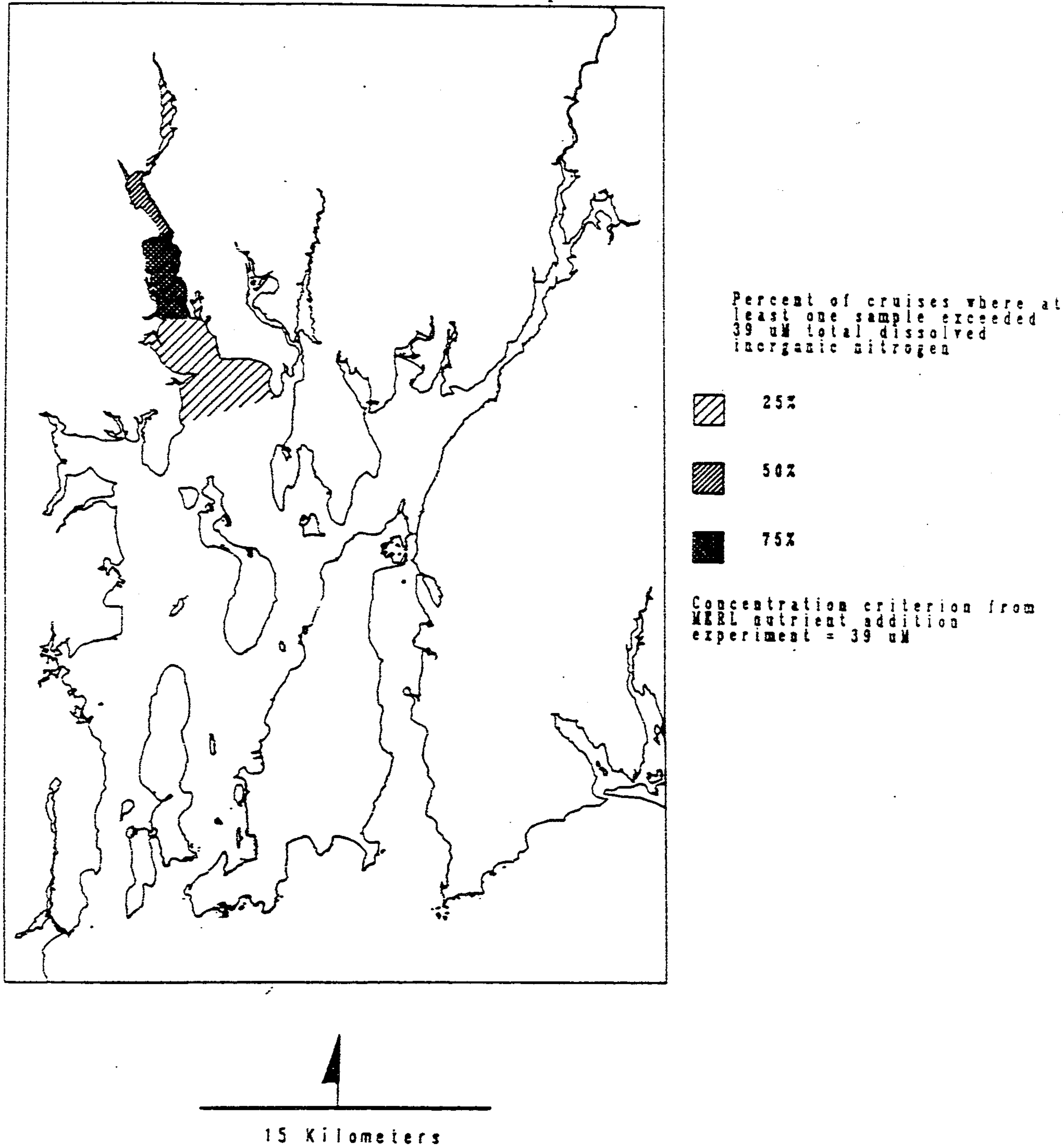

Figure 3-1. *Narragansett Bay Project Rhode Island Department of Environmental Management*

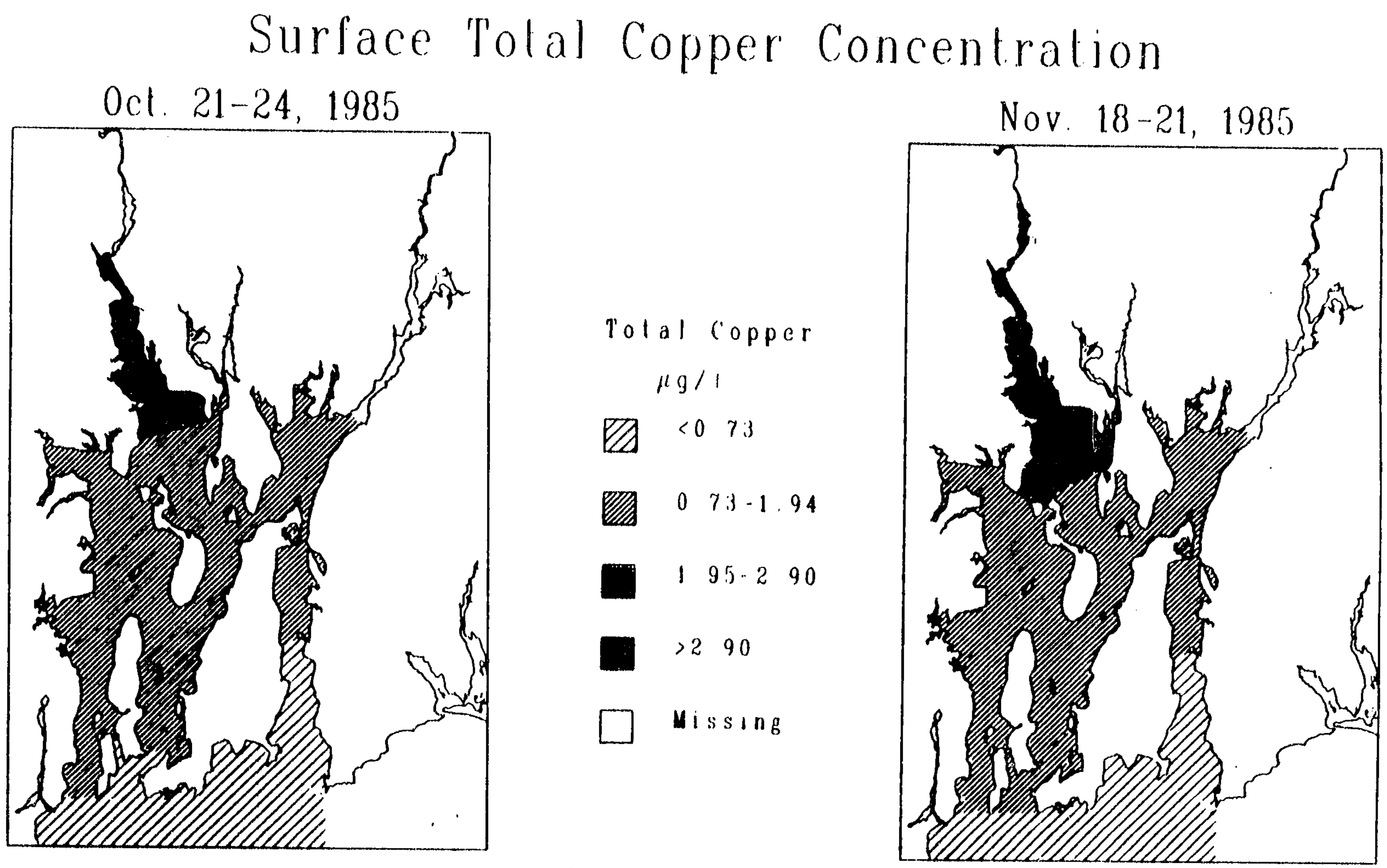

Figure 3-2.

Narragansett Bay Project
Rhode Island Department of
Environmental Management

Surface Total Nickel Concentration

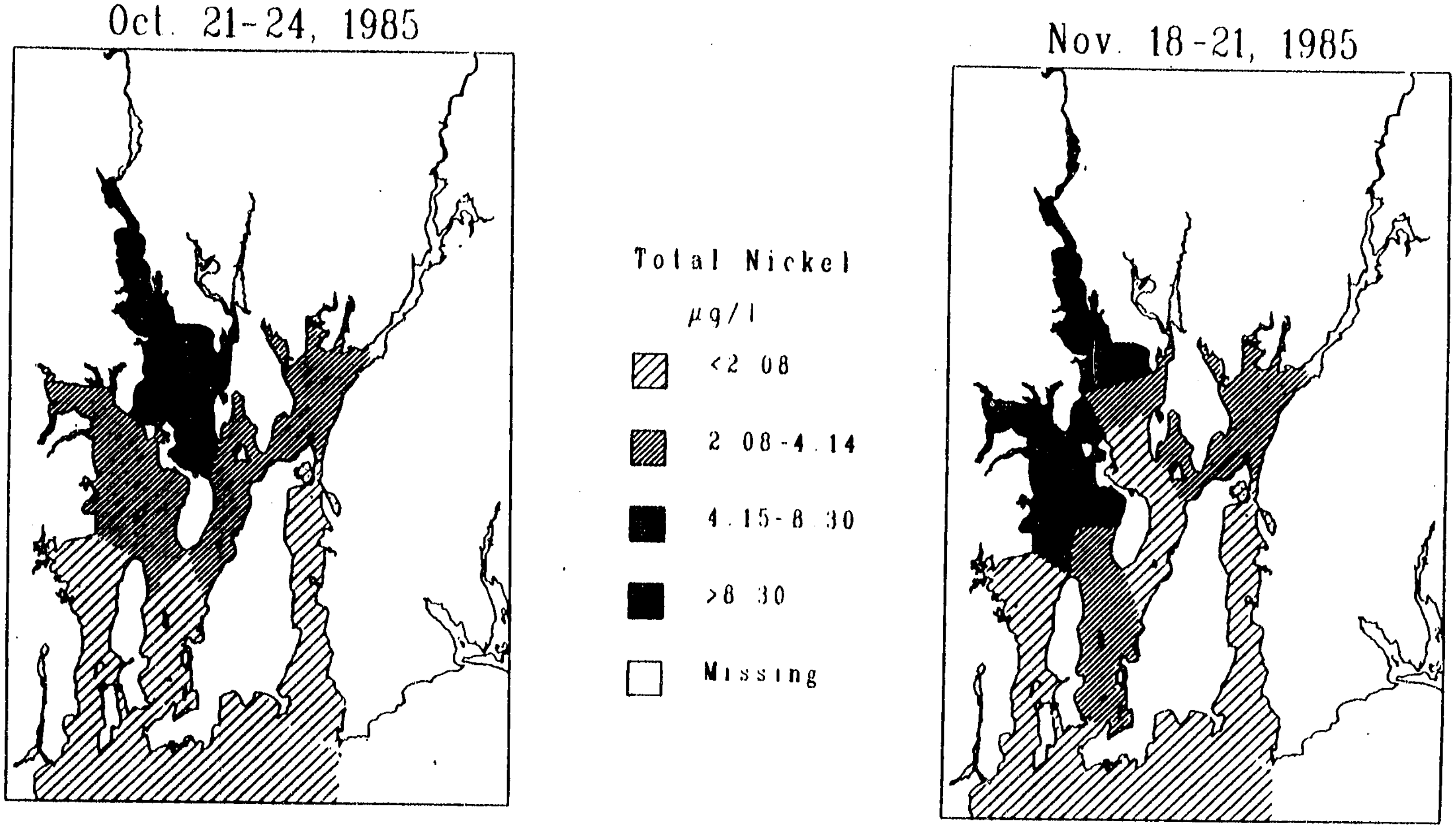

Figure 3-3.

Narragansett Bay Project
Rhode Island Department of
Environmental Management

In the Providence River and upper portions of the Bay, the metal concentrations were usually highest in the surface waters and lowest in the bottom waters. Figures 3-4 and 3-5 illustrate copper and nickel in the bottom waters. Here, again, the concentrations in the bottom waters decrease down Bay, but are consistently lower in concentration than at the surface. The metals are associated with freshwater (sewage and rivers) as they enter the Bay. The metals are, therefore, found in the fresher water which sits on the surface in the Providence River until it is more completely mixed with seawater further down the Bay.

But what do these concentrations mean for water quality? The state and federal governments have issued water quality standards for metals (see Table 3-1) . The standards were derived for a variety of purposes. The EPA and DEM standards are designed to estimate a level where impacts on marine aquatic life begin to occur. These values are revised occasionally as new data are available. Two time frames are included--acute and chronic. In practice, the acute standard is used when slugs of contaminants are discharged and the resulting high concentrations cause death to marine organisms. But the chronic standard is more applicable when considering long term effects from the more usual daily trickle of pollutants into the water body. Long term exposure to these concentrations have sublethal effects on organisms such as reduction of growth and reproductive failure. The effects from the day-to-day pollution will have long term implications to the ecosystem.

TABLE 3-1

Seawater standards for metals (ug/l)*

	Ag	**Cd**	**Cu**	**Cr**	**Ni**	**Pb**	**Hg**
E.P.A-1986							
Acute	2.3	43	2.9	1100	75	140	2.1
Chronic	-	9.3	-	50	8.3	5.6	0.025
Proposed quahog consumer protection guideline	-	0.30	22.4	9.1	5.73	0.43	0.0092

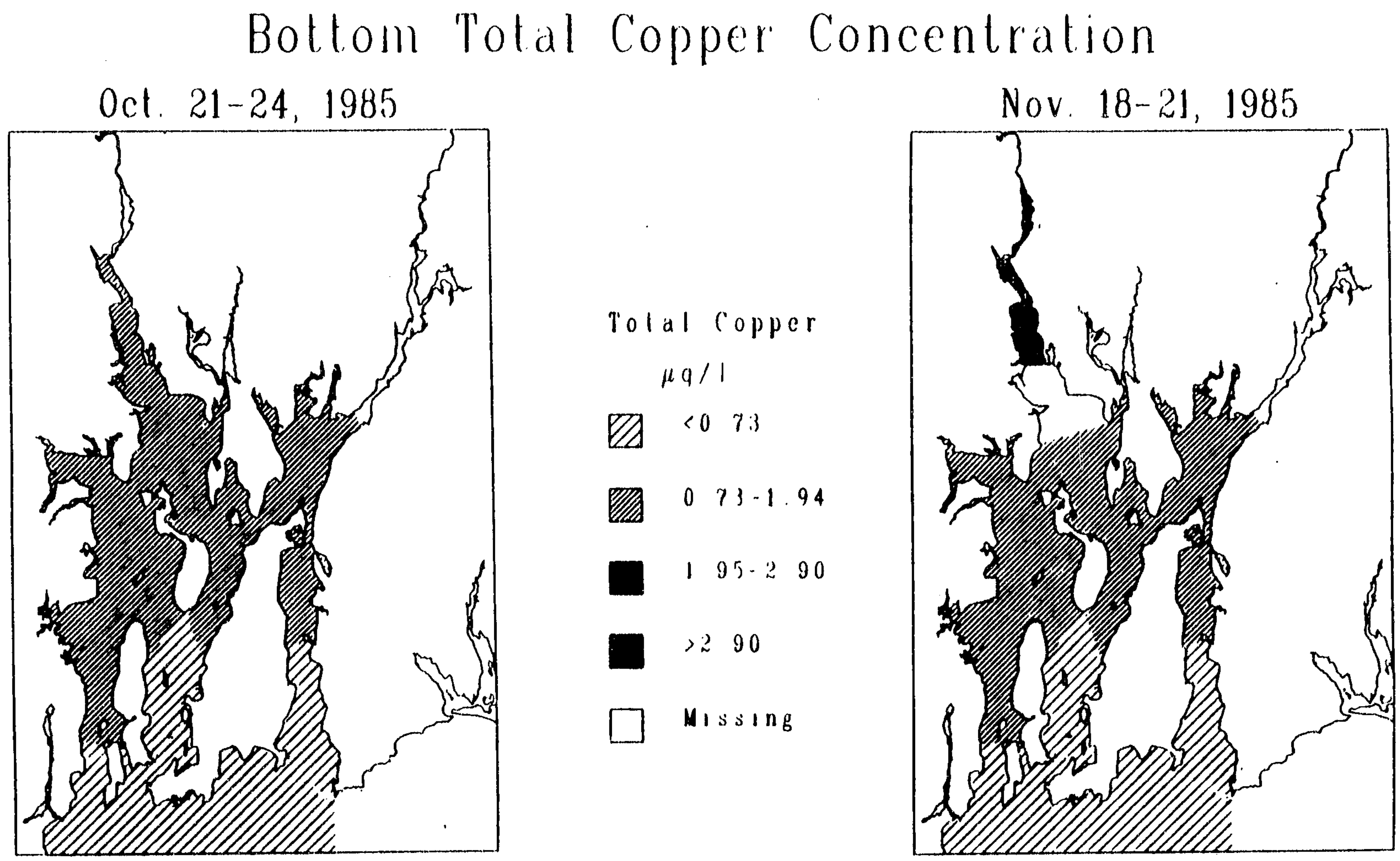

Figure 3-4.

Narragansett Bay Project
Rhode Island Department of
Environmental Management

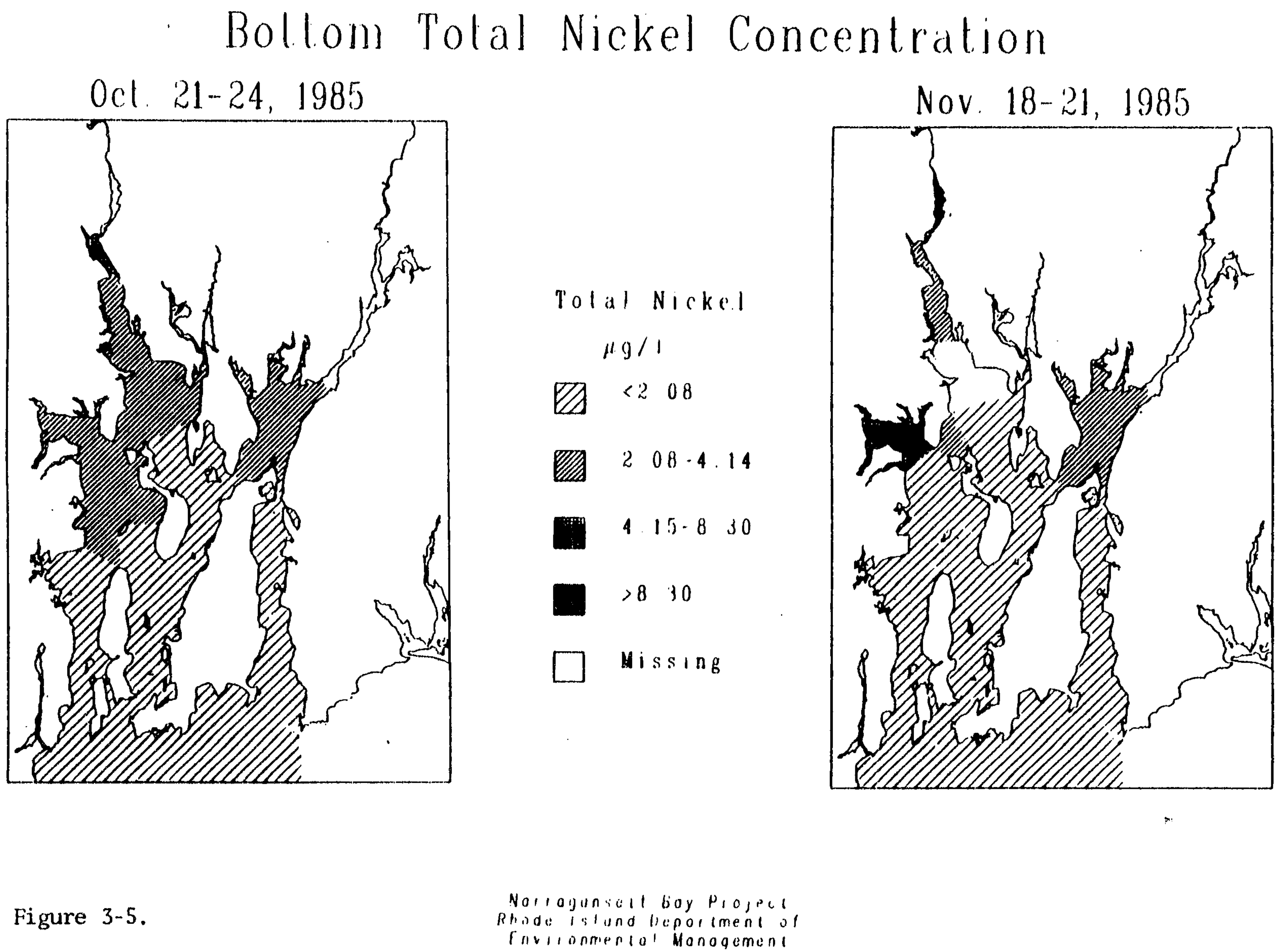
Bottom Total Nickel Concentration
Oct. 21-24, 1985
Nov. 18-21, 1985
Total Nickel
µg/l
<2.08
2.08-4.14
4.15-8.30
>8.30
Missing
Narragansett Bay Project
Rhode Island Department of
Environmental Management

Figure 3-5.

The quahog protection guideline is not official; it was derived by the Narragansett Bay Project simply to protect quahogs from bioaccumulating metals at a level which could pose a threat to human health (the derivation of this guideline is discussed elsewhere). Bay water can be compared to these official and unofficial standards to determine if potential problems exist and where they exist.

No violations of any of the standards occurred for Ag, Cr, and Hg. The highest concentration observed for Ag was 0.11 ug/l, 21 times lower than the EPA -86 standard of 2.3 ug/l. The highest concentration observed for Cr was 2.02 ug /l, 9 times lower than the DEM standard of 18 ug/l. The highest concentration of Hg observed in this study was 0.0038 ug/l, 6 times lower than the EPA-86 standard of 0.025 ug/l. The highest Hg concentration of 0.0038 ug/l was beginning to approach the 0.0092 ug/l Hg standard for quahogs. Vigilance that Hg should not be allowed to increase is warranted.

Violations of the EPA-86 water quality standard were routinely observed in the Providence and Seekonk Rivers for both copper and nickel. The geographic distribution of the violations is shown in Figures 3-6 and 3-7. For Cu, the average concentration in the Providence River surface waters was 4.67 ug/l, or 61% higher than the standard of 2.9 ug/l. The highest concentration was 6.69 ug/l, or 130% higher than the standard. There is, therefore, a need for reduction of Cu inputs to the Providence River, but only slight improvements are necessary to achieve the standard for most of the lower Providence River. As discussed later, the majority of the copper enters the Bay from the Fields Point Wastewater Treatment Facility.

Segments where at least one sample exceeded the EPA 1986 water quality criterion for total copper (2.9 $\mu g/l$)

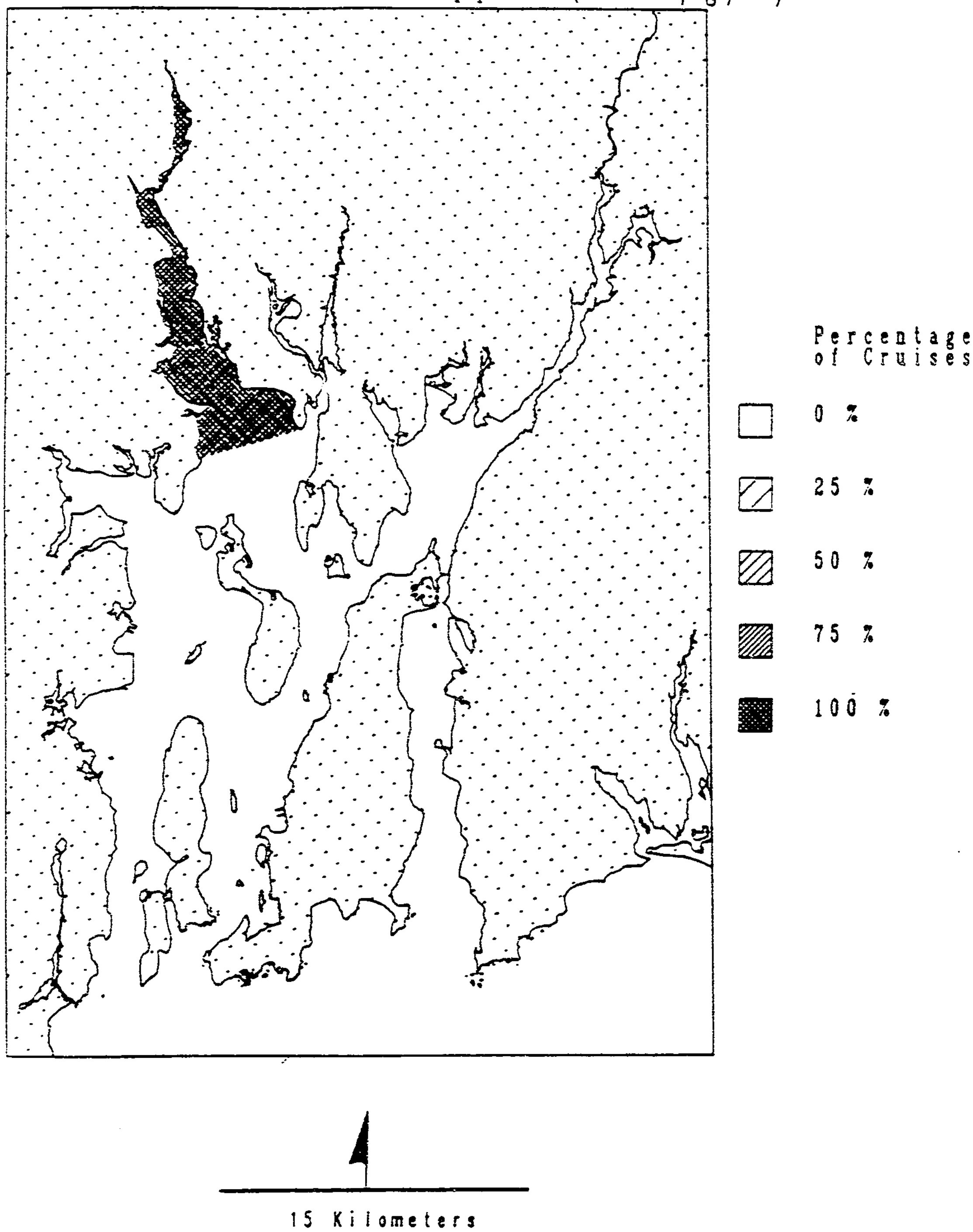

Figure 3-6.

Narragansett Bay Project
Rhode Island Department of
Environmental Management

Segments where at least one sample exceeded the EPA 1986 water quality criterion for total nickel (8.3 µg/l)

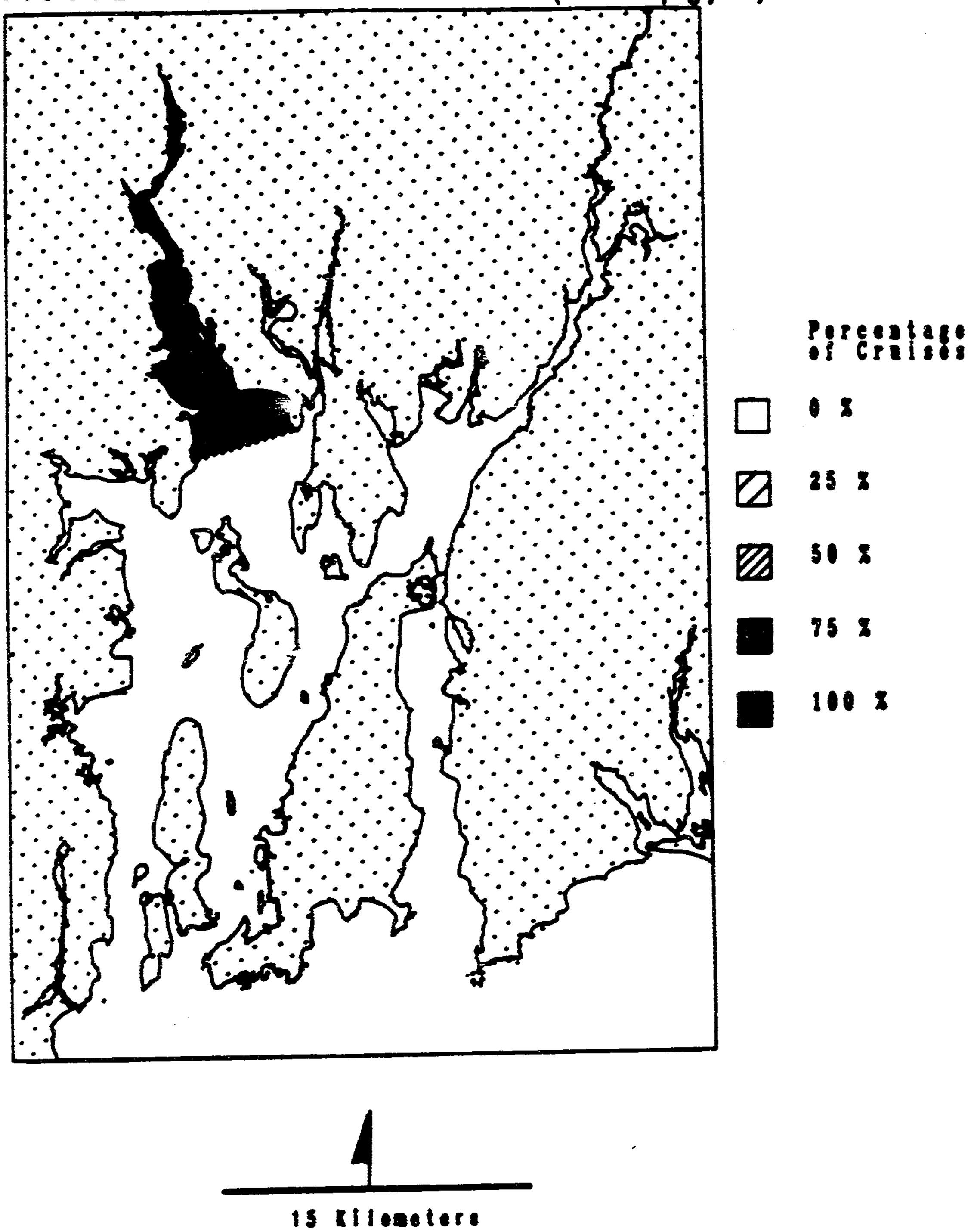

Figure 3-7.

Narragansett Bay Project
Rhode Island Department of Environmental Management

The geographic distribution of the violations for Ni is similar to the pattern for copper; however, the magnitude of the violations are more serious. The average Ni concentration in the Providence River surface waters was 12.06 ug /l, or 42% greater than the standard of 8.5 ug/l. The highest concentration observed was 23.55 ug/l, or 177% greater than the standard. This would suggest that nickel inputs to the Providence River should be reduced at least by a factor of 2 if the standard is to be approached. The majority of the nickel enters the Bay from the Fields Point Wastewater Treatment Facility.

The official EPA-86 standards for Pb and Cd were not violated in the Providence River or Narragansett Bay, but routine violations of the unofficial quahog protection guideline occurred in the Providence River and occasionally elsewhere in the Bay. The geographic extent of the lead violations are shown in Figure 3-8. Note that the violations were routine in the Providence River, but were also observed occasionally in the upper Bay and Mt. Hope Bay. The quahog protection guideline was derived to protect quahogs destined for human consumption from bioaccumulating potentially harmful amounts of metals. Most of the areas where the routine violations occurred are in areas currently closed for quahogging. But these data suggest that reductions of lead inputs to the Providence River will be necessary if the Providence River area is to be considered as a future commercial resource. The severity of the violations were usually a factor of 2 or 3 times the guideline, suggesting that reductions of this range will be needed to achieve the guideline for the Providence River. Violations in the Seekonk River were a factor of 5 times the guideline. Reductions of lead sources into the Seekonk would have to be drastic in order to achieve edible quahogs in this area.

Routine violations of the proposed Cd guideline for quahog growing areas occurred in Seekonk River. Again, the Cd concentrations in the Seekonk exceed the guideline by a factor of 2.

In summary, there were several metals which violate standards in the Providence River. The water quality standard violations for Ni were the most severe but routine violations also occurred for Cu. The more conservative quahog consumer protection guidelines were violated for Pb in the Providence and Seekonk Rivers and for Cd in the Seekonk River (although the official DEM standards were not violated). The standards for Ag, Hg, and Cr were not violated in the Narragansett Bay area, but there were some close calls for Hg.

Segments where bottom water sample exceeded the quahog protection standard for total lead (0.43 µg/l)

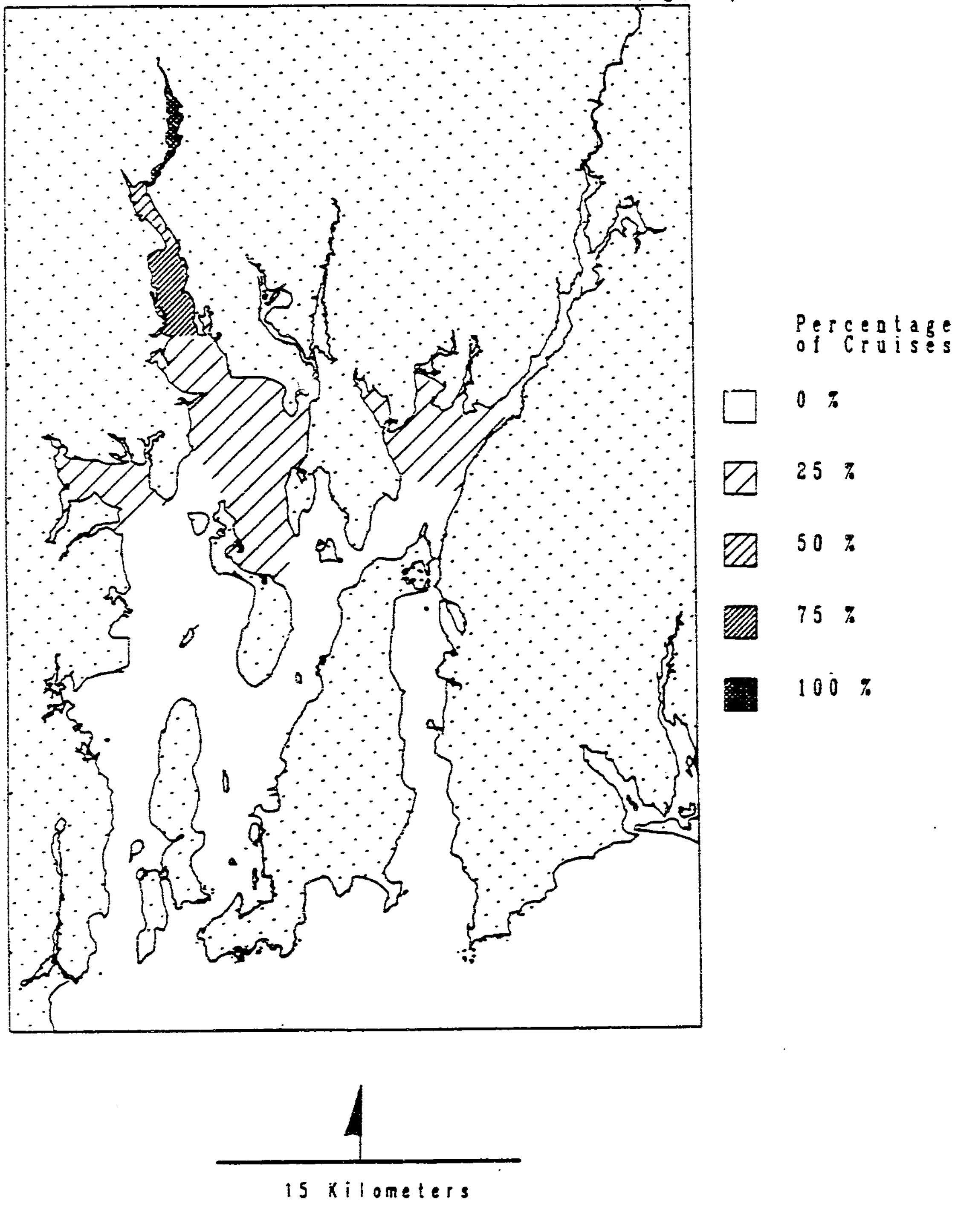

Figure 3-8. Narragansett Bay Project Rhode Island Department of Environmental Management

Fecal, bacteriological and viral indicators

Three water quality surveys of the Providence River and upper Narragansett Bay areas were conducted for the Narragansett Bay Project by Victor Cabelli and his colleagues at URI's Microbiology Department. It is possible to compare the results of these surveys with existing water quality standards. However, these surveys were not particularly designed for this purpose. The existing standards have come under considerable criticism recently because of advances in medical and environmental knowledge since the standards were originally enacted. For example, the standards originally were proposed using total and fecal coliforms, bacterial indicators, to protect users from disease borne by bacterial agents such as those that cause typhoid fever and cholera. Today, concern about disease has shifted toward viral agents. Recent epidemiological data clearly show that viruses are responsible for most of the swimming and shellfish associated infection diseases whose causative agents come from wastewater discharges. Included is the serious disease, infectious hepatitis, and a much less serious but more common illness, gastroenteritis, caused primarily by the Norwalk-like viruses. Exposure to Norwalk viruses results in diarrhea for 24 - 72 hours. It is recognized that the existing standards using fecal coliforms, a bacterial indicator, may or may not be an appropriate predictor of viral-related maladies and diseases. The surveys conducted by the Bay Project determined fecal coliform levels in the waters of the Bay but also determined four other bacterial and viral indicators. At the time of this writing, these other indicators are being evaluated by EPA, especially to determine which of these indicators, if any, can best predict the occurrence of illness in a controlled shellfish feeding study. The results of this epidemiological study are not expected before the end of 1989. For recreational purposes, EPA has already accepted enterococci for monitoring marine recreational waters because illnesses associated with swimming correlated more strongly with enterococci levels in the seawater than did coliform.

At present, we can only compare the results of these surveys to existing standards. But the data on the other indicators in this study will become even more valuable when the epidemiological study is completed. To reiterate, the greatest value of these data is not for comparison with existing standards. The RIDEM already has a routine monitoring program for this purpose. The data from these surveys will become far more valuable as predictors of human disease in later years.

The current water quality standards for fecal indicators are given in Table 3-2. Cabelli and his colleagues conducted several surveys in the upper Bay and Providence River. When the upper Bay was closed to shellfishing due to rainy conditions resulting in combined sewer overflow inputs, the data confirmed that the upper Bay and the Providence River waters violated the shellfishing standards for the fecal coliform indicator. On two other sampling series, when the upper Bay was open, the shellfishing standard violations were limited to the Providence River above Gaspee Point.

TABLE 3-2

Seawater quality standards for fecal indicators
Units are in counts/100 ml.

	Total Coliform	Fecal Coliform	Enterococci
Shellfish growing waters (FDA)			
Approved			
geometric mean	70	14	
maximum*	230-330	43-49	
For relay			
geometric mean	700	88	
maximum*	2300-3300	260-300	
Bathing beach			
Rhode Island			
geometric mean	700	50	
maximum*	2300	500	
EPA-86			
geometric mean	-	-	35
maximum*	-	-	104

***only 10% may exceed this value**

There are two standards which can be used for determining the suitability of seawater for swimming. The State of Rhode Island currently uses a standard based on fecal coliform, but EPA has also derived a guideline based on enterococci. The results of the surveys would indicate that the enterococci guideline violations for swimming were limited to an area in the upper Providence River north of Sabin Point, even when the upper Bay was closed. However, the fecal coliform standard used by the state was violated throughout the Providence River down to Conimicut Point. During dry conditions when the upper Bay was open, the swimming standard for fecal coliform was violated only at the mouth of the Pawtuxet River and north of Fields Point. There were no violations at all of the EPA enterococci guideline for swimming. A more extensive survey of bathing beaches themselves using these two indicators occurred during the summer of 1986 as a cooperative project between the state and the Narragansett Bay Project. Recommendations concerning which of the two standards is most appropriate to Narragansett Bay will be possible using both data sets next year.

Often, there has been discussion that perhaps the monitoring of surface waters for fecal coliforms is inappropriate because the shellfish live in the bottom waters. The US Food and Drug Administration's protocol for monitoring shellfish growing areas specifically suggests that surface water quality be used for classification purposes unless the state can prove through studies that some other sampling protocol provides a better predictor of shellfish meat quality. Cabelli's survey results suggest that bottom waters contain less of all the indicator organisms than the surface waters. Certainly, the water quality at the bottom for fecal coliform is considerably better than the water quality observed in the surface waters during these surveys. But is the bottom water quality a better measure to use as a predictor of shellfish quality? Preliminary data available in Cabelli's report suggest that neither surface water quality or bottom water is a particularly good predictor of shellfish quality collected at the same time, at least when fecal coliforms are used as the chosen indicator. There was also not a clear relationship between F. phage in shellfish as a function of F. phage in seawater, at least when data from all seasons are examined together (Figure 3-9). However, there is a strong relationship for the summer and fall surveys. The report points out that uptake and retention of the indicators may be seasonal. Whenever the epidemiological study is completed, a much more detailed determination of the relationship of seawater concentrations to shellfish concentrations will be necessary. If bioaccumulation of the chosen fecal indicator is demonstrated to be a function of season, it may be necessary to have different shellfishing standards seasonally.

The work done for the Narragansett Bay Project by Cabelli can be viewed in two ways. The data on bacteria indicators, e.g. fecal coliform and enterococci, confirms the previous state observations that wet weather results in poorer water quality and that conditional closures during these conditions are warranted. The data on the viral simulant, F. phage, does raise ample cause for concern that even in dry conditions, the shellfish do concentrate this simulant to a much greater degree than the bacterial indicators. Therefore, the state cannot afford to become complacent. Without the epidemiological data, it is too soon to conclude that there is a problem. But likewise, it is also too soon to conclude that there is not a problem in Narragansett Bay.

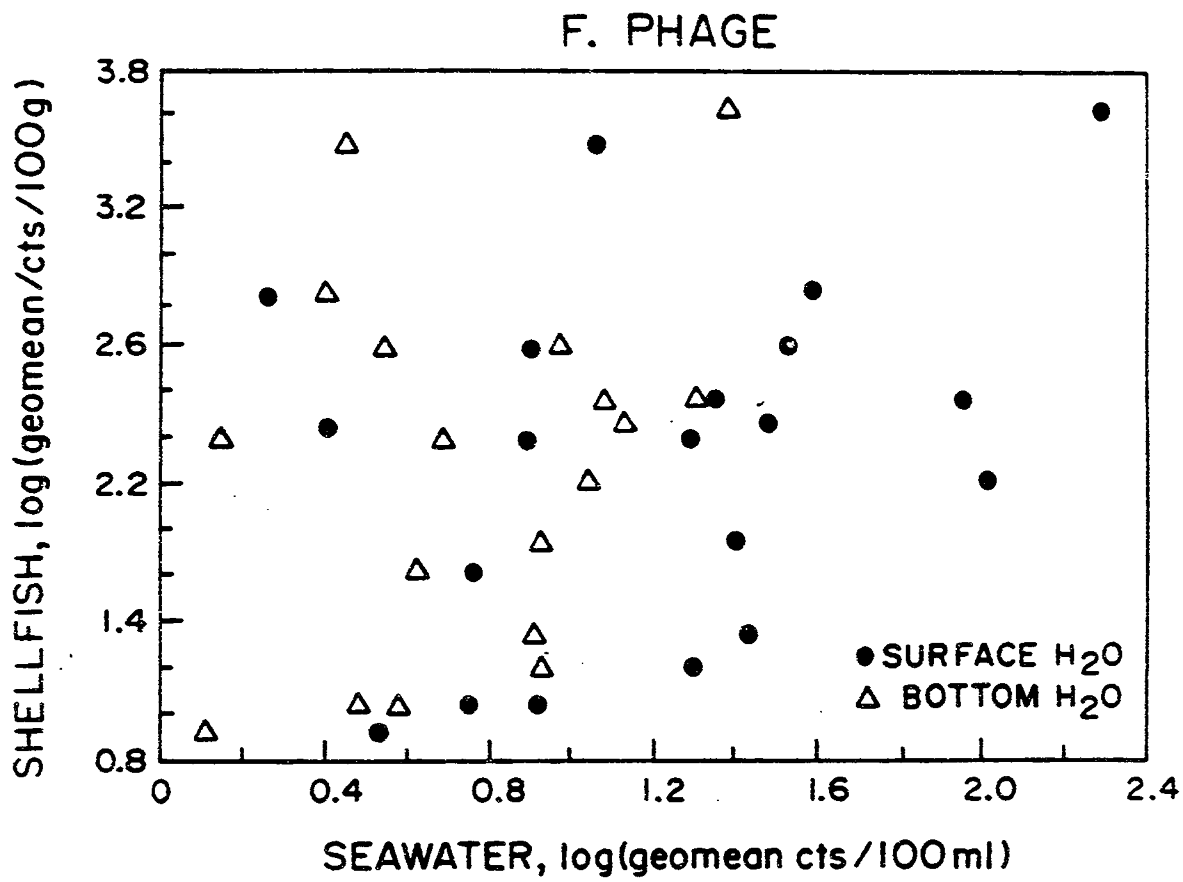

Figure 3-9. Relationship between F. phage in seawater and F. phage in shellfish.

WHAT ARE THE SOURCES OF POLLUTION TO THE BAY?

The Bay monitoring activities revealed that there were some components, particularly in the Providence River, which exceeded official standards and others which exceeded proposed guidelines for protection of quahogs and prevention of eutrophic conditions. These excessive concentrations in the Bay suggest that further abatement of pollution is required. But where do these pollutants come from? What are the implications for abatement effectiveness in improving water quality?

There are a number of ways to find out where the pollution enters the Bay. The Narragansett Bay Project scientists felt it important to monitor the sources of pollutants at the same time the Bay itself was being monitored during the SINBADD surveys. This activity was supervised by the Pilson, Hunt, Oviatt, Nixon team. Monitoring of the 5 major rivers and all the sewage treatment plants took place for 3 days prior to the Bay sampling activities in the region. This massive effort was accomplished only through the voluntary cooperation of a large team. The bottles for the sewage treatment plant samples were delivered to the plants and retrieved by Paul Desrosiers from the DEM Water Resources Division. The samples were collected by Narragansett Water Pollution Control Association members who serve as treatment plant operators and administrators at the various treatment facilities around the Bay. And the samples themselves were analyzed for metals by the chemistry lab at the Narragansett Bay Commission's Fields Point facility, for nutrients by the URI Oceanography team, and for fecal indicators by the URI microbiology team. The riverine samples were collected by the Narragansett Bay Project administration staff with the aid of staff from the EPA laboratory in Narragansett. At the same time the river samples were collected, the river flow rates were monitored by the US Geological Survey office in Providence. Therefore, the data about the sources of pollutants to the Bay are the handiwork of a large team, most of which were providing services to the Narragansett Bay Project on a voluntary basis.

The pollution source monitoring was designed to answer two questions: (1) where does the pollution come from and how much and (2) can the pollution input rates be coupled with the Bay monitoring activities to determine how pollution inputs can be related to water quality in the Bay. At this time, we can discuss the pollution--how much and where from--but only begin to address how all of this affects water quality in the Bay. Further monitoring and modelling activities started during the second year of the Narragansett Bay Project will address the second question with more detail.

It should be pointed out that the Narragansett Bay Project is not the only group who has monitored pollutants as they enter the Bay. The States of Rhode Island and Massachusetts require that routine monitoring take place at all the RI and MA treatment plants as a part of fulfilling the requirements of permits issued to each plant. In addition, the states conduct surveys of their own. Sometimes more sophisticated analyses are done on these state surveys to determine if other components should be limited in future permits. Other times the states want to be sure, by independently monitoring a facility, that the facility's self monitoring records are accurate. All of these records can be used to generate of pollution input picture for the Bay.

Metals

Before constructing a pollution input inventory of the Bay based on Narragansett Bay Project data, the Bay Project data were compared with the state and local data to see if the Bay Project data were typical. Exact agreement, of course, was not expected because the samples were collected at different times. This comparison between Bay Project and state data is given on Appendix 4. In general, the values were similar with a few exceptions. For Ni, Quonset Point and Fields Point reach higher values in the state data than observed in the Bay Project data. For Cu, BVDC, Fields Point, and Quonset have higher concentrations in state records than observed in the Bay Project, but East Providence had lower values in state data than observed during Bay Project monitoring. For Cd, East Greenwich had higher values than observed in the Bay Project. For most of the metals common to both data sets, it appears that Quonset Point's treatment plant seemed to be performing better during Bay Project monitoring periods than was the typical case. Therefore, in the pollutant inventories based on Bay Project data, Quonset's contributions could be underestimated.

The average percentage contributions of metals entering Narragansett Bay from rivers and sewage treatment facilities are given in Table 3-3. For metals associated with the plating and surface finishing industries (Cu, Ni, Cr), Fields Point is the major contributor to the Bay and is the source of 50% of these metals entering the Bay. For the metals which have been implicated with non-point sources (Cd and Pb), the Blackstone River is the largest source (over 35%), but here again, Fields Point is also a major contributor (greater than 20%). The major sources of Ni, Cu, and Pb are shown on maps in Figures 3-10, 3-11, and 3-12. The maps show that for Ni and Cu, the highest contributions enter the Bay through locations on the Providence and Seekonk Rivers. The two largest contributions of lead also enter the Bay through the Seekonk-Providence River system but there are other sources of lead entering throughout the length of the Bay. In terms of metals generally, Fields Point is the largest contributor, followed by the Blackstone River, the second largest contributor, then the Pawtuxet River third, the Blackstone Valley plant fourth, the Fall River plant fifth, the Taunton River sixth, and the Newport plant seventh.

TABLE 3-3

Metal sources to Narragansett Bay - Dry Weather Only

percentage of total input, average of 4 surveys

	Cd	Cr	Cu	Ni	Pb	Hg*
TREATMENT PLANTS						
Bristol	0.7	0.1	0.2	-	-	-
BVDC	6.2	7.7	5.0	7.1	3.4	2.1
E. Green	0.1	0.4	0.5	-	1.1	-
E. Prov	0.8	0.8	0.1	1.1	0.9	1.7
Fall Riv	8.3	4.8	1.8	1.3	9.3	-
Fields Pt	10.7	58.5	66.3	55.8	17.3	40.1
Jamestown	0.1	-	-	-	-	-
Newport	15.3	4.4	1.4	0.5	5.7	-
Quonset	0.1	0.4	0.2	0.2	-	-
Warren	0.2	0.3	0.6	0.3	0.6	-
SUM of PLANTS	42.5	77.0	76.1	66.3	38.3	43.9
RIVERS						
Blackstone	44.8	16.1	13.5	19.0	35.9	41.5
Woonasquatuck.	0.4	1.1	0.6	0.6	2.5	3.5
Moshassuck	0.9	0.5	0.8	0.3	3.4	1.4
Pawtuxet	12.5	3.1	6.8	10.3	9.7	9.7
Taunton	4.7	1.4	2.5	3.4	9.9	-
SUM of RIVERS	63.3	22.2	24.2	33.6	61.4	56.1
Average input rate (kg/day)	7.8	29.8	127	166	44	0.0289

* one survey

The entry point of metal pollution sources is consistent with the water quality violations observed in the Seekonk and Providence Rivers. The conclusion here is common sense: the largest sources of metal pollution enter the Providence and Seekonk Rivers and directly cause the worst metal water quality problems in the Bay which also occur in the Providence and Seekonk Rivers. Therefore, metal abatement should begin with these larger sources.

The first year's survey was conducted primarily during dry weather conditions such that no active runoff or CSO discharges were entering the Bay directly. However, it is clear that metals associated with runoff, Cd and Pb, were present in the larger rivers perhaps from rain events prior to the sampling period. There are not severe differences in the geographic distribution of the metals entering from point and non-point sources because the populations which produce the most sewage and industrial effluents also produce the highest runoff loadings.

Over a year's period, how much metal contamination can be attributed to point sources, such as treatment plants, and how much from non-point source pollution such as runoff and CSOs? More data on this subject will be available later in the Narragansett Bay Project. Earlier data on runoff suggests that 54,000 kg/yr of lead could enter the Bay from runoff (Hoffman, 1984). The Narragansett Bay Project data on point sources suggests that 6150 kg/yr of lead enters the bay from all the sewage treatment plants on the Bay and another 9900 kg/yr enters from rivers to the Bay. These data indicate that abatement of lead from point sources would not have a significant impact on water quality. However, earlier data on runoff also predicted that 6700 kg/yr of Cu enter Narragansett Bay from runoff (Hoffman, 1984). The Narragansett Bay Project data indicates that 35,200 kg/yr of Cu enter the Bay from sewage treatment plants (30,700 kg/yr from Fields Point alone) and another 11,200 kg/yr from rivers. In this case, point sources are clearly dominant and water quality improvements could be expected if the Cu emitting treatment plants were abated. It should be noted that sewage treatment plants are not designed to treat metals, although some treatment is possible. Industrial pretreatment, therefore, offers the best hope for abatement of such metals as Cu, Ni, and Cr.

Average Percentage Contribution of Total Nickel

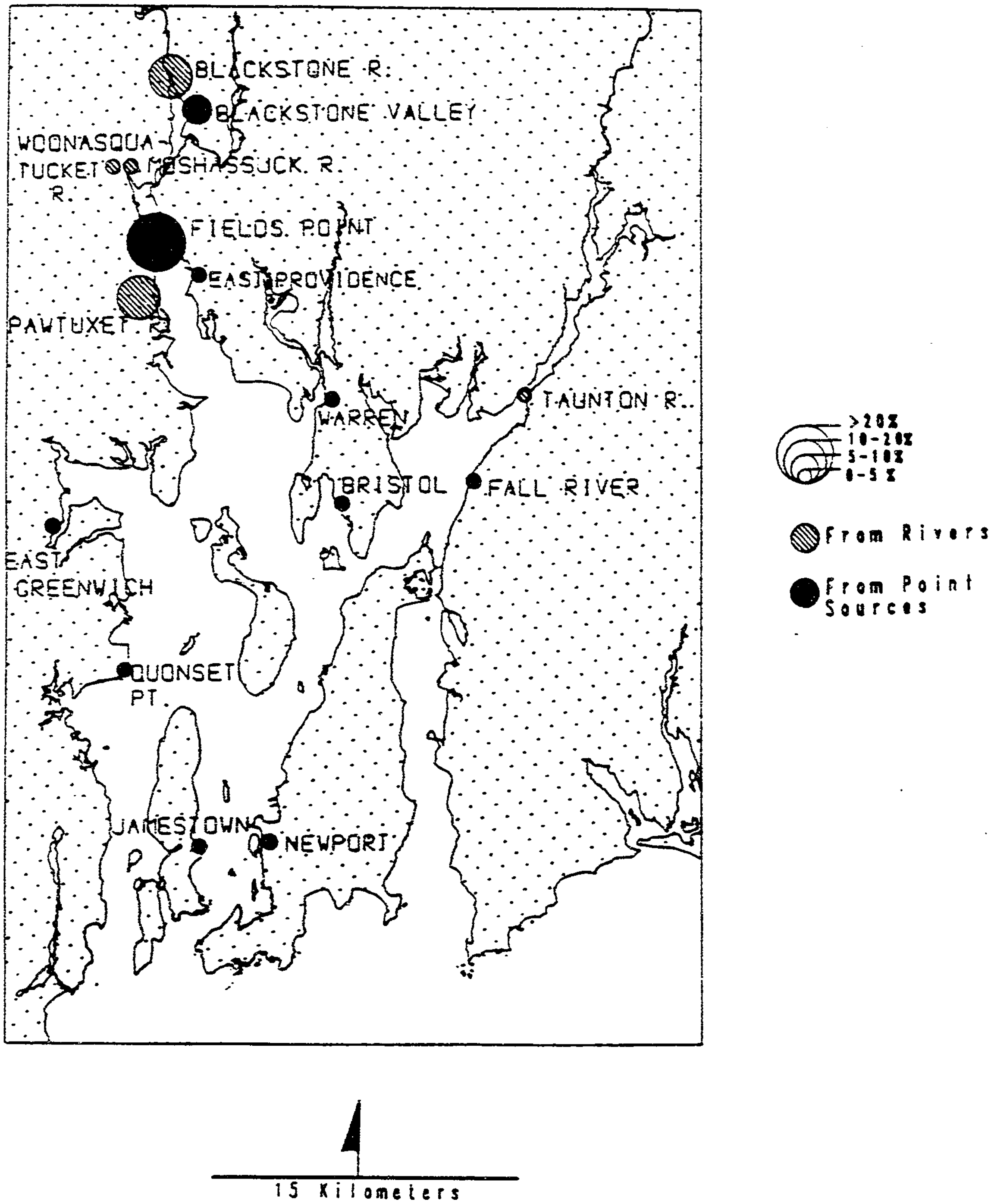

Figure 3-10. Narragansett Bay Project Rhode Island Department of Environmental Management

Average Percentage Contribution of Total Copper

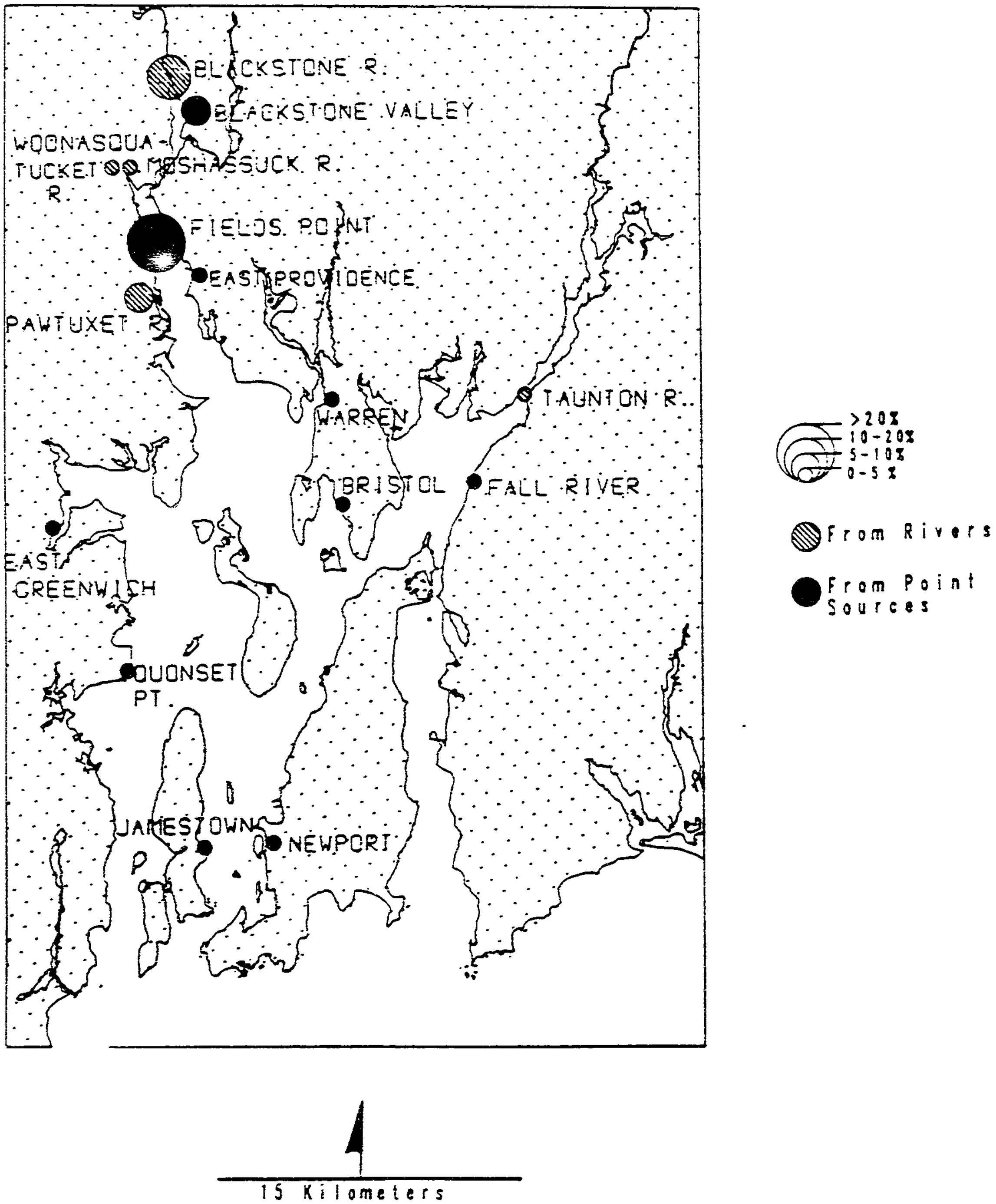

Figure 3-11.

Average Percentage Contribution of Total Lead

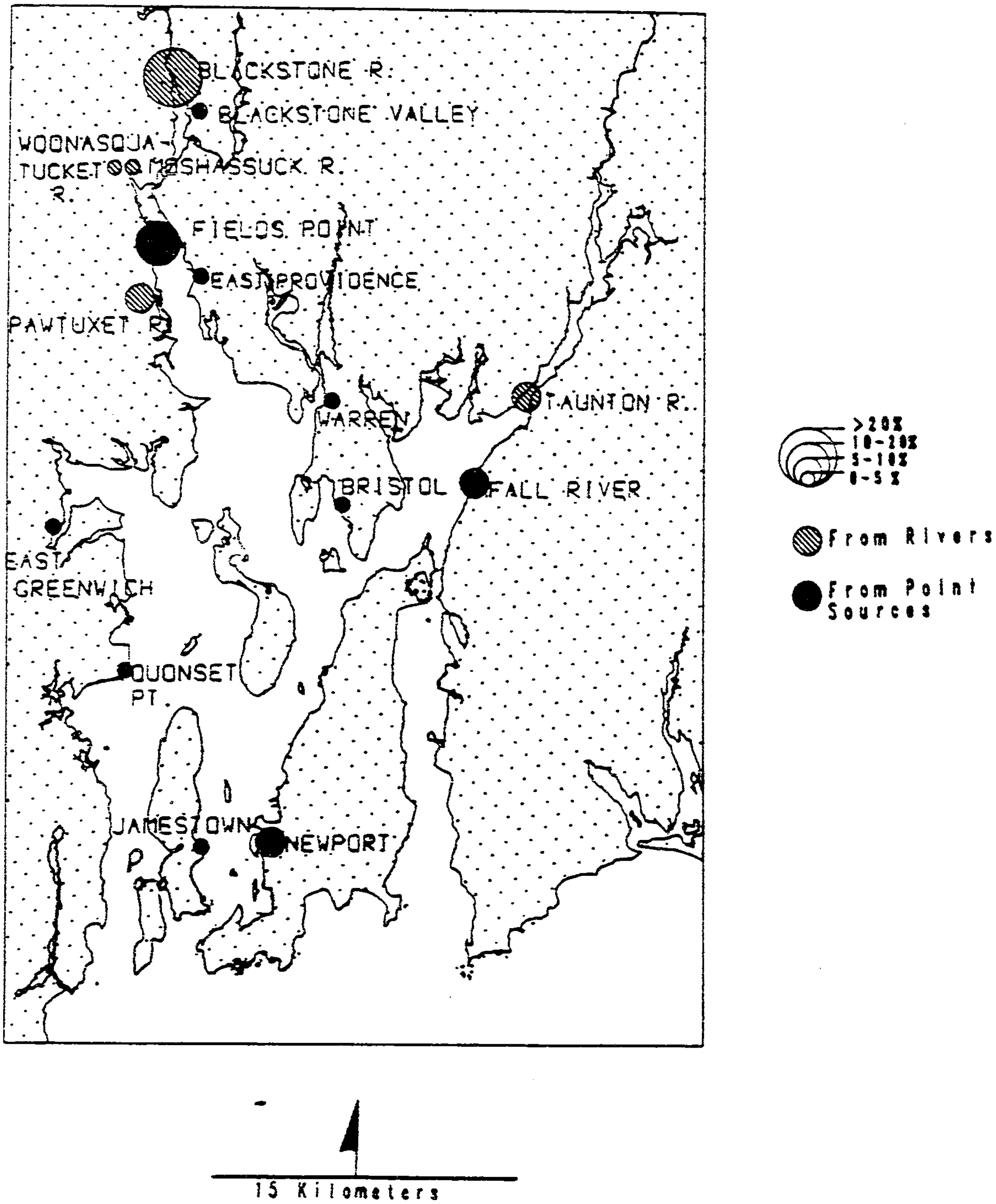

Figure 3-12.

Comparison of monitoring data for 1980-1982 for sewage treatment plants (before initiation of pretreatment programs, Hoffman, 1984) with data from these surveys can give an indication of the effectiveness of pretreatment (see Table 3-4). All of the larger plants on the Bay have made significant progress already in reduction of loads of Cu and Ni. Even though compliance with standards is not 100%, those industries who have complied have already made a significant impact on reduction of loads to the Bay.

TABLE 3-4

Comparison of metal loading rates from larger treatment plants before and after start of industrial pretreatment programs

	Loading rates (kg/day)			
	Cu		Ni	
	1980-2	1985-6	1980-2	1985-6
Fields Pt	204	85	262	107
BVDC	14.6	7.4	15.0	9.6
Fall River	5.04	4.4	no data	3.6
E. Prov	0.97	0.39	1.78	2.2
Newport	16.7	2.18	34.2	1.6

Nutrients

The sources of nutrients to Narragansett Bay are detailed in Table 3-5. The largest sources of nutrients entering the Bay are the Fields Point Treatment Facility and the Blackstone River. A map of Narragansett Bay showing the sources (Figure 3-13) illustrates that the largest sources enter the Bay through the Seekonk-Providence River. In fact, 78% of the total nitrogen and 71% of the total phosphorus inputs enter the Bay through the Seekonk-Providence River and it is here that eutrophic conditions have been shown to occur.

Non-point sources such as agricultural and suburban runoff have been implicated in the Chesapeake Bay Project as the main sources of nutrient input to Chesapeake Bay. Earlier data on nutrients in runoff in the Narragansett Bay region, however, suggest that runoff is only a minor contributor (706 kg/d of total N was calculated to come from runoff vs 13349 kg/d from riverine and treatment plant sources, Hanson, 1984). Riverine inputs account for nearly half the nutrient input to the Bay but, at present, the ultimate source of these nutrients is not known. The importance of nutrient inputs from the sediments is also uncertain. Until more is known about the sources of nutrients entering the rivers and entering from the sediments, abatement alternatives for nutrients cannot be realistically evaluated.

TABLE 3-5

Nutrient sources to Narragansett Bay

	percentage of total input, average of 4 surveys	
	Total Nitrogen	**Total Phosphorus**
TREATMENT PLANTS		
Bristol	1.1	0.8
BVDC	6.5	11.6
E. Greenwich	0.5	2.1
E. Providence	1.9	2.6
Fall River	9.2	20.8
Fields Pt.	28.0	18.2
Jamestown	-	0.3
Newport	3.4	3.0
Quonset	0.5	0.4
Warren	0.5	0.7
Sum of Plants	50.3	55.0
RIVERS		
Blackstone	23.8	23.9
Woonasquatucket	1.2	0.8
Moshassuck	0.9	0.4
Pawtucket	15.3	13.9
Taunton	8.8	6.6
Sum of Rivers	49.7	45.0
Average input rate (kg/day)	13349	2435

Average Percentage Contribution of Total Nitrogen

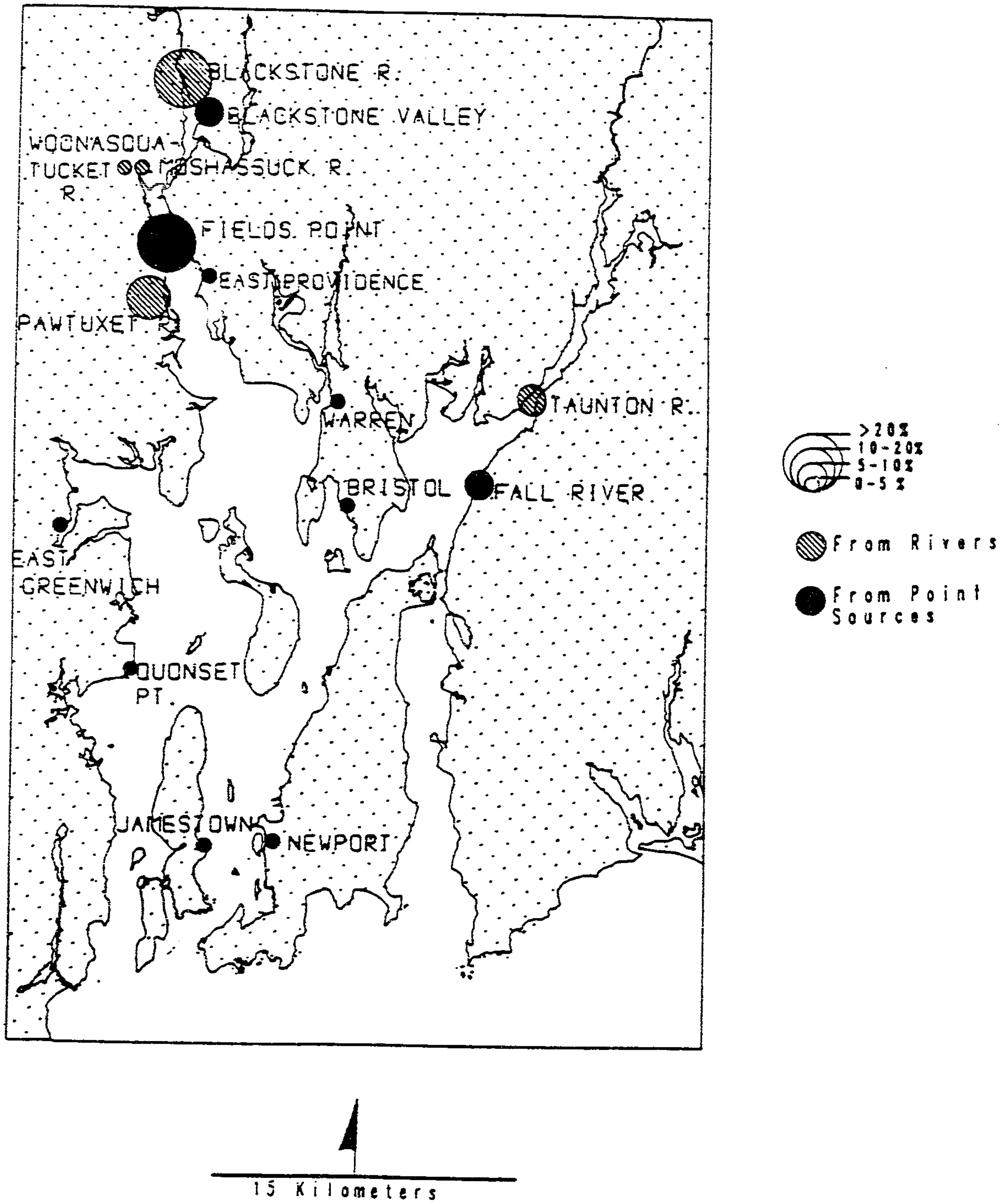

Figure 3-13. Narragansett Bay Project Rhode Island Department of Environmental Management

Fecal indicators

The input inventory of fecal indicators entering the Providence River and the upper Bay is given in Table 3-6. Two quite different patterns emerge from this inventory. The three fecal indicators which are susceptible to chlorination disinfection, e.g. enterococci, fecal coliform and E. coli, all have their major sources entering the Providence River via the rivers. In fact, during December 9-11, 1985, following a rain storm, the Seekonk-Blackstone River was contributing more than 90% of these indicators to the Bay. Even during the drier conditions of July 1986 and 1987, the rivers continued to be the major source.

However, the two indicators which are not affected by chlorination, at least to the same degree, e.g., C. perfringens spores and F-phage, enter the Providence River largely from the Fields Point Treatment Plant. This observation leads inevitably to a number of scientific, regulatory, and philosophical questions.

(1) Is the disparity between the sources of fecal contamination which arise from two different classes of indicator determinations solely due to different degrees of disinfection effectiveness affecting these two sets of indicators? Or is the nature of the contamination (point sources versus non-point sources also implicated? If instead of considering the effluents after chlorination, we consider the inventory again using the effluent constituents before chlorination, we can evaluate whether chlorination alone is the reason why the two classes of indicators are dissimilar (see Table 3-7). On this basis, the inventory distributions of all the fecal indicators are quite similar. We can conclude therefore than the reason the fecal indicators had different inventories is the impact of chlorination of the sewage effluents.

(2) Does the dissimilarity of the different indicators have utility in water quality assessments? The utility of using a suite of indicators in terms of tracing and identifying sources of contamination was already demonstrated in the water quality surveys conducted by Cabelli and his colleagues. The water downstream of Fields Point showed an increase of the spores and F-phage relative to upstream stations but there was no increase in fecal coliform or enterococci. On the other hand, downstream of the Pawtuxet River, there was an increase in fecal coliform and enterococci but no increase in spores of F-phage. Each of these observations reflect the respective inputs of the chlorinated Field Point discharge and the input of river water each with its own signature relative to fecal indicators. Even if only one indicator is used for regulatory purposes, monitoring a suite of indicators could

be used to suggest possible sources of the contamination better than any one of these by itself.

(3) If different fecal indicators have different sources, which fecal indicator is best for regulatory purposes? The data here are not helpful in resolving this issue since the relationships between any of these indicators and disease have not been established. The data only suggest that regulation of more than one indicator may be needed in the future since the pattern for chlorinated effluents is different than unchlorinated discharges. It is clear than chlorination affects some of the indicators to a greater extent than others and the question becomes what is happening to disease-causing viruses. Previous studies (Keswick, et al.) have reported that the Norwalk virus was resistant to chlorination and was similar to F. phage in this regard. Therefore, besides killing some of the fecal indicators, is chlorination doing the job we want it to do in prevention of disease.

A section of the study conducted by Cabelli sought to discover which treatment plant was the most effective in reducing the concentrations of the most resistant indicators, especially F-phage. The most effective plant was Quonset followed by Jamestown. The least effective plants were Newport and East Providence. The surveys were not designed to investigate the influence of treatment plant operations on the effectiveness of disinfection. So unfortunately, other than providing some basic data on the range of chlorination effectiveness for F. phage in the region, the study gave no clues as to how operational improvements might be used to improve the disinfection effectiveness for this indicator.

TABLE 3-6

Sources of fecal indicators to Narragansett Bay

SOURCE	spores	F-phage	enteroc.	F. Coliform	E. Coli
	Percentage of total input				
Dec. 1985					
Fields Pt	71.0	76.3	4.5	4.7	3.8
E. Prov.	3.4	3.3	0.3	0.1	0.1
Warren	0.1	0.1	0.3	0.1	0.2
Seekonk R.	20.1	16.9	91.9	90.5	91.2
Pawtuxet R.	5.4	3.4	2.9	5.7	4.7
Sum input (cts/day) x 10	3176	1626	119.7	800	613.9
July 1986					
Fields Pt	96.7	95.8	22.0	20.2	-
E. Prov.	0.4	0.6	0.2	0.2	-
Warren	0.1	0.0	0.2	0.3	-
Seekonk R.	0.8	0.7	14.5	48.7	-
Pawtuxet R.	1.8	2.8	57.8	20.5	-
MoshassucK	0.1	0.1	0.5	10.2	-
Sum of inputs (cts/day) x 10	2390	2176	18.5	198	-
July 1987					
Fields Pt	92.4	95.0	6.4	2.5	2.3
E. Prov.	4.3	2.1	0.7	1.0	0.6
Seekonk R	1.3	0.1	44.5	25.8	16.5
Pawtuxet R	1.7	2.7	41.3	27.0	39.2
Moshassuck	0.2	0.1	7.0	43.6	41.3
Sum of inputs (cts/day) x 10	1196	1010	3.71	149.8	87.95

TABLE 3-7

Effect of chlorination on sources of fecal indicators to Narragansett Bay (Dec. 1985)

SOURCES	spores	F-phage	enteroc.	F. Coliform	E. Coli
	Percentage of total inputs				
CHLORINATED EFFLUENTS					
Fields Pt	71.0	76.3	4.5	4.7	3.8
E. Prov.	3.4	3.3	0.3	0.1	0.1
Warren	0.1	0.1	0.3	0.1	0.2
Seekonk R.	20.1	16.9	91.9	90.5	91.2
Pawtuxet R.	5.4	3.4	2.9	5.7	4.7
EFFLUENTS PRIOR TO CHLORINATION					
Fields Pt	85.1	87.7	82.2	82.0	70.3
E. Prov	5.6	3.6	16.3	16.5	27.7
Warren	0.3	0.1	0.6	0.0	0.6
Seekonk R	7.2	7.1	0.8	1.0	1.3
Pawtuxet R	1.9	1.4	0.0	0.1	0.1

Scientific implications

These surveys have been useful in pinpointing to water quality managers where the water quality in the Bay is unacceptable relative to existing and proposed standards, and where the pollution is entering the Bay system. The data are also useful for scientists who are concerned about what happens to the pollutants entering the system and for engineers who want to examine the distribution of pollutants in the system as a function of input rates and water movements in the Bay. Future modelling efforts will help the scientific community learn more about the fate of the pollutants in the Bay.

The data provided in the SINBADD surveys did allow calculation of how much of the various pollutants are in the waters of the Bay at any one time (see Table 3-8). However, there was usually no clear relationship between the inventory and the input rate measured at the same time. The inventory represents an accumulation of several days rather than one day's inputs.

TABLE 3-8

Inventory of pollutants in Narragansett Bay

(metric tons)

Date	Survey	Ag	Cd	Cu	Cr	Ni	Pb	N
10/21/85	1	0.022	0.099	2.59	0.40	6.02	0.50	962
11/18/85	2	0.027	0.139	3.15	0.50	5.32	0.72	1143
4/7/86	3	0.025	0.134	2.88	0.59	3.60	0.50	731
5/19/86	4	0.024	0.104	2.60	0.63	4.14	0.58	750

The inventory of Pb and N does suggest that there are additional sources of these pollutants than were monitored during these surveys (see Hunt, 1988). These two have non-point source inputs to the bay which, although they were not occurring at the exact time of monitoring, could have been introduced prior to monitoring. In addition, both N and Pb can be introduced to the water column from the sediments. The significance of the cycling of N through the sediments of Narragansett Bay has been the subject of intense scientific endeavor recently. These data would suggest that these studies are particularly timely. Depending on the significance of these benthic fluxes of nutrients, it is possible that reductions of inorganic dissolved nutrients actively entering the Bay might not have immediate impacts on the concentrations of inorganic nutrients in the water column. Even reductions of all the nutrient species may not have an immediate effect if the nutrient reservoir in the sediment continues to provide a benthic flux of these species back into the water column.

The data provided by Cabelli and his colleagues also has utility for water regulators and will become even more valuable when the interpretive questions are settled. But in addition, the data are useful for scientists and engineers who are concerned with the fate of these fecal indicators as they attempt to develop models for the estuary. Some particularly intriguing results were developed on the biological decay coefficients of the indicators in the bay. The most conservative indicator, C. perfringens spores, was found to have the slowest decay rate. That is to say, they decreased in concentration at a slower rate downstream from sources than did the other indicators. The fastest decay rate was found for fecal coliforms. All the decay rates were appreciably less in the bottom waters than at the surface. The decay rates were a function of season for the viral simulant, F-phage, presumably due to increased kills due to the increase of solar radiation. The fecal coliform biological decay did not seem to be affected as much by the increased temperature. The explanation of this observation is that, although increased die-off may be occurring, the die- off may be masked by some regrowth of chlorine-damaged coliforms. It is also possible that some of the fecal coliforms, a mixture of species, are affected differently by chlorination and by environmental conditions, thereby leading to very complex die-off equations for the total population. The biological decay of some of the fecal indicators, especially enterococci, was also shown to be influenced by location in the Bay. Enterococci had faster decay rates in the Providence River than in the upper Bay. Enterococci belong to a class of organisms which have been shown to be susceptible to certain inorganic and organic pollutants (Cabelli, 1988a).

In addition to the information on how these various indicators behave in the water column as they are transported and biologically decay, the Cabelli study reported that shellfish bioconcentrate the different fecal indicators at different rates. Fecal bioconcentration factors are given in Table 3-9. The differences in bioconcentration factors are particularly pronounced in the late fall and early spring samplings. The data show that the levels of fecal coliforms in the shellfish and, for that matter, all the indicators in the water column, do not accurately reflect the levels of the other indicators in the shellfish. Of particular concern was the poor correlation between fecal coliform levels in the water or the shellfish to the F. phage levels in the shellfish. This suggests that, at least during the winter, the bioconcentration factor for fecal coliform should not be used for any other class of indicator or pathogen. During the summer, the bioconcentration factors (except for the spores) were similar to each other. The data suggest that bioconcentration factors may also be a function of location, but considerably more data will be necessary to confirm this observation and examine the causative parameter(s) involved.

TABLE 3-9

Bioaccumulation factors for fecal indicators in shellfish of Narragansett Bay

$$\frac{\text{cts/100 gm shellfish}}{\text{cts/100 ml seawater}}$$

	spores	F. phage	enteroc	F. Coliform	E. Coli
Dec 1985					
Prov River	18.2	153.6	162	2.96	2.74
Upper Bay	25.1	100.5	47.7	9.61	12.1
July 1986					
Prov River	216.9	8.4	13.4	1.00	-
Upper Bay	196.3	3.9	7.8	5.81	-
Jan 1987					
Prov River	1.2	13.7	0.67	0.31	-
Upper Bay	3.0	15.6	1.06	0.90	-
July 1987					
Prov River	25.7	13.0	>20.8	0.73	-
Upper Bay	56.7	7.2	>11	3.5	-

The studies conducted on the variety of new fecal indicators provide a wealth of background data both on the basic scientific principles involved and on specific data about Narragansett Bay. The full utility of these observations may find practical application in future years. Future efforts of the Narragansett Bay Project include monitoring of Bay water quality during rainy conditions when non-point sources are important and modelling of pollutant behavior in the Bay. The recommendations concerning Bay water quality can only be partial at this point. Yet already pieces of a comprehensive water quality plan for the Bay can be seen clearly. For other pieces, results from future years of the Bay Project will be necessary.

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CHAPTER 4

NARRAGANSETT BAY METALS: A PROBLEM FOR NARRAGANSETT BAY QUAHOGS?

EXECUTIVE SUMMARY

The safety of shellfish products from Narragansett Bay is a major concern of Rhode Island shell fishermen and of Rhode Island seafood consumers. Rhode Islanders are clam lovers, consuming twenty times more clams per capita than the rest of the nation. Presently, there are no guidelines from the U.S. Food and Drug Administration which could be used by the states to evaluate the safety of shellfish products with regard to metal content. Although some alert levels were proposed in 1971, human health considerations were never included in their derivation and are therefore useless for regulatory purposes. Because FDA is unlikely to adopt any alert levels for metals in shellfish in the near future, the Narragansett Bay Project developed its own alert levels based on human health considerations. Quahogs in open areas of Narragansett Bay have metal contents much lower than the proposed Narragansett Bay Project alert levels. Only quahogs in the recently closed Allens Harbor area consistently violated the proposed alert levels for lead. In addition, individual clams from the closed areas of the Providence River and Mt. Hope Bay occasionally exceed the guidelines for lead and mercury respectively.

Currently, even for clam lovers, shellfish from open areas constitute only a minor fraction of the average adult dietary intake of metals. There are no significant differences between the Narragansett Bay Project information on metals content of quahogs and similar data on file at the Rhode Island Department of Health. Narragansett Bay quahogs also compare well to national averages for metal content, except that Narragansett Bay clams have more nickel than is typical nationally. Although Narragansett Bay clams have higher amounts of nickel, this level is still well below the alert level.

Because current EPA and Rhode Island seawater criteria for metals do not consider protection of quahog meats from potentially unacceptable metal content, the Narragansett Bay Project has developed new seawater guidelines which consider the human consumption of quahogs. These new seawater guidelines for protection of quahog consumers should be used in conjunction with the current metal standards developed to protect aquatic life habitat in future waste load allocations and discharge permits. Comparison of the current water quality status of Narragansett Bay with the new seawater guidelines for quahog consumer protection show frequent violations in the Seekonk River for

lead, cadmium and nickel and occasional violations for nickel and lead in the Providence River. The water quality in the parts of Narragansett Bay which are open and conditionally open for shellfishing is acceptable in terms of protecting quahog consumers from undesirable metal concentrations. It is clear that lead inputs to the Bay must be reduced, however, if the Providence River is ever opened for shellfishing. Mercury is a particular problem for Mt. Hope Bay clams. A localized problem for lead also exists for Allens Harbor clams. This area should remain closed.

The incidences of quahog disease were not a function of pollution gradient, although Greenwich Bay clams were generally in better condition than in the rest of the Bay. The most common abnormality observed in Bay clams was abnormal coloration which was most pronounced in the deeper waters of the Providence River. This could influence marketability of Providence River clams should the area be reopened. The Providence River contains a rich quahog resource with many dense patches and shows evidence of active replenishment by younger clams. The growth rate does appear to be slower than in other sections of the Bay.

There were fewer clams in the Mt. Hope Bay area, and beds in deeper waters had no younger clams. If this area is reopened, repopulation after harvesting is uncertain. Clam beds in shallower regions do not appear to have this problem.

RECOMMENDATIONS

1. Narragansett Bay Project guidelines for maximum acceptable metal contents of quahogs should be used by Rhode Island and Massachusetts on an interim basis to evaluate quahogs for suitability for transplanting and to evaluate the feasibility of opening new areas for shellfishing. Formal adoption of these standards would allow the RI shellfishing industry to use these protections as a marketing tool.

2. New Narragansett Bay Project water quality guidelines for seawater designed to protect quahog meats from unacceptable metal content should be used in conjunction with the aquatic habitat standards for future waste load allocation efforts, considered as a part of any reissuance of RIPDES and NPDES permits and considered in the development of industrial pretreatment standards. The formal adoption of these standards would give the state legal authority to require their full usage.

3. Pressure from the State of Rhode Island, the Commonwealth of Massachusetts, their congressional delegations, and EPA should be utilized to encourage the U.S. Food and Drug Administration to issue guidelines the states can use to

evaluate the safety of seafood and food products with regard to metal contamination. Even if a few concerned individual states derive their own standards, a national standard is appropriate so consumers will not have to be concerned with the exact origin of their seafood. In the absence of national guidelines, states must adopt their own.

4. Lead inputs to Narragansett Bay should be reduced if the Providence River is to be considered as a future shellfishing resource area. Because lead enters Narragansett Bay primarily from urban runoff and atmospheric deposition due to usage of leaded gasolines, the phasing out of leaded gasoline should be continued by EPA.

5. The sources of mercury contamination entering Mt. Hope Bay - Taunton River should be closely monitored to prevent further insults. More monitoring of this area for the mercury content of clams should be done to determine the extent of the contamination before the area is reopened.

6. Allens Harbor should remain closed due to levels of lead in clams far in excess of proposed standards.

7. Revisions of industrial pretreatment standards to protect quahogs from unacceptable nickel content may be necessary for the Blackstone Valley District Commission, if shellfishing is anticipated in the Seekonk River.

8. A detailed health risk assessment of the hazards of environmental exposure to lead (both dietary and air quality) should be completed using local data. The impact of unacceptable maternal blood lead levels on the development of their fetuses should be particularly investigated. An overall package of lead abatement in the Rhode Island and SE Massachusetts environment may be necessary. In the meantime, continued reductions of the usage of leaded gasolines is highly advisable. If regulation of lead ingested orally is warranted (food and beverage), shellfish products alone should not be targeted. The approach should be holistic.

9. Although quahog growth is slower in the Providence River, and there is some dark coloration of clams near Sabin Point, there is a high standing crop, recruitment of juveniles is taking place, and color is acceptable at Gaspee and Bullock Points. The high potential value of this population as a fisheries resource provides justification for attempts to upgrade the water quality of the lower Providence River. Experiments should be conducted on the causes and remedies of the occasional dark coloration.

10. The quahog population in the deeper areas of Mt. Hope Bay has very few juveniles the causes of which are unknown. This

suggests that the quahogs here may not be able to replenish their populations under fishing pressure. The potential productivity of this area should be further evaluated following an experimental harvest to determine the value of this area as a long term resource in Rhode Island waters.

INTRODUCTION

Rhode Islanders love seafood. In fact, they consume ten times more clams than the average American. Clambakes are part of Rhode Island's cultural heritage. But in addition, clam-digging is a popular recreational activity and an important industry in the state. Both the Rhode Island consumer and the Rhode Island shellfishing industry have a large stake in safe seafood. In a recent poll conducted by Harold Ward of Brown University, 58% of the consumers said they were willing to pay twice the cost if they could be assured that the shellfish products were safe. The shellfishing industry, as represented by the RI Shellfishermen's Association, became particularly supportive of high profile enforcement activities when an outbreak of stomach disorders in NY were blamed, erroneously, on RI shellfish products (Providence Journal, 1985). The market for RI shellfish dropped markedly for 6 months following this widely reported incident. It was obvious to the industry that even the perception of an unsafe RI shellfish product could hurt them financially. For this reason they are supportive of enforcement activities relating to prevention of suspect shellfish from entering the market; they are supportive of efforts to reduce pollution in shellfish growing areas; and they are supportive of scientific research designed to help resolve these issues.

The Narragansett Bay Project has funded several projects relating to the safety of seafood products:

(1) Metal contaminants in quahogs
(2) Preliminary health risk screening for selected contaminants
(3) Organic contaminants in quahogs (4) Bacteria and viral contaminants in quahogs
(5) Contaminants in winter flounder.

The first two projects are now completed and the remaining three are in progress.

Because the Rhode Island and Southeastern Massachusetts area is an international center for electroplating, metal finishing, metal working, machinery manufacturing, and jewelry industries, contamination of fresh waters and estuarine waters by metals has been a particular concern to local and state governments. Municipalities and state sewer authorities are beginning to enforce limits on metal discharges which enter sewer systems, and state governments are beginning to include metal limits in their discharge permits. The federal guidelines for metal limits have been adopted by most municipalities, at least on an interim basis.

Do these metal inputs to the Bay threaten the production of safe seafood? There are a number of management issues which require technical input before this potential use conflict can be resolved:

(1) Is metal contamination of shellfish from open areas a concern for the health of the human consumer of the product?
(2) Is metal contamination of shellfish an issue which should be examined when considering the opening of new areas for shellfishing?
(3) How clean for metals do the waters of the Bay need to be to protect seafood consumers?
(4) Are there any rules and regulations which should be changed to protect consumers from unsafe levels of metals in seafoods?
(5) Are the waters clean enough now or are additional controls necessary to protect present and potential shellfish resources?

METAL CONTAMINATION IN SHELLFISH - A HUMAN HEALTH CONCERN?

Lack of guidance

Initially assessment of human health risk from eating Narragansett Bay clams was thought to be a simple, straightforward process. It would be simple to monitor quahogs from a few open areas to see if the levels were acceptable, and then monitor quahogs from a few closed areas to see how much abatement might be required to bring the levels into an acceptable range if opening of these areas were contemplated. However, the Bay Project discovered that the U.S. Food and Drug Administration (FDA) had not adopted any alert levels that would allow scientists to compare their results with an established criteria. What other approaches were possible in the absence of national criteria? Bay Project scientists and committee members, with the aid of their Congressional delegation, evaluated three options.

The first option was to evaluate the alert levels proposed in 1971 by FDA personnel in a National Shellfish Sanitation Workshop. Although these alert levels were never officially adopted, could they be used, at least on an interim basis, as a human health guidepost. But why did the workshop refuse to adopt these proposed alert levels for metal concentrations? The complete record of these deliberations revealed that there was very vocal and intense criticism of these levels, first in the Chemistry Task Force which reviewed them. Then as a result of the criticism, they were again rejected in the entire general session of the National Shellfish Sanitation Workshop. The primary reason these metal alert levels were rejected was that the levels had no relationship to human health. The levels were only the result of analysis of the national average of metal content of shellfish collected in 1965-1971, with an extra allowance of account for the range of the data (one standard deviation). Thus the levels would simply reflect concentrations where 80-85% of the nation's shellfish should fall beneath the proposed alert level (implying that these were safe) and 15-20% would be above this level (implying that these were unsafe). FDA noted that the levels would be useful only in the sense that it would inform regulators when shellfish in any area fell outside the normal national range. A state regulator participating in the Task Force summarized the thoughts of many of the members, "I object to the proposal as stated as long as it contains any numbers that do not relate to health figures. I think if we are going to put numbers with various metals, then there should be some toxicity ratings behind them."

Some members were so upset by the proposed levels that they suggested the levels not even be published as a part of the official record of the conference. They thought that publishing them would give them more credibility than they deserved. This observation turned out to be prophetic. One scientist suggested a compromise: "What I suggest that we do is publish these numbers as the averages for the Northeast, Southern, and Pacific that we have at this time. Do not use them as indicator levels or suggest they are action levels--but publish them as averages for these areas."

The alert levels were therefore, rejected unanimously by the Chemistry Task Force. The issue was again raised at the general session of the conference. Again the alert levels for metals were unanimously rejected.

It is interesting to note that until recently Rhode Island DEM used these published but highly criticized "alert" levels as a guide to judge the suitability of RI clams for transplanting purposes. RI Department of Health officials still use them for possible closure of shellfishing areas, although closure has not ever been suggested by monitoring data. FDA officials also cited these alert levels in a reply to recent inquiries by the State of New York (Long Island Sound Study, 1987). The simple publishing of these values in a FDA publication has, in fact, given them credibility they did not deserve even when they were first published in 1971.

After a thorough investigation of the checkered history of the 1971 FDA proposed alert levels for metals, the Narragansett Bay

Project Science and Technical Committee rejected their use for any shellfish regulatory purposes. The relationship of these values to human health, or even organism health, was not considered in the assumptions behind their derivation. The Science and Technical Committee determined that these so-called "alert" levels were fatally flawed, even when published in 1971, and were even more appropriate for use today.

Having rejected the utility of the 1971 proposed "alert" levels, the Science and Technical Committee of the Narragansett Bay Project investigated the status of FDAs progress toward more credible alert levels for metal content in shellfish. An inquiry revealed that FDA has assigned this issue a very low priority, and official Congressional inquiry was not able to influence this priority (Schneider, 1987; Cannon, 1987). In the meantime, EPA has established a human health risk assessment protocol based on procedures that they use for Superfund purposes and for development of recommended ambient water quality criteria. However, there are significant differences between FDA's and EPA's methodologies and assumptions that lead to different conclusions. These differences are explained in the EPA Risk Assessment Guidance (1988). Only recently have EPA and FDA come to an agreement regarding the jurisdiction and responsibilities of each agency in providing risk assessment guidance (EPA-FDA Joint Agreement, 1987).

The Science and Technical Committee had to conclude that it is unlikely that FDA will propose any new alert levels for metals in shellfish in the near future, unless outside pressure is brought to bear. Therefore, the Narragansett Bay Project decided to establish metal guidelines of its own to use in Narragansett Bay until guidance at a federal level is available. The establishment of locally appropriate guidelines for particular waterbodies is now recommended by FDA and EPA policy (EPA-FDA Joint Agreement, 1987). Such guidelines have been developed. The remainder of this chapter describes the methods and assumptions used to develop the Narragansett Bay quahog guidelines for metals and then evaluated the practical implication of their adoption by the state.

Narragansett Bay Project proposed metal alert levels for quahogs

The Bay Project has proposed an interim alert level for metals in quahogs. Two approaches were evaluated:

(1) An alert level can be derived using the assumption that clam consumers should not be exposed to metals in clams in any greater amount than is allowed from exposure to metals allowed in drinking water. One advantage here is that the state can use the national drinking water standards and take advantage of the toxicological research and risk assessments performed at a national level without having in-house

expertise. Another advantage is that quahog regulation would not become any stricter than those for water and this industry would not be singled out for regulations any stiffer than already in practice for drinking water. However, there are disadvantages too. The primary disadvantage is that drinking water standards incorporate protection of infants and toddlers. Some metals are known to produce developmental effects at early ages, but are not important later. Use of standards which incorporate protection for infants could therefore produce stricter standards for clams than is really needed by the clam consuming public. Since clams are not a normal part of an infant's diet, such strict limits based on infant protection would be inappropriate.

(2) A detailed risk assessment analysis as developed by the Puget Sound Estuary Project and modified by Halina Brown at Clark University for the Narragansett Bay Project could also be used to generate alert levels. This is a more sophisticated approach because it can incorporate local data on consumption rates and is more appropriate for the population affected.

Both approaches yielded similar results. The drinking water approach yielded stricter alert levels for Cd, Cr, Cu, Hg, Pb, Zn, Ba, and Se. The risk assessment approach yielded stricter alert levels for Ni and As. Because the risk assessment approach was more appropriate to the clam consuming public, this method was used to develop alert levels recommended in this report.

A. Consumption rate of clams by RI consumers

There are two reports concerning the consumption rate of clams. According to Hu in a 1985 report, the national consumption rate of clams at home is 0.381 lbs/cap/yr (pounds per capita per year), and clam consumption away from home is 0.315 lbs/cap/yr, for a total of 0.696 lbs/cap/yr. But Hu also reported that the consumption rate in New England is considerably higher at 0.991 lbs/cap/yr at home and 1.042 lbs/cap/yr away from home for a total of 2.033 lbs/cap/yr, based on surveys in 1979 and 1981.

Rhode Islanders, however, consume many more clams per person than the national rate. A telephone survey conducted by Harold Ward and his students at Brown University for the Bay Project found that 79% of the Rhode Island public who eat clams, consume them at a rate of 2 or 3 meals per month. Another 8% eat clams about once per week. Assuming that a meal of clams is a generous 0.5 lbs/ meal, the average annual consumption rate of Rhode Island clam consumers is 15 lbs/cap/yr. Only 4% of the Rhode Island clam lovers ate more than 26 lbs/cap/ yr. This should be considered a maximum, since clam chowder is a popular dish in Rhode Island, but the clam content is considerably less that 0.5 lbs. A summary of the various clam consumption rates is given in Table 4-1.

TABLE 4-1

Annual consumption rates of clams (lbs/cap/yr) wet weight basis

Region	clams at home	clams away	total consumption
National*	0.381	0.385	0.696
New England*	0.991	1.042	2.033
Rhode Island clam eaters@			
79%			15
8%			26

***Hu, 1985**
@Ward, 1987, does not include people who do not eat clams at all. Average daily consumption rate is 18 gm/day; high consumption rate is 32 gm/day.

B. Proposed metal alert levels for quahogs based on a preliminary health risk assessment.

The basic health risk data for the development of quahog metal alert levels were recently compiled by Halina Brown, Robert Goble, and Lynne Tetelbaum of Clark University with joint funding from the DEM-EPA Toxics Integration Project (using fines levied against the City of Providence for permit violations in the late 1970s) and from the Narragansett Bay Project. Dr. Brown and her colleagues have started a three phase assessment of chemicals potentially hazardous in Narragansett Bay quahogs. In the first phase, Dr. Brown developed a screening method using a five part check list to identify those chemicals which warrant further investigation. Each chemical was screened for 4 potential health effects (carcinogenicity, mutagenicity, developmental/ reproductive toxicity, and systemic toxicity) and rates of exposure. The metals which, upon this screening procedure, had one or more areas of concern were then evaluated further. The results of this initial screening for the metals is given in Table 5-2, where an asterisk indicates a potential area of concern.

TABLE 4-2

Results of Preliminary Health Screening for metals

From Brown, et al, 1987

Element	Systemic Toxicity	Cargino-genicity	Muta-genicity	Repro-Devel. Toxicity	Exposure Level
As	*	*	*	*	ND
Ba				ND	ND
Cd	*		ND	*	
Cr	*		ND	ND	
Cu				ND	*
Pb	*			*	
Hg	*		ND	*	
Ni			ND	*	*
Se			ND		ND
Zn			ND	ND	*

* = potential areas of concern (codes a and b in Brown, et al., 1987)

ND = no data available on this topic

Based primarily on EPA Health Assessment data, Dr. Brown then derived "acceptable daily doses" for metals in clams. Her acceptable daily dose calculations were based on several very conservative assumptions, as is typical in assessments of this nature. Dr. Brown's acceptable daily dose data for metals (given in Table 4-3) were then converted to alert levels. Two different rates of clam consumption were used in the calculations. The average consumer (79%) eats 18.6 grams of clams daily, according to Harold Ward's telephone survey. Another 8% in Dr. Ward's survey ate clams averaging 32 grams daily, but only 4% ate more clams than this. Considering also the non-clam consuming public (55% of those Rhode Islanders surveyed), the use of an average consumption rate of 18.6 grams of clams per day would protect 90% of the adult Rhode Island population, and the use of a higher consumption rate of 32 grams of clams per day for the real clam lovers would protect 98% of the adult population.

TABLETABLE 4-3

Proposed alert levels for quahogs

Elements analyzed by Bay Project	Acceptable Daily Dose (ug/kg-day)*	Acceptable Dose to 70 kg person (ug/day)	Alert level (ug/gm, wet) Average Consumption Rate@ (18 gm/day)	High Consumption Rate@ (32 gm/day)
Cd	0.5	35	1.88	1.09
Cr	5.0	350	18.8	10.9
Cu	40.	2800	150.5	87.5
Hg	0.1	7	0.37	0.21
Ni	10	700	37.6	21.8
Pb	0.6	42	2.26	1.31
Zn	200	14000	752.6	438.
Others				
As	0.2	14	0.75	0.43
Ba	50	3500	188	109
Se	3.0	210	11.3	6.6

*** from Brown, et al., 1987**
@ from Ward, et al., 1987

C. Comparison of Narragansett Bay quahogs with the proposed alert levels.

The Narragansett Bay Project funded Thibault and Associates to analyze quahogs from four test areas for the purpose of evaluating Narragansett Bay quahogs relative to these proposed alert levels. A summary of the analytical results is given in Table 4-4.

Table 4-4

Metals in quahogs collected from different areas of Narragansett Bay (Means ± standard deviation) ug/dry weight

	Cd	Cu	Cr	Pb	Ni	Zn	Hg
Closed areas							
Providence River I fall	0.90 ± 0.20	46.3 ± 20.4	5.8 ± 2.6	4.8 ± 2.4	20.9 ± 9.5	237 ± 78	0.29 ± 0.15
Providence River I spring	1.06 ± 0.18	49.6 ± 18.8	4.9 ± 1.7	5.1 ± 1.9	25.3 ± 5.5	249 ± 36	0.36 ± 0.15
Mt. Hope Bay 55 fall	0.70 ± 0.24	16.5 ± 3.8	4.9 ± 2.4	3.0 ± 1.3	15.9 ± 6.4	158 ± 58	0.39 ± 0.26
Mt. Hope Bay 51 spring	0.75 ± 0.24	26.9 ± 6.5	5.4 ± 3.0	4.2 ± 2.4	26.0 ± 7.5	201 ± 69	0.50 ± 0.10
Conditional Areas							
Ohio Ledge I fall	0.69 ± 0.19	16.1 ± 4.0	3.9 ± 2.6	2.1 ± 0.8	15.7 ± 6.7	156 ± 46	0.14 ± 0.09
Ohio Ledge I	0.84 ± 0.33	25.9 ± 3.9	2.6 ± 1.1	5.5 ± 2.0	18.8 ± 5.9	197 ± 39	0.22 ± 0.19
Open area Greenwich Bay I fall	0.60 ± 0.15	17.2 ± 4.2	1.5 ± 1.0	0.84±0.22	12.5 ± 6.2	138 ± 18	0.072±0.063
Greenwich Bay I spring	0.54 ± 0.12	17.2 ± 3.0	<0.9	1.2 ± 0.4	11.2 ± 1.7	155 ± 48	0.086±0.011

From Thibault, 1987

In addition to the two surveys conducted by the Bay Project, quahogs from all over the Bay have been regularly monitored by the RI Department of Health (RIDOH) from 1981 to present, especially in the conditional and open areas. The variations, temporally, spatially, and seasonally have be thoroughly investigated by Sheldon Pratt of URI, another investigator of the Bay Project in his study of the historical trends in the quahog fishery. This RIDOH data compare well with the NBP data when the station locations are similar (see Table 4-5). Special studies in the Allens Harbor area also can be used to evaluate quahogs from this areas.

Table 4-5

Comparison of Narragansett Bay Project clam analyses (fall with RI Department of Health data (ppm wet weight)

Closed areas	Cd	Cr	Cu	Pb	Zn
Gaspee (1-RIDOH)	0.15 ± 0.08	0.60 ± 0.19	4.1 ± 0.9	0.84 ± 0.24	25.9 ± 4.7
Prov. Riv (PR1-NBP)	0.18 ± 0.04	1.16 ± 0.52	9.3 ± 4.1	0.96 ± 0.48	47.4 ± 15.6
Mt. Hope (8-RIDOH)	0.17 ± 0.12	0.78 ± 0 61	2.1 ± 0.9	0.69 ± 0.33	21.7 ± 8.4
Mt. Hope (MH55-NBP)	0.14 ± 0.05	0.98 ± 0.48	3.3 ± 0.8	0.60 ± 0.26	31.6 ± 11.6
Conditional areas					
Ohio Ledge (7-RIDOH)	0.19 ± 0.02	0.82 ± 0.76	2.2 ± 0.8	0.73 ± 0.11	20.8 ± 3.9
Ohio Ledge (OL1-NBP)	0.14 ± 0.04	0.78 ± 0.52	3.2 ± 0.8	0.42 ± 0.16	31.2 ± 9.2
Open Areas					
Colt Past. Pt (9-DOH)	0.11 ± 0.10	0.24 ± 0.13	2.5 ± 0.4	0.69 ± 0.20	21.6 ± 5.8
Greenwich (GB1-NBP)	0.12 ± 0.03	0.30 ± 0.20	3.4 ± 0.8	0.17 ± 0.04	27.6 ± 3.6

TABLE 4-6

Violation of the proposed alert levels for metals in Narragansett Bay quahogs (high consumption alert level)

Area	Total	Cd	Cu	Cr	Pb	Ni	Zn	Hg
Closed areas								
Providence R.*	99	0	0	0	11.1%	0	0	0
Providence R.@	69	0	0	0	4.3%	-	0	-
Mt. Hope Bay*	42	0	0	0	4.8%	0	0	4.7%
Mt. Hope Bay@	56	0	0	0	4.3%	-	0	-
Mt. Hope Bay#	5	-	-	-	-	-	-	20.%
Allens Harbor&	4	0	0	0	75.0%	0	0	0
Allens Harbor@	11	0	0	0	18.%	-	0	-
Allens Harbor%	8	0	0	0	25.%	0	0	0
Conditional areas								
Ohio Ledge*	23	0	0	0	17.4%	0	0	0
Upper Bay@	102	0	0	0	6.8%	-	0	-
Open Areas								
West Passage*	53	0	0	0	7.5%	0	0	0
West Passage*	64	0	0	0	0	-	0	-
Greenwich Bay@	15	0	0	0	0	-	0	-
East Passage@	38	0	0	0	5.2%	-	0	-
Sakonnet R.@	20	0	0	0	15.%	-	0	-

* Analytical results from Thibault, 1987
@ Analytical results from the Rhode Island Department of Health as synthesized
from Pratt, 1987

Analytical results from Massachusetts DEQE (Pratt, personal communication,
1988)

& Analytical results from Department of Defense (unpublished)

% Analytical results from TRC (1985)

TABLE 4-7

Ratio of metals in clams from Narragansett Bay to proposed alert level (high consumption rate)

A ratio of greater than 1.0 would indicate area-wide violations

Area	**Cd**	**Cu**	**Cr**	**Pb**	**Ni**	**Zn**	**Hg**
Closed areas							
Providence Riv.*	0.18	0.11	0.098	0.75	0.21	0.11	0.30
Providence Riv.#	0.14	0.046	0.055	0.64	-	0.054	-
Mt. Hope Bay*	0.13	0.05	0.095	0.54	0.19	0.082	0.42
Mt. Hope Bay#	0.16	0.024	0.071	0.53	-	0.049	-
Mt. Hope Bay@	-	-	-	-	-	-	0.58
Conditional area							
Ohio Ledge*	0.14	0.048	0.060	0.32	0.16	0.081	0.17
Ohio Ledge#	0.13	0.036	0.076	0.56	-	0.047	-
Open area							
Greenwich Bay*	0.11	0.039	0.022	0.16	0.11	0.066	0.075
Recently closed							
Allens Harbor&	0.43	0.034	0.028	1.50	0.039	0.028	-
Allens Harbor%	0.39	0.14	0.086	0.71	0.16	0.056	-

*** Narragansett Bay Project, Thibault**
 # RI Department of Health
@ Massachusetts DEQE
& Department of Defense
% TRC (1985)

Providence River quahogs, Mt. Hope Bay quahogs, and Allens Harbor quahogs were collected in areas permanently closed to shellfishing, and are, thus, not available in the marketplace (see Figure 4-1). The clams should represent the worst conditions Narragansett Bay has to offer. Ohio Ledge clams are from the upper region of Narragansett Bay which is a conditional area, normally open to shellfishing but closed following rainfall events. The rest of the Bay is open for shellfishing.

Shellfish Water Quality Closure Areas

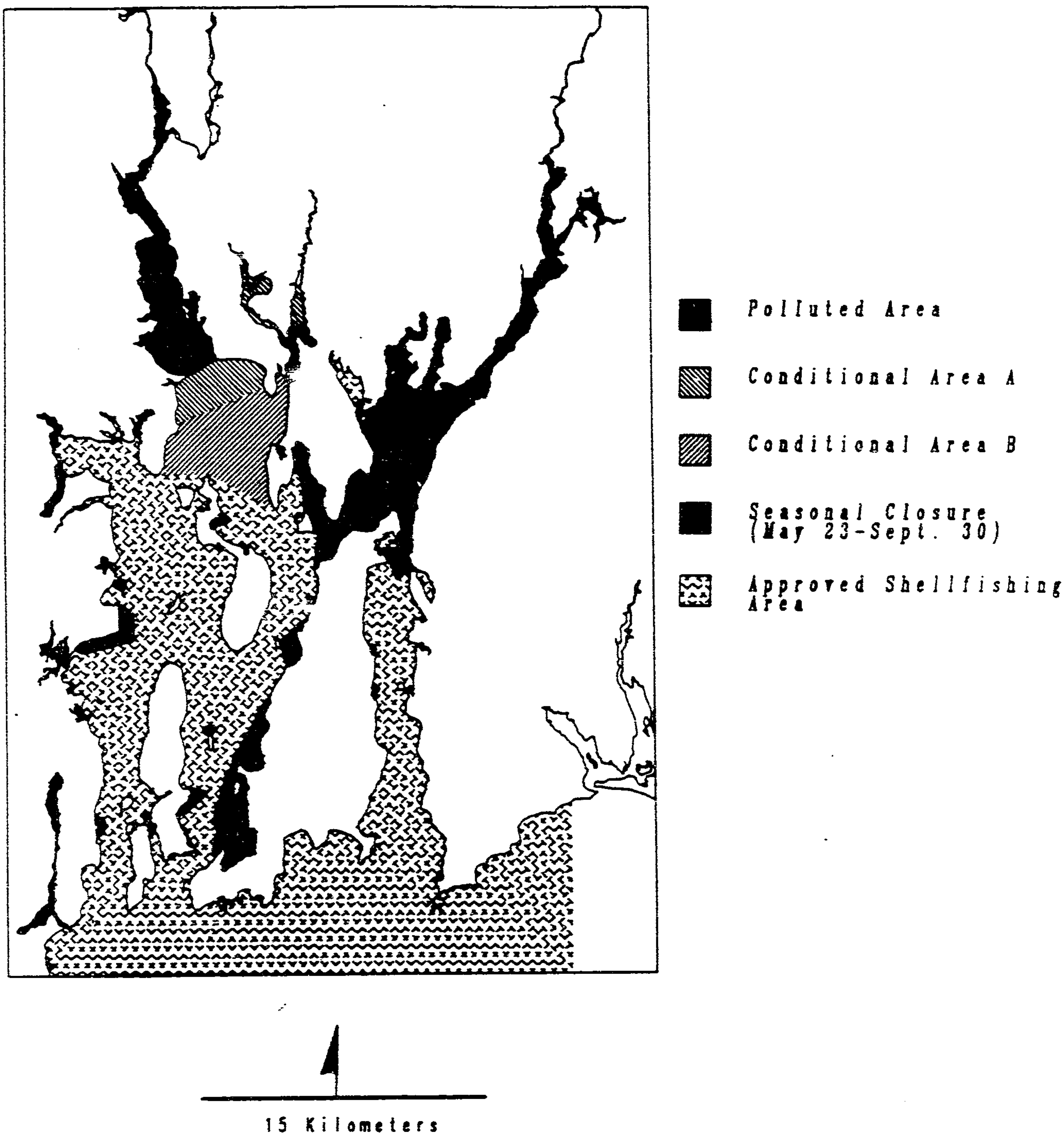

Figure 4-1. Narragansett Bay Project
Rhode Island Department of
Environmental Management

As can be seen in Table 4-6, the worst record of violations occur for lead in Allens Harbor, where 75% of the samples collected in a recent Department of Defense survey, 18% of the RIDOH samples, and 25% of samples in a Navy survey violated the proposed alert level for lead. Violations by a factor of 2 or 3 were common. Even the average concentration was 50% higher than the alert level. This area should therefore remain closed until the source of the lead, presumably an abandoned landfill, can be mitigated. Even if active leaching is found and stopped, contamination in the sediment may prevent reopening of the area for shellfishing for several years. It has been theorized that some of the violations in this area may have come from incorporation of contaminated sediment inside the shells of the clams. If this is the case, depuration of the contaminated sediment from clams harvested in the area may be an alternative worth exploration.

In other closed areas, the Providence River had occasional violations for lead and the average concentration in this area was 75% of the standard. While a normal diet of Providence River clams should pose no hazard for the consumer, it would not be a good idea to eat a steady diet of clams more than once a week from this area.

There were a few violations of the mercury alert level in Mt. Hope Bay. The average concentration ranged from 42% to 58% of the alert level. Again this could pose a greater health risk for consumers who eat more than one clam meal each week over extended periods. It is suspected that the source of the mercury is historical. An industry on the Taunton River used mercury as a catalyst in their processes and discharged their wastes directly into the river until 1974. The sediments, particularly in the Taunton River, were heavily contaminated with mercury. Because of this background, it would be prudent to be extra vigilant that current mercury discharges do not increase, particularly if this area is reopened.

Occasional violations of the proposed lead alert level occur throughout the Bay even in open areas. But since the average levels of lead are lower than the alert level, the exposure of the consumer to an occasional individual clam which exceeds the limit should not pose a hazard. Nonetheless, the presence of even these occasional violation indicates that two actions are warranted: (1) reduction of lead entering Narragansett Bay should be a priority to prevent the situation from getting any worse; (2) a detailed health risk assessment for lead is indicated.

In conclusion, legally harvested quahogs pose little risk to the clam consuming public. Allens Harbor should remain closed to shellfishing due to unacceptable lead concentrations. Clams from other closed areas in the Providence River and Mt. Hope Bay are safe in terms of metals at normal consumption amounts. However, careful monitoring of these areas will be necessary, if these areas are reopened. Lead is of particular concern in the Providence River and mercury in Mt. Hope Bay.

D. Intermediate Health Risk Assessment for lead and cadmium

Because by a certain fraction of quahogs in the Bay exceeded the proposed guidelines for lead and cadmium, an intermediate risk assessment was performed by Dr. Brown and her colleagues. Of particular concern in these assessments was protection of unborn fetuses from developmental toxicity. The maximum cadmium concentration in seafood for pregnant women would be 2.5 ug/gm wet weight. No clams in the Bay were in excess of this amount. The maximum lead concentrations in seafood for pregnant women is thought to be 0.4 ug/gm wet weight. This value is exceeded by the average clams in closed areas, but not frequently in open areas. However, the assumptions on which these calculations were made are based on older data before the reductions in the usage of leaded gasolines and "background" blood levels may have been higher then than today. Dr. Brown's recommendation that further investigations will be necessary to further refine the assumptions. Considering the variety of ways lead can enter the body, an overall environmental assessment is warranted. If this is funded by the Narragansett Bay Project, local data necessary to do a thorough job should be collected in the near future. This will be necessary to decide whether a warning to pregnant women is advisable.

SHOULD THE STATE ADOPT THESE STANDARDS FOR REGULATORY PURPOSES?

Before the Narragansett Bay Project can recommend the adoption of these standards by the state of Rhode Island, other risk management principles need to be addressed: (1) How does consumption of RI shellfish affect the overall dietary intake of these metals and would regulation of this industry without consideration of other food adequately protect consumers? (2) How should the standards be used? for consumer education only? for opening and closing shellfish beds? for determining the suitability of clams for transplanting? for water quality classification? for discharge permit modifications? (3) What would be the impact on the RI shellfishing industry if RI imposed standards but other states did not? Each of these aspects are discussed.

A. How does consumption of RI shellfish affect the overall dietary intake of metals and would regulation of this industry without consideration of other foods protect consumers?

A market basket survey of items in the normal American diet was conducted by Gartrell of the Food and Drug Administration in 1979, and published in 1985. These data on metal intakes from other foods can be used to compare with the metal intakes from Narragansett Bay quahogs (Table 4-8).

The average dietary intake of lead is 81.8 ug/day; the average consumption of 2-3 quahog meals a month would contribute another 3.7 ug/day for an increase of 4%. Consumption of clams would increase cadmium intakes by 6%, mercury intakes by 5% and zinc intakes by 3%. This suggests that quahog consumption of these shellfish from open areas of the Bay do not add significantly to the normal intake for metals. However, there are more reasons for concern if quahogs from the Providence River would become a part of the diet. In this case, quahog consumption could increase the lead intake by a more serious 22% and the mercury by 23%. This assessment would tend to support the previous conclusions that, if the Providence River is to be considered for opening in the future, lead and mercury inputs to the waters of the Providence River must be reduced.

It is clear from inspection of the data in Table 8, that clams from open areas would not significantly impact the total intake of these metals. Yet when the standard is approached for lead, an excessive diet of these clams could become significant, even in the light of other items in the diet. Regulation of shellfish in addition to drinking water could provide a significant measure of protection for RI consumers. However, the data also suggest that FDA should examine more fully the overall dietary intake of food contaminants. In the interim, EPA protection of drinking water and state protection of shellfish resources is a first step.

B. How should the standards be used?

There are a variety of ways the alert levels could be used. One option is to use the standards simply to inform the clam-consuming public. Fifty-five to sixty percent of the RI population surveyed in Harold Ward's telephone poll said this option should be the only action required by the state. For example, recreational clam diggers who regularly dig in closed areas could be warned that the practice isn't safe for their families (for more reasons than just metal contamination). However, the effectiveness of this educational option was recently questioned by Ted Cable, a scientist who surveyed sportsfishermen in Michigan along streams where warning signs had be posted, and dangerous areas published. He found that 72% knew of the dangers but 53% of them planned to eat their fish anyway (Cable, et al., 1987).

Regulations can be used to restrict fishing areas and thereby prevent contaminated product from reaching the unwary consumer. About 34 - 37% of the fish and shellfish consumers in Harold Ward's poll said that the state should strictly regulate the sales of "unsafe" seafood. This option would necessitate that opening and closing shellfish beds be contingent both on the bacterial standards presently used for this purpose, but also any standards for chemical contamination. The practical effect of this option would be to preserve the status quo with regard to RI shellfishing areas. It would require, however, that more monitoring of more pollutants would be required before closed beds are reopened. Unless lead inputs are reduced, the Providence River would probably have to remain closed and Allens Harbor would definitely have to remain closed. And unless mercury inputs to Mt. Hope Bay can be closely monitored and regulated, Mt. Hope Bay might have to remain closed. Such a course of action would tend to preserve the status quo for the fishing industry but boost consumer confidence in this product.

The state currently compares clam concentrations for metals with the old proposed FDA limits to determine if the clams are suitable for transplanting to clean areas. The new proposed alert levels could be substituted for this purpose. Yet, because the new proposed standard for lead is violated in certain sections of the Providence River more frequently than others, the safer areas would have to pinpointed with close attention to detail and location, and possible influences of size and season will need to be investigated. Since not all of these metals are of health concern at the observed concentrations (such as Cu, Cr, and Zn), the samples need not be analyzed for all components on a routine basis.

Another way the state could use the proposed standards is to use them to develop special water quality guidelines designed to protect quahog consumers from quahogs with unsafe metal concentrations. These water quality guidelines could even be used in conjunction with the coliform, oxygen, EPA salt water criteria to develop new water quality classifications for Narragansett Bay. Adoption of a guideline to protect quahog consumers would legitimize any discharge permit modifications which may be necessary to protect quahogging areas close to a discharge. The new guidelines could also be used as a water quality goal of waste load allocation efforts if more than one discharger is involved (e.g. the Providence River -upper Narragansett Bay or the Mt. Hope Bay -Taunton River areas). Development of such use-specific water quality guidelines is consistent with EPA guidance and could be used legally in every way that other water quality criteria are used. These guidelines could be derived with data currently available from the Narragansett Bay Project. The derivation of a new seawater guideline specifically designed to protect quahog consumers is discussed in another section.

Table 4-8

Average daily intake (ug/day) of selected elements by food group
Gartrell, 1985

	ug/day		mg/day	
Food Group	Pb	Cd	Hg	Zn
Dairy	4.48	0.638	0.0744	3.65
Meat	6.96	1.21	3.84	8.11
Grain	19.6	10.1	0.209	3.63
Potatoes	4.87	6.73	0.0555	0.44
Leaf Vegetable	1.61	1.85	0.0113	0.12
Legumes	9.56	0.308	0.0111	0.55
roots	1.21	0.843	0.0031	0.08
Garden fruit	7.72	1.11	0.0308	0.17
Fruits	11.1	0.535	0.0235	0.15
oils	1.17	0.963	0.0071	0.33
sugar	3.20	1.87	0.0672	0.23
beverages	10.3	5.35	0.881	0.24
TOTAL	81.8	31.5	5.21	17.7
quahogs (open)	3.7	2.1	0.29	0.54
quahogs	18.5	3.7	1.2	0.91
FAO limit	429	52-72	43	15
drinking water limit	40	20	4.	10

C. What would be the impact on the RI shellfishing industry if RI imposed standards but other states did not?

First, are RI clams different than clams from other regions of the country? A comparison of metals in Narragansett Bay clams and national statistics for metals in clams is given in Table 4-9.

Table 4-9

Comparison of Narragansett Bay clams with national averages for clams

ppm wet weight

National averages	Cd	Cr	Cu	Pb	Hg	Zn	Ni
Lamb	0.07	0.97	3.75	0.39	0.07	38.03	-
Seagran	0.22	0.33	1.96	0.64	0.02	14.42	0.82
Chem Task	0.21	0.35	5.6	1.95	0.08	40.0	-
Cummingham	0.20	0.30	1.86	0.24	-	18.3	0.45
Narragansett Bay open areas	0.12	0.30	3.4	0.17	0.014	27.6	2.5
Providence River closed area	0.18	1.16	9.9	0.96	0.058	47.4	4.2

In open areas, metal results in clams from Narragansett Bay fall close to or less than the national averages for all the metals in clams except for nickel which is much higher in Narragansett Bay clams than clams from the rest of the US or Canada. Nickel is heavily used by industries of the Narragansett Bay region, so higher averages for nickel in clams of our area would be expected. However, these higher concentrations are still beneath the proposed criteria. (Perhaps nickel concentrations could be used to tell if clams originate from Narragansett Bay the next time an accusatory finger is pointed toward Rhode Island clams.)

Of all the metals in clams of Narragansett Bay, the lead concentrations pose the greatest concern. Average open area concentrations in Narragansett Bay, as discussed earlier, are well beneath the proposed standard. However, the national statistics indicate that Narragansett Bay clams, especially in open areas, are cleaner than the national average. We would have to conclude that imposing these standards in RI would have little current impact because RI clams are cleaner for lead than clams from other parts of the country. If, however, these standards were imposed nationally, the shellfishing industries in some other parts of the nation could be economically impacted.

Imposition of standards here in RI would not have much negative impact on the shellfishing industry, other than maintaining the status quo with the regard to closed areas in the Providence River, Mt. Hope Bay, and Allens Harbor. However, there could be some positive impacts from imposing the standards: (1) Rhode Island would be regarded as a progressive state in terms of consumer protection. (2) The RI shellfishing industry could use these regulations as another marketing tool, assuring consumers that RI clams pass tough standards for metals. Please note that Harold Ward's telephone survey indicated that 58% of the consumers in RI would pay twice as much for the product if they could be insured that product were safe. Skillful marketing of RI clam products could take advantage of this consumer concern. "RI clams fresh and clean from Narragansett Bay" could be a phrase that could propel clam lovers to purchase Rhode Island clams.

The imposition of standards unilaterally by Rhode Island would certainly not change the status quo and could have positive marketing implications. However, a long term goal should still be the derivation of national standards to protect clam lovers everywhere in the US (even those who buy clams from other states). Lobbying efforts to convince FDA of this wisdom should continue even if Rhode Island acts unilaterally in the beginning.

D. How clean should the waters of Narragansett Bay be to protect clam consumers from unsafe metal content? Are EPA salt water criteria restrictive enough to protect the quahog consumers?

Having calculated proposed alert levels for metals in quahog flesh, it is possible to estimate the maximum concentrations in the waters of Narragansett Bay which would keep the quahog metal content at levels safe for human consumption. The relationship between water quality as determined by Carlton Hunt and his colleagues at URI and the metal concentrations in quahogs as determined by Thibault is given in Table 4-10.

The ratio of contaminant concentrations in clams to the contaminants in the bottom water is called a bioconcentration factor. Bioconcentration factors can vary widely between contaminant to contaminant, from species to species, and from body part to body part. They may also vary with season, age of the organism, temperature, contaminant concentration, speciation of the contaminant and nature of the sediment. Therefore, these bioconcentration factors reported here are appropriate only for Narragansett Bay and any water quality standard derived from them would also be appropriate only for Narragansett Bay. These water quality guidelines may not be appropriate at all for other organisms or for other areas of the US.

TABLE 4-10

Bioconcentration factors for metals in quahogs*

	Cd	Cu	Cr	Ni	Pb	Hg
	November, 1985					
Station@						
3	0.33	2.6	-	1.4	0.91	-
4	3.2	-	-	1.9	-	-
5	2.1	1.9	-	0.8	1.4	-
6	1.6	1.8	-	1.3	0.54	-
7	2.6	3.1	-	2.6	0.75	-
17	3.3	2.7	-	1.1	0.86	-
18	3.2	3.0	-	1.5	0.44	-
Ave.	2.7	2.5	-	1.5	0.98	-
	April, 1986					
3	3.8	5.2	1.19	3.0	2.8	-
4	3.6	2.6	0.60	3.5	1.1	7.3
5	3.1	3.9	1.01	2.1	7.2	20.0
6	1.5	1.8	0.33	0.8	0.8	-
7	6.2	5.3	-	7.2	-	25.0
17	3.4	2.6	0.78	4.9	1.9	39.4
18	3.6	6.0	3.3	4.9	4.9	-
Ave.	3.6	3.9	1.2	3.8	3.1	22.9

$$\text{* Defined as} \quad \frac{\text{Quahog meat metal concentration (ug/gm, wet weight)}}{\text{Bottom Seawater metal concentration (ug/l)}}$$

@ Water quality sampling stations of Narragansett Bay Project SINBADD series.

Water quality guidelines for bottom waters in shellfish growing areas of Narragansett Bay were calculated on this basis. Bottom water with metal concentrations less than these water quality limits would result in quahog meats which are safe by the proposed quahog metal criteria. These limits are reported in Table 11. Because the bioconcentration factors seem to vary with seasons for quahogs, it was necessary to use the highest seasonal bioconcentration factors to yield guidelines which would be protective all year.

TABLE 4-11

Proposed water quality guidelines for shellfish growing waters (ug/l)*

Element	Guidelines
Cd	0.30
Cu	22.4
Cr	9.1
Ni	5.7
Pb	0.43
Hg	0.0092

$$\text{* Seawater guideline} = \frac{\text{quahog criteria}}{\text{bioconcentration factor}}$$

A comparison of various sea water quality standards with the proposed seawater guideline for quahog consumer protection (SW guideline QCP) is given in Table 4-12.

TABLE 4-12

Comparison of various seawater standards with proposed water quality standard for quahog growing waters

Type of standard	Cd	Cu	Cr	Ni	Pb	Hg
Proposed quahog growing water guideline	0.30	22.4	9.1	5.7	0.43	0.0092
Chronic seawater standard (EPA-1986)	9.3	2.9*	50	8.5	5.6	0.025
Recommended value to protect fish consumers (EPA-1986)	-	-	-	4700	-	0.146

*** Acute value, no chronic standard given**

The SW guideline QCP is more stringent that the current Rhode Island and EPA saltwater criterias for cadmium, chromium, nickel, mercury, and lead, but is less stringent for copper. Note that these seawater standards were derived for different purposes. The EPA and RI criterias were derived to protect aquatic habitats in general, and are appropriate at all depths. Protection of seafood consumers was not considered in their derivation. The SW guidelines QCP are specially derived only to protect human consumers of quahog products, and are appropriate only for bottom waters in shellfish growing areas. Therefore, use of these guidelines would depend on the particular use being protected. If opening of shellfishing beds is a goal for a section of the Bay, then these new SW guidelines QCP are appropriate. It is the recommendation of the Narragansett Bay Project that both sets of standards and guidelines be used in future waste load allocation efforts for the Bay. If the result is unachievable or economically infeasible, then goals of usage for the particular area of the bay will need to be revised.

Comparison of the SW guidelines QCP with the results of the water quality surveys conducted by Dr. Hunt in 1985-1986 and Dr. Doering in 1986-1987 is given in Table 4-13.

TABLE 4-13

Ratios of existing water quality in bottom waters of the Bay to the proposed seawater criteria for quahog protection. Only stations with violations are listed.

Cadmium

Date U. Bay Status*	10/85 open	11/85 closed	4/86 open	5/86 closed	10/86 closed	12/86 closed	3/87 open	4/87 closed	6/87 open	8/87 closed
Mid-Seekonk R.	ND	ND	ND	ND	-	1.16H	-	3.14H	-	-
	ND	ND	ND	ND	-	4.07L	2.83L	2.79L	-	-
Lower-Seekonk	-	2.2H	1.2H	-	-	1.94H	-	1.62H	-	-
	ND	ND	ND	ND	1.12L	1.82L	1.[illegible]4L	3.55L	1.25L	-
Fox Pt.	-	-	-	-	-	-	-	-	-	-
	ND	ND	ND	ND	-	1.20L	-	-	-	-

No cadmium violations in bottom waters further down Bay

Nickel

Mid Seekonk R.	ND	ND	ND	ND	1.35H	1.09H	-	-	1.28H	1.07H
	ND	ND	ND	ND	-	2.03L	1.21L	-	1.32L	-
Lower Seekonk	-	2.23H	1.30H	-	1.35H	2.13H	-	-	1.34H	-
	ND	ND	ND	ND	1.64L	1.31L	-	1.18L	1.80L	-
Fox Point	-	-	-	-	1.28H	-	-	-	-	-
	ND	ND	ND	ND	1.34L	1.02L	-	-	1.23L	-
Upper Prov Riv	ND	ND	ND	ND	-	-	-	-	-	-
	ND	ND	ND	ND	-	-	-	-	-	-
Mid Prov. Riv.	-	-	-	-	-	-	-	-	-	-
	ND	ND	ND	ND	-	-	-	-	-	-
Mid Prov. Riv	-	-	-	-	-	-	-	-	-	-
	ND	ND	ND	ND	-	-	-	-	1.18L	-

No nickel violations in bottom waters further down Bay

Lead (high tide only)

Mid Seekonk Riv.	ND	ND	ND	ND	ND	4.71H	2.05H	42.3H	3.09H	3.60H
Lower Seekonk	-	4.79	3.28	-	8.83H	5.72H	1.46H	33.3H	4.35H	3.05H
Fox Point	-	-	-	-	3.04H	3.57H	-	1.81	5.56H	2.18H
Upper Prov Riv	ND	1.16	-	2.02	2.15H	2.25H	-	3.31	3.84H	6.02H
Mid Prov Riv	1.26	2.47	-	2.32	2.14H	3.46H	-	7.76	3.24	9.10H
Mid Prov Riv	ND	ND	ND	ND	1.58H	2.04H	-	1.75	1.95	2.24H
Lower Prov Riv	ND	ND	ND	ND	1.65H	2.44H	-	1.05	3.85H	3.42H
Lower Prov Riv	-	-	-	1.37	1.78H	1.51H	-	-	1.36H	2.14H
Upper Bay	-	-	-	1.23	2.17H	2.83H	-	2.28	2.75	2.41H
Upper East Pass	-	-	-	1.55						
Upper Mt. Hope	-	-	1.30	-						
Lower Mt. Hope	-	-	1.00	-						

No lead violations in bottom waters further down Bay

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*Migliore, 1988.
- Concentrations below criteria
ND No data available
H, L - high or low tide.

The guidelines were regularly violated for lead, cadmium, and nickel in the bottom waters of the Seekonk and Providence Rivers (areas presently closed for shellfishing). The violations for lead involved the whole Seekonk-Providence River area; the nickel violations occurred primarily at Fox Point and above with a single violation near the mouth of the Pawtuxet River. All the cadmium violations occurred at Fox Point and above.

Since the water quality violations relative to the proposed SW guideline QCP occurred only in areas where shellfishing is already restricted, then there is no immediate concern. It would become an issue if these areas were considered as future resource areas. However, there was a violation of the SW guideline QCP for lead in the conditional area in the upper Bay. The upper Bay was closed to shellfishing at the time this survey occurred. Such short lived episodic violations of the guideline may not result in elevated tissue concentrations. However, this single violation in the conditional area of the Bay indicates that abatement of lead inputs to the Bay should not be postponed until clean up of closed areas is contemplated.

The next question follows quickly: how much abatement is necessary to meet the proposed SW guideline QCP for these metals? The ratios of the present concentrations to the proposed SW guideline QCP are also given in Table 13 where violations occur in the bottom water. The lead reductions necessary to meet the SW guideline QCP are high in the Providence River above the southern tip of Fields Point. Reductions of lead between 50% - 75% would be required in the lower stretches of the Providence River in order to meet the proposed standard. Most of the lead violations in the lower part of the Providence River occurred when the upper Bay was closed due to heavy rains. This observation implicates urban runoff as the source of the problem. Based on data collected in 1981- 1982, Eva Hoffman estimated that 79 metric tons of lead enter Narragansett Bay each year. Of this amount only 13 tons come from point sources (sewage and industries). The remainder, 66 tons/year, or 84% of the total, comes from mainly from urban runoff and atmospheric deposition, originally emitted to the atmosphere and highways from the usage of leaded gasoline products. Dr. Hoffman's data would suggest that, in time, the discontinued use of leaded gasolines would be enough to achieve compliance with the lead standard in the lower parts of the Providence River. This alone may not solve the violations in the Seekonk River. Conditional closures in this area may be required due to contamination of the soil and sediments in the watershed. However, the elimination of lead from gasolines would also have several other benefits to the RI population. Not only would our seafood be exposed to less lead, but our drinking water, our food, and the air we breathe would also contain less lead.

Abatement of about 50% of the inputs of nickel to the Seekonk River would be necessary to meet the standards most of the time in the Seekonk River. If this area is considered for reopening, industrial pretreatment requirements for the Blackstone Valley District Commission may be required.

Abatement of cadmium entering the Seekonk River is more problematic. The source of the cadmium is the Blackstone River. However, current point sources both in Rhode Island and Massachusetts cannot account for the loads which are observed. The cadmium could have a non-point source origin or may be coming from contaminated sediments which have accumulated in the river. The Seekonk River does serve as an effective trap, preventing violations further downstream. Also, it should be noted that the Seekonk River is not a viable quahogging area because the water is too fresh for their survival. Although the Seekonk River is a suitable oyster and soft-shelled clam habitat, the SW guideline QCP will not apply since the bioconcentration factor for these species is different than the quahog. Data concerning these species will have to be collected to determine if the water quality is sufficient to allow consumption of these species from the Seekonk.

E. Options for implementation

The water quality regulators of the state have a number of options with regard to usage of these data. In the past, consideration of the issues surrounding the safety of metal content in clams has been minimal due to the lack of standards and the data to generate them. Such is no longer the case. Therefore, the only unacceptable use of the data is non-usage. It is unlikely that FDA will produce any such standards in the near future, so it will be necessary for the state to act on its own in the interim. Incorporation of the proposed guidelines in the formal water quality regulations of the state would have positive benefits for use in waste load allocation exercises, and in development of water quality discharge permits when shellfish growing areas are likely to be impacted. The availability of formal regulations on this subject which have credibility within the shellfishing industry would at least demonstrate that regulatory decisions are based on real data.

OTHER ISSUES SURROUNDING THE POTENTIAL OPENING OF CLOSED SHELLFISH BEDS FOR SHELLFISH HARVESTING

There are a number of issues other than potentially harmful metal concentrations which should be considered in evaluating the possible opening of shellfish beds:

1. Contamination of shellfish meats by unacceptable amounts of potential pathogens (bacteria and viruses);

2. Contamination of shellfish meats by unacceptable amounts of toxic organic pollutants (PCBs, PAHs, etc);

3. Ability of shellfish beds to sustain their population under fishing pressure (rate of shellfish diseases, ability to reproduce);

4. Are there enough shellfish in the area to make the fishing effort and pollution abatement effort worthwhile?

5. Negative economic impacts due to flooding the market with new resources.

The studies of two of these issues have been completed (3 and 4); the others are in progress.

A. The health of quahogs in closed areas of Narragansett Bay

In recent years, there have been many reports that pollution has caused increased levels of disease and pathological disorders in fish and shellfish (see for example the conference proceedings of Toxic Chemicals in the Aquatic Environment). Locally, quahogs have also been studied for pathological disorders, presumably caused by pollution in Narragansett Bay (Brown, 1977; Barry and Yevich, 1972; Cullen, 1984). These investigators have studied the incidence of neoplasia (sometimes referred to in press reports as clam cancer) and incidence of kidney concretions (the clam equivalent of kidney stones). Although these conditions are not related to human health, these studies have been cited in press reports and caused concern among shellfish consumers, shellfishermen, and shellfish regulators. The Narragansett Bay Project therefore considered that an in-depth investigation of this issue was important, especially to evaluate the health of the organisms on which an important industry depends.

Frederick Kern of the National Marine Fisheries Oxford Biological Laboratory was contracted to study the histopathological disorders of Narragansett Bay clams collected at the same stations used for metal and organic analysis. It was hoped that, if significant disorders were found at any station, the metal and organic chemical analysis could tell if pollution was implicated as a major factor.

A summary of the disorders found in Narragansett Bay clams is given in Table 4-14. Emphasis was placed on clams from closed areas of the Providence River and Mt. Hope Bay with a few controls from conditional and open areas. Of all the disorders noted, color abnormalities were the most frequent (47%), and shell abnormalities second (18%). Only four of the clams were found with neoplasia. The pathological disorders did not vary with the pollution gradient, except that Greenwich Bay clams, the control clams, were in better condition that the rest of the clam population. It was found that the occasional disorders in Mt. Hope Bay and the Providence River also occur in open and conditional areas already being harvested. Although this study leaves a number of scientific questions still unanswered as to why some stations in the Providence River and Mt. Hope Bay had higher incidences of disorders than adjacent stations, it can be concluded that the clams in the closed areas examined here are healthy enough to be harvested. The product, however, might not be as commercially appealing due to coloration and shell abnormalities if sold still in the shell. This should present no problem for their use as fried clams or in clam chowder if they meet standards for metal, organic and fecal content. The investigator concluded:

"The hard clam is a hardy and very tolerant species when exposed to many environmental contaminants. The very presence of quahogs during this study indicates that they are capable of sustaining their present populations in the existing environmental conditions" (Kern, 1987).

TABLE 4-14

Summary of pathological disorders in Narragansett Bay quahogs *
Gross pathological observations:

1. Pale digestive gland - infrequent (0.31%)

2. Shell abnormalities -high at two lower Providence River locations (30-50%), but low at two mid Providence River locations (0-12%). Wide variety in Mt. Hope Bay (0-45%). Low in Greenwich Bay (0%).

3. Color abnormalities - higher amounts of color in spring than in fall. Lower amount in Greenwich Bay. Closed areas similar to open areas (46.4%).

4. Gametogenesis - no disruptions found.

5. Necrosis - higher incidence in Greenwich Bay than other stations. Cause not known (10 out of 963 total clams sampled).

Pathology

1. Inflammatory lesions - localized response not associated with toxic response (0.04%).

2. Degenerative changes - least common in Greenwich Bay, cause unknown (3.7%).

3. Neoplasia - incidences found but no relation to location (0.07%).

4. Sarcoma - one found in Mt. Hope Bay. This condition had not be found in previous studies of the quahog (one out of 963 clams).

Parasitology

1. Chlamydia - found but no relation to location (0.7%).

Condition index

1. In the fall, condition was highest in Greenwich Bay and lowest in the lower Providence River

2. In the spring, the condition index was highest in Greenwich Bay and lowest in Mt. Hope Bay and lower Providence River.

Kern, 1987

B. Population density in closed areas--is the resource large enough to sustain harvesting?

Another issue involved in the consideration of opening shellfishing beds for commercial harvesting is the nature and volume of the resource in these closed areas. Dr. Saul Saila and his colleagues Sheldon Pratt and Brooks Martin from the Graduate School of Oceanography at URI in cooperation with Richard Sisson and John Stolgitis from the Fish and Wildlife Division of the RI Department of Environmental Management were contracted to conduct a population survey of clams in the closed areas of the Providence River and Mt. Hope Bay.

Several dense patches of quahogs located south of Bullocks Point, south of Gaspee Point, and north of Conimicut Point were found in the Providence River during this 1985 survey (see Figure 4- 2), similar to locations found in 1956 and 1965. However, density was low in an area south of Sabin Point where it had previously been high, apparently due to high mortalities reported there during the early 1970s. The density of clams in the Providence River area ranged between 640 and 18,000 clams per acre.

High density patches of clams were also found in Mt. Hope Bay off Touisset and east of Mt. Hope (see Figure 4-3), similar to loactions found in the 1956 survey. However, there were many

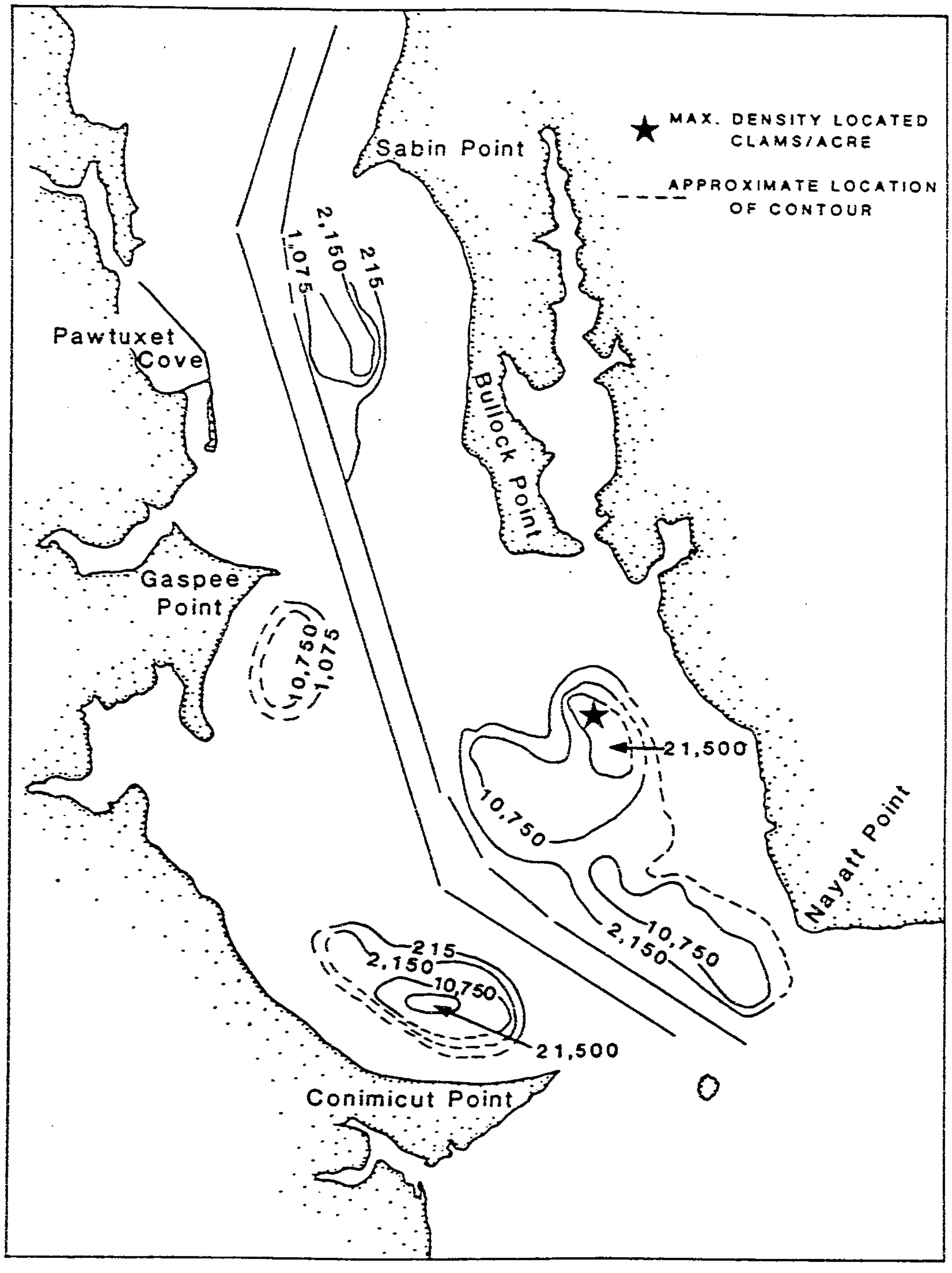

Figure 4-2. Distribution of hard clams in the Providence River, 1985.

locations in Mt. Hope Bay which yielded no clams, but this too was noted in the earlier surveys. The density of clams in Mt. Hope Bay ranged from 0 to 400 clams per acre.

Clams of all sizes were found in the Providence River, indicating evidence of active recruitment in the area. But there were no smaller clams found at Mt. Hope Bay stations, except close to shore, indicating that there had been no recruitment of adults for a number of years in deeper water stations. Because some evidence of recruitment was found in shallower waters, there must be sufficient larvae present. Competition from adults could be the problem. Dr. Saila suggests that this lack of recruitment could pose a problem if Mt. Hope Bay is reopened for shellfishing because postharvesting recovery is uncertain. He suggests that small areas be fished out and the repopulation monitored before opening the whole area.

There was one possible pollution effect noted by Dr. Saila and his colleagues. The size of the clams in the Providence River is limited to 100 mm and the average size was slightly smaller for upstream Providence River clams than lower in the river. Mt. Hope Bay clams grew larger. This and other evidence suggests that long-term growing conditions in the Providence River are sub-optimal.

Coloration abnormalities were also noted by Dr. Saila, the worst being found in the deeper areas in the upper parts of the Providence River. At the Bullocks Point area, the older clams tended to be darker than the smaller ones, but this trend did not continue at other stations. However, there were no very dark meated clams found in this 1985 survey such as were found in 1968. The reason for color differences is not known, and it is also not known if transplantation to cleaner waters would improve color. These investigators also point out that, while the colorations abnormalities are observable to the trained scientific investigator, the abnormalities might not be severe enough to be observed by the consumer and would not affect their marketability (Pratt, 1988).

The resource in the Providence River is certainly large enough to make the fishing effort worthwhile. There are also areas of Mt. Hope Bay with patches dense enough to make the fishing effort worthwhile in the short term. There is some concern that the Mt. Hope Bay clam population might not be able to sustain fishing pressure over the long haul. An experiment in a limited area might help learn whether this could be a problem. Since two different studies noted a high incidence of off-color clams in the Providence River, it would be useful to find out if transplantation could be used to improve color and make the clams more pleasing visually to the consumer.

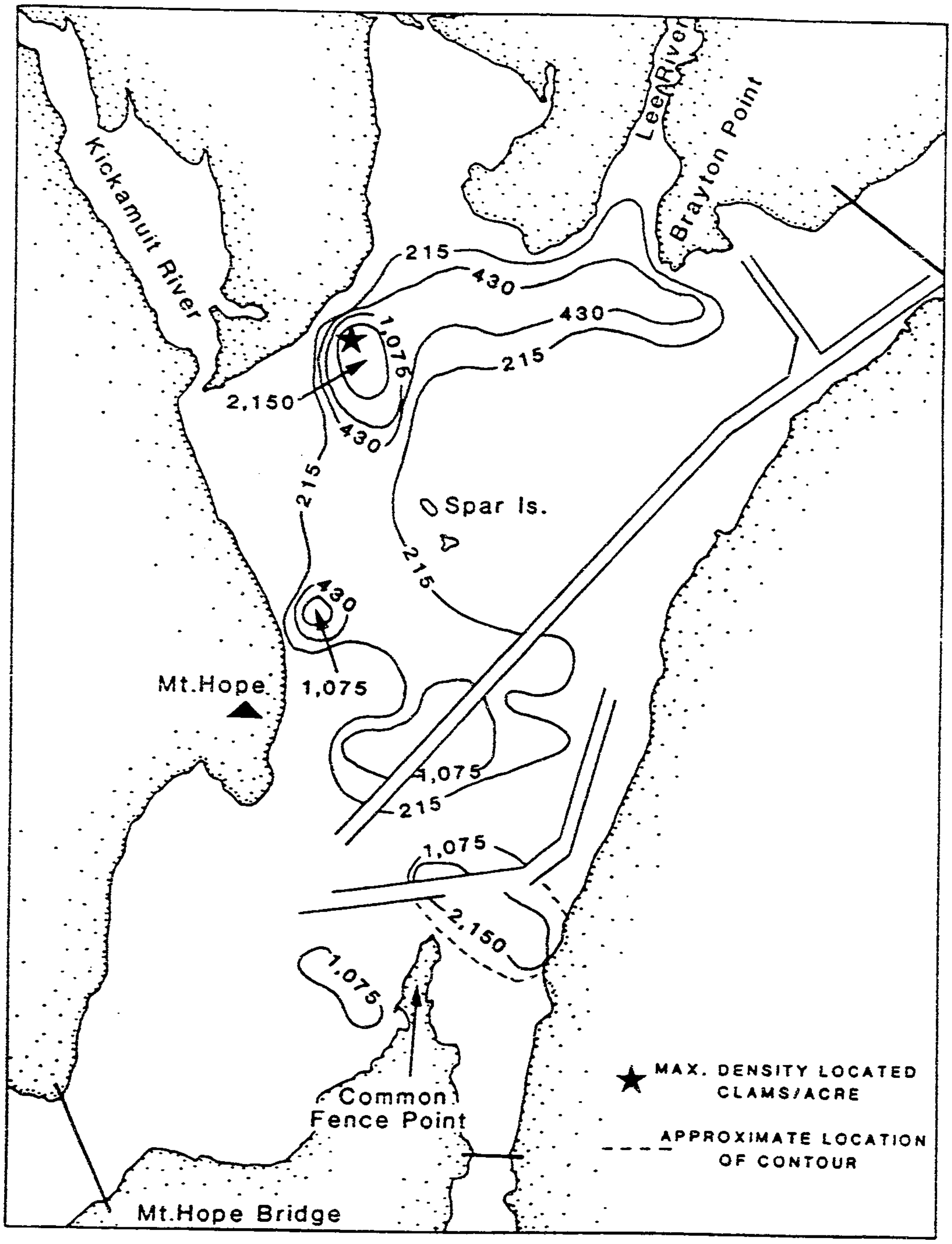

Figure 4-3. Distribution of hard clams in Mt. Hope Bay, 1985.

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CHAPTER 5

WHAT DO THE PUBLIC AND USER GROUPS PERCEIVE TO BE THE PROBLEMS FACING NARRAGANSETT BAY MANAGEMENT?

EXECUTIVE SUMMARY

The Narragansett Bay Project and Sea Grant conducted several surveys of the general public, user group leaders, ordinary people who use Narragansett Bay, and state legislators to determine what particular Narragansett Bay issues were of most concern and to evaluate whether the Narragansett Bay Project plans were addressing these priority issues. Most agreed that water quality issues were the primary concern and the emphasis of the Bay Project on these issues was consistent with the desires of the public. The strength of the public concern about water quality has also been confirmed through the passage of water pollution control project bond referenda.

Protection of shellfishing resources was given a particularly high priority among the public and all the user groups, both in terms of priority of the use itself relative to other activities, and in terms of seafood quality. Users and the public were also given specific situations which pitted one group's interests over another. The results, in general, favored shellfishermen, but this was not absolute. User group conflicts over space were not perceived to be a major problem however.

Users were also concerned about the cleanliness of the shoreline, and shoreline development was of concern to some groups. Recreational land uses along the shore were given the highest priority in terms of shoreline use.

There is some disagreement about the current effectiveness of governmental performance in Bay management. Some groups are satisfied, others not. Some of the perceived problems are real, but other are due to lack of communication.

The public has shown a willingness to participate with the Bay Project and the state in their efforts to devise a management plan for the future of the Bay. Comparison of successful and unsuccessful efforts at public participation revealed that attitude, rather than methodology, is the key factor.

RECOMMENDATIONS

General recommendation:

The state should expand its public participation activities in environmental regulatory affairs.

The user workshop forum and the user leadership surveys generated hundreds of recommendations for state governmental agencies, all of which were based on perceived problems. Based on the user surveys, there are a number of particular issues which are in dire need of a dialogue between affected parties and state regulators. These include fisheries enforcement issues, pretreatment enforcement issues, and shoreline development issues. Although formal public hearings are required by law, the workshop or task force forum are more effective vehicles for exchange of ideas. Specific, knowledgeable individuals with the respect of their user group community can be specially invited. An agenda with a series of specific troublespots can be given in advance to both public and regulatory participants so that both sides can be prepared. Both groups should come prepared, ont only to participate, but to listen.

It may also be worthwhile to assign a full time public participation coordinator to investigate which public participation form is most useful for given situations, and develop more formal guidelines on methods.

The Bay Project in its short existence cannot be expected to organize and prepare workshops for every issue of environmental interest. The main regulatory agencies should incorporate real public participation programs into their normal business. Full and open discussions of the issues prior to the public hearings or before introduction of proposed legislation will foster the same spirit of cooperation evident with the Bay Project but will last long after the Bay Project is history.

Responsibility for the success of public participation rests both on the public and the state. The public who wishes to participate with the state must make an effort to be an informed participant, and the state must be willing to discuss the issues openly, including not only the technical justifications for proposed action, but also the potential political and economic impacts.

Specific recommendations

1. Federal governmental agencies should pay more attention to aiding the states in terms of health risk issues. The public is concerned about the quality of the seafood they consume. If federal agencies do not produce guidelines, the states must act individually in this regard.

2. The Bay Project should make some form of the user workshops a continuing practice with a more limited and specific agenda. The exchange of ideas was useful for the Bay Project and the state. A model for success here can be found, not only in Bay Project efforts , but also in public participation efforts associated with Special Area Management Plans. A basin plan involving the whole of Narragansett Bay will require participation by the public, scientists, regulators, and policy makers. As the drafting of a management plan becomes closer, the forum will be particularly valuable.

3. The state should consider the use of polls to determine in advance the likelihood of passage of proposed bond referenda. The accuracy with which the responses to the Bay Project poll predicted the results of the RI Clean Water Act bonds demonstrates the usefulness of polls. Polling can aid administrators and legislators to judge public sentiment and decide whether the timing of future bond referenda is appropriate or if delay for extensive promotion or education will be necessary. Polling can also help government in formulation of priorities. Cooperation with various media outlets could help here.

4. Bay Project committee members and scientists should continue their participation in Task Forces on specific issues so that information, expertise, and contacts of the Bay Project can be used by these groups, and duplication of effort is avoided. The Bay Project could also aid in the formation of other task forces or workshops as recommended earlier.

5. Fisheries enforcement activities should be more highly publicized. Inadequate fisheries enforcement was mentioned in workshops as a problem for Narragansett Bay management. Examination of media coverage of this issue showed that very few fisheries enforcement activities were mentioned in the newspaper. It is natural for the public to assume that nothing is happening. Fisheries enforcement officials could easily remedy this misconception by cooperating with media in a fashion similar to other law enforcement agencies. A high-profile in governmental affairs here is warranted because of benefits in discouraging illegal practices. An example of intense media coverage of enforcement activities is evident in industrial pretreatment enforcement activities. The adverse publicity may be even more effective in reducing violations than the enforcement action itself.

6. Should the Bay Project recommend combined sewer overflow abatement in the future, it will be necessary to educate the public about what they are. They are not perceived to be a problem by user group leaders, users themselves, or by the public.

7. The Bay Project should continue to investigate Bay governance issues. There are sufficient data to suggest that the public feels the situation in some agencies could be improved. Other agencies receive high praise from some groups and not from others. Agencies with Bay governance responsibilities should evaluate the results of the Narragansett Bay Project public opinion polling and survey efforts to evaluate their own needs in terms of scientific informational needs, and agency needs in terms of public education.

WHAT DO THE PUBLIC AND USER GROUPS PERCEIVE TO BE THE PROBLEMS FACING NARRAGANSETT BAY MANAGEMENT?

INTRODUCTION:

The concept is simple: If we in the U.S. Congress are going to give the Narragansett Bay Project taxpayer money each year to examine Narragansett Bay, we have to have some assurance that you will examine what the taxpayers feel is important. The bureaucratic term for this is "public participation".

Theoretically, in a democratic society, the public already participates in governmental affairs by voting for their elected officers and legislators every two, four, or six years. They can also band together in special interest groups to lobby at the legislature when laws affecting them are being considered. But in everyday practice, many decisions are made administratively; that is to say, non-elected government officials make rules and regulations for their departments which affect how those departments conduct their daily affairs. Examples of such decisions could be the design of the tax form, the citing of a government owned facility (courthouse or sewage treatment plant) and the choice of its architectural design, the route of a highway.

The U.S. Congress often mandates public participation in construction or environmental projects using federal funds. This public participation requirement gives the citizens an opportunity to influence these administrative decisions. A few state funded programs have similar requirements written in the legislation. Other state programs have chosen to institute public participation programs even though they are not required. Minimally, a public hearing is used to satisfy the public participation requirement. And the public hearing is the usual extent of public participation for most programs. A citizens advisory committee or a technical task force is formed by those governmental bodies seeking more active public involvement.

The U.S. Congress has required that all estuarine programs have a public participation program. The Narragansett Bay Project

Management structure was designed to incorporate this concept internally (see earlier chapter). The Bay Project Management Committee was well-acquainted with the more typical forms of public participation. The main concern with these traditional forms was their perfunctory nature. Governmental agencies could easily go through the motions by appointing easygoing people to advisory panels and by dismissing opinions of malcontents at public hearings by labeling their comments as "nonsubstantive". This pattern had been experienced by most of the committee members, and they did not want it repeated in the Narragansett Bay Project.

It is no coincidence that the Bay Project Management Committee authorized "experiments" in the area of public participation using the same logic as in scientific experiments. Not only did the Management Committee want to find out what the public thought should be the goals of Narragansett Bay management and the goals of the Narragansett Bay Project, they were also not opposed to experimentation with different public participation techniques.

In the first two years of the project, the Management Committee and its staff authorized several forms of public participation. The first and most important form was internal structure where members of the public representing industrial, commercial, and environmental interests were invited to participate within the Management Committee itself and to participate in subcommittees and working groups (see earlier discussion). The second form was the invitation of public participants to a workshop on goals for the project. The third form was to obtain public input through traditional polls and surveys. During the first year public attitudes were measured by direct personal interviews, by a telephone poll, and by a mailed survey. The fourth form of public participation used by the Project is more informal than the others but nonetheless useful. Bay Project committee members, staff, and contractors were encouraged to participate informally with governmental agencies and special interest groups. Each of the various methods of public participation has been useful for different purposes.

As a matter of introduction, there are a number of public opinion and public participation efforts which serve as the basis for the substance of this chapter. The Narragansett Bay Project funded Dr. Harold Ward of Brown University to conduct a two pronged study. In the first part, the leadership of various special interest and user groups were interviewed to determine what specific issues were of primary interest to their group (Ward, 1987). Some of these groups are very active in legislative lobbying and could influence attitudes of legislators. After these interviews, a telephone survey of the general public was conducted with questions which arose from some of the interviews, from some of the scientific research, and from the Bay Project Management Committee (Ward, 1987). At the same time, Sea Grant funded Dr. Niels West of the University of Rhode Island to conduct another survey of Narragansett Bay user groups (West, 1987a). The difference was that a population of actual user participants was interviewed in the Sea Grant study. Only the leadership of organized user groups were interviewed in the Brown University study. To avoid confusion between the results of the surveys, the Sea Grant results will refer to users and the Brown University results will refer to user group leadership.

Another effort funded by the Narragansett Bay Project was conducted by J. Michael Keating, an attorney with the firm of Tillinghast, Collins, and Graham. A series of workshops with various user group leaders and participants were held with the hope of refining the priorities and goals discussed in the earlier surveys (Keating, 1987). Following the workshops, a questionnaire was sent to the 60 workshop participants to further refine approaches to the problems identified in the workshops. The responses to these questions came after about 9 hours of discussions of these issues. The same questionnaire was also sent by Dr. Eva Hoffman to the entire membership of the RI General Assembly (Hoffman and Martin, 1988). Though the questionnaires were identically worded, the legislators did not all have the same level of education about the specific issues as did the workshop participants. The specific details of these various surveys are given in Table 5-1. These efforts serve as the core of the results but confirmation of the findings can be found through examination of election results, newspaper coverage and other polls.

TABLE 5-1

SUMMARY OF RECENT OPINION SURVEYS ABOUT NARRAGANSETT BAY ISSUES

Investigator	Participants	Method
Ward (1987)	42 leaders of user groups and special interest organizations	personal interviews
Ward (1987)	500 RI adults	telephone poll
Keating (1987)	37 user workshop participants	mailed questionnaires
Hoffman (1988)	48 RI legislators	mailed questionnaires
West (1987)	42 residents 71 beachgoers 48 quahoggers 50 boaters 29 tourists	personal interviews

All of these activities together give a picture of the public's perceptions about the Bay and specific kinds of research they feel are necessary for the Narragansett Bay Project. The major management questions these activities hoped to address are: (1) what do the public and users expect for the future of the Bay; (2) is the current emphasis on water quality management issues supported by the public; (3) what other problems do the public recognize which should also be addressed in an overall management plan for the estuary; and (4) what would be the reaction of the public to several specific alternatives which might be recommended in a Bay management plan. In addition, these investigations gave an added bonus in allowing the Bay Project to evaluate which particular method is most effective in given situations to aid government in managing Bay activities. A knowledge of current public attitudes is important when new programs are proposed, and a mechanism should be available to obtain these opinions on an ongoing basis.

WATER QUALITY ISSUES

A. Public support for clean water

The Brown University survey of user group leaders (Ward, 1987) indicated that water pollution in the Bay was a major concern to most of the group leaders, although the focus of each group depended on its perspective. Fishermen, environmentalists, boaters, sportsfishermen, divers, surfers, all specially mentioned pollution of the Bay as a major concern. Marina owners, however, thought water pollution was of secondary concern to them (compared to economic issues), but felt that boaters were blamed unfairly for pollution. They felt that municipal treatment systems were really the greatest contributors to pollution. They did recognize that pollution makes the Bay less pleasant for boaters.

In the URI Sea Grant poll of actual users (West, 1987a,b) the various user groups identified good water quality as a primary optimum condition they would desire for Narragansett Bay. The survey participants were actually asked to describe the Bay nearshore environment they'd prefer. "Clear" water and "clean" water were apparently used interchangeably in this study. Although scientists would argue that there is a difference between the two descriptions, the public equates the two (West, 1987a). What should the water of Narragansett Bay be like? The results of the survey of different users are given in Table 5-2. All but a very few of the descriptors the users mentioned were water quality related. The general term "clean" or "clear" water was used most frequently. When particular pollutants were mentioned, garbage (litter), oil and chemical pollution were mentioned most frequently but odors and sewage were also mentioned. Sometimes effects of poor water quality were mentioned (e.g. dead fish, inedible fish or absence of life). Competition for space with other user groups was mentioned, but very infrequently in comparison to the water quality descriptors and effects.

TABLE 5-2

What should Narragansett Bay waters be in the optimum situation (West, 1987a)

User group percentage mentioning these words as a descriptor of optimum conditions for the nearshore (water environment

	clean or clear water	**absence of floating garbage**	**no oil & chemical pollution**	**highest non-water quality descriptor**
Tourists (62)*	45.0	30.3	5.0	nice sand (3.3%)
Beachgoers (121)	50.4	9.9	13.2	no seaweed (6.6%)
Boaters (105)	48.9	13.0	13.0	absence of marine traffic (2.2%)
Shell-fishermen (77)	37.7	19.5	19.5	no marine traffic (2.6%)
Residents (98)	30.6	17.3	14.3	swimmable (5.1%)

***West (1987b)**

In the Brown University-Alpha Research telephone poll (Ward, 1987), public respondents were given nine bay problems and were asked to rank each in terms of which was most and least important. The two water pollution problems, pollution of the Bay and the dangers from eating contaminated fish, were the two issues most important to the public. In fact, 79% of the respondents listed Bay pollution as the most important Bay issue. The accuracy of this response was confirmed several months after the poll when RI voters were asked in November 1986 to approve $35M in bonding authority to upgrade several sewage treatment plants. These RI Clean Water Act bonds were approved 204,272 to 62,439, or a 77% approval. The $87.7M bond issue in 1980 to upgrade the Fields Point Sewage Treatment Plant also passed by a large margin, 215,614 to 103,069, or a 67% approval. There seems to be a close correlation between the way the public responded to the telephone poll with their behavior in the voting booth when it comes to concerns about Bay pollution. The concern about pollution was very strong among the public no matter how they used the Bay personally.

The media does contribute to the public's knowledge of Bay pollution problems (Martin and Hoffman, 1987). Of the over 3000 articles written about Bay activities, 13.9% dealt with sewage treatment plant problems, the impact of the trash incinerator on the Bay and the dumping of hazardous waste in the Bay. Another 15.2% of the articles dealt with shoreline development or land use issues which also have a relationship to water quality.

B. Where does the public think water pollution comes from?

Obviously, the best way to find out where pollution comes from is not through public opinion polls. It is a question for scientific inquiry and will not be answered by voting for your favorite polluter. But the results of this inquiry can give water quality regulators an idea of how much educational activity might be needed to convince the public about the effectiveness of any abatement proposal. In the public opinion survey (Ward, 1987), 37% mentioned industry as the main source of the problem, 31% mentioned sewage, 19% mentioned people, 8% mentioned oil, and 4% mentioned toxic waste. User group leadership were not asked which source was most important. They mentioned boat effluent, industry, septic tanks, sewage treatment plants, the Navy, trash incineration and shoreline development (Ward, 1987).

Quahoggers are the group most directly impacted by water pollution. In the URI survey (West, 1987a), most of the quahoggers (46%) mentioned rather specifically that the Fields Point Wastewater Treatment Facility was the major source of the pollution. Other quahoggers mentioned failing septic systems (19%), industry (19%), and urban runoff (14%). These are certainly major contributors to water pollution in general, but upper Bay closures affecting the shellfishermen most severely are the result of combined sewer overflows, which were not mentioned at all. Quahoggers, like the general public, may think that overflows during rains occur at the treatment plants themselves. Even though the overflows mostly occur before the sewage reaches the plant, the quahoggers may not consider this to be a separate problem. In addition, combined sewer overflows were not mentioned by any of the user group leaders or in the public opinion poll (Ward, 1987). So while the public has a good general knowledge of pollution sources, their knowledge of severity is not as strong. Notably absent from public concern, even though the effects are known, is the problem of combined sewer overflows.

C. Management approaches to water quality problems.

In the polls, user surveys, and workshops, there were a number of specific suggestions made on (1) how to solve water pollution problems, (2) what aspects of water pollution should be studied by the Narragansett Bay Project, and (3) which solutions should be evaluated by the Bay management plan. In the survey of user group leaders (Ward, 1987), recreational leaders said that sewage treatment facilities should be improved to prevent odors and unsightly water. Boaters were annoyed at the lack of pump-out facilities for boats. Environmentalist leaders thought that industrial pretreatment regulations should be enforced better, older ISDS systems should be repaired and sewage treatment facilities updated. Industrialists not in compliance with pretreatment regulations complained of the expense of installing the equipment and those in compliance complained that enforcement should insure that those out of compliance do not gain an economic advantage.

In the URI survey of users (West, 1987a), boaters felt that the biggest need for water quality improvement was abatement of chemical pollution (74%) and oil slicks (26%). Residents felt that the biggest need for improvement in Bay management was effluent and pollution control (52%), special attention to effluents from Providence (another 12%), public use conflicts (8%) and planning (8%). Only occasionally mentioned (<4%) were education, coastal management, Newport, boating effluents, and shellfishing management.

Although the message was clear that the public wants clean water for Narragansett Bay, it was not yet clear what sacrifices they would be prepared to make. When the public opinion poll asked respondents to choose between water pollution and development, 74% were in favor of excluding development, even when reminded about the potential economic benefits of development (Ward, 1987). In another question, respondents were asked who should pay to clean up industrial wastewater, the industries themselves, the state, or should pollution be allowed to continue. Only 1% said that pollution should be allowed to continue. Seventy-six percent said that industry should bear the cost for cleaning up their wastewater (Ward, 1987).

The Narragansett Bay Project received advice from the public as to which particular issues should be a major, minor or no part of the study (Ward, 1987). Greater than 90% of the respondents felt that effects of pollution should be a high priority with 98% favoring studies on effects of raw sewage, 97% favoring studies on the effects of industrial wastes, and 91% favoring studies on pollution from development. In addition, 85% favored studies on risk from consuming contaminated fish, 83% favored studies on effects of water quality on the ecosystem and 63% favored studies on the effects of recreation on water quality. Non-technical studies usually received lower responses: 84% favoring monies spent on public education, 77% favoring monies spent on public opinion studies, 77% favoring monies spent on how to improve enforcement, and 69% favoring monies spent on how to improve Bay management. All of the topics presented to the public in this poll received at least a 63% favorable rank. Therefore, all these projects had a majority of support from the public for inclusion in the Narragansett Bay Project. However, it was clear that the water quality issues gained the most support. It is interesting to note that most of these ideas were discussed by the Bay Project Management Committee and they all received a favorable response from the public.

But what should the Bay Project study if it can't study everything? In order to further refine priorities, participants in the user workshops (Keating, 1987) and a poll of legislators (Hoffman and Martin, 1988) were asked to rank which of the following approaches would be most effective in addressing the problems of the Bay (see Table 5-3):

Table 5-3

Evaluation of the potential effectiveness of various approaches to Narragansett Bay Management

Approach	**Rank of user workshop participants**	**Rank of legislators (Hoffman, 1988) (Keating, 1987)**
Provide for clear and consistent enforcement of existing regulations	1	3
Gather sufficient baseline data to be able to measure future progress or retro-gression in regard to water quality	2	4
Develop a comprehensive plan for Bay management	3	1
Develop better tools for monitoring pollution and predicting upset	4	2
Educate the public about the benefits of and dangers to the Bay	5	5

There were some significant differences between the order the users ranked the approaches and the order the legislators preferred. Several of the differences, however, can be easily explained. The user workshop participants ranked these issues after three meetings. One meeting was a pre-workshop meeting where each of the interest group representatives met with representatives from their own interest. During the next two meetings, the 60 participants shared with each other the issues particularly interesting to their groups. During the workshops, both the commercial users group (fishermen, marine trades) and the industry group (electroplaters, chemical companies, manufacturers, developers) pleaded that enforcement of existing regulations was the solution to Bay problems. Illegal discharges and illegal fishing practices were perceived as detrimental to the industries and fishermen by allowing the perpetrators an unfair economic advantage over more responsible members of the industry and as detrimental to the Bay and its resources. Their eloquent pleas in the workshop forum were able to sway the participants to rank "clear and consistent enforcement" as the best way to achieve improvement in Bay water quality.

Likewise, during the workshops, the scientific community group spoke eloquently about the complete lack of baseline data and the fact that even with all the public monies that have been spent in the past, regulators are still unable to say if the Bay water quality has improved because there has been no routine monitoring of the Bay. The participants ranked baseline data as their second highest priority. The legislators were not in attendance during the workshops and did not have the benefits of listening to the discussions which took place. In some ways, legislative responses are also a function of their role. As legislators, they must think about the future and plan ahead to solve anticipated problems for state government. They ranked the highest priority approaches as the need for a comprehensive management plan and development of tools necessary to predict upsets. Both the user workshop participants and the legislators ranked public education as a lower priority. It should be pointed out that all of the user groups in the workshop forum mentioned the need for education in their lists; in fact, education was the only issue at first (other than water quality concerns in general) which originally appeared on all the lists of the various user groups. However, at the end of the process, education was not perceived as the most effective way to approach Bay problems. Plans and actions came first, then education.

Pollution is known to influence man's use of Narragansett Bay, but with limited dollars, which of these impacts should be studied first. User workshop participants (Keating, 1987) agreed that pollution impacts on shellfishing should have the highest priority, followed by impacts on finfishing (a distant second) and lastly the impacts on swimming.

The legislators agreed that impacts of pollution of shellfishing should receive the highest priority of the Bay Project with impacts on swimming as a distant second (Hoffman and Martin, 1988). As discussed later, shellfishing is perceived by the public, the users and the legislators as the most important use of the Bay, and thus, the emphasis on how pollution affects the shellfishing is a further manifestation of the importance of this industry to the citizens of the state.

D. Technical approaches to the study of water quality.

The user group workshop participants (Keating, 1987) and legislators (Hoffman and Martin, 1988) were asked to elaborate on the specific goals of scientific measurements and evaluations (see Table 5-4).

TABLE 5-4

Priority of goals for Bay monitoring

Goal for monitoring	Rank of user workshop participants (Keating, 1987)	Rank of legislators (Hoffman, 1988)
Measure the magnitude of various pollution sources	1	1
Describe baseline conditions	2	6
Develop capability to predict changes due to pollution	3	4
Develop long term monitoring strategy	4	3
Evaluate risk to human health from consumption of contaminated fish and shellfish	5	2
Develop techniques tc enhance growth of commercial fisheries	6	5

Both the workshop participants and the legislators agreed that the top priority in monitoring should be the determination of the magnitude of the various sources of pollution to the Bay. Clearly, abatement of pollution begins with a knowledge of where the pollution comes from. The secondary priority goals for monitoring were divergent between the two groups responding to the questionnaire. The workshop participants ranked description of baseline conditions as their second highest priority. Again the workshop discussions about the need for a baseline on which to evaluate progress clearly influenced the workshop participants. The second priority of the legislators involved the risk from consuming contaminated fish, in rough agreement with the interest that the RI public expressed in its telephone survey. The third highest priority of the workshop participants was developing methods to predict change while the legislators felt a long term monitoring strategy was more important. Again the legislature often mandates monitoring requirements for the state and their interest in this particular aspect of Bay management is understandable. The lower priorities for the legislators and workshop participants were very close. Both groups assigned enhancement of commercial fisheries as a low priority.

E. Consistency of the Narragansett Bay Project Work Plan with the concerns of the public and user groups.

The emphasis of the Bay Project on water quality related issues is clearly supported by all the user leadership surveys, public polls, legislature polls and user workshops. The workshop participants agreed that the Bay Project's primary goals should be stated this way: (1) Preserve and promote the environmental quality of Narragansett Bay, including its biological, chemical, physical and socio-economic aspects; and (2) Preserve a healthy Narragansett Bay for posterity so our children may enjoy some of the same benefits we have derived from the Bay.

But how does the current 5 year plan agree with the priorities expressed by the public (see Table 5-5)? Most of the individual studies in the Bay Project could be used to address several goals. For example, one project determined metal concentrations in shellfish as a function of water quality. This project could be used to describe baseline conditions, develop capability to predict changes due to pollution, develop a monitoring strategy, and evaluate risk to human health from consumption of shellfish. This one project therefore addresses four of the six priorities suggested by workshop participants.

TABLE 5-5

Comparison of priority of monitoring goals with emphasis of the Narragansett Bay Project Five Year Work Plan (1986)

Rank by user workshop	Monitoring Goal	No. of Bay Project Activities	Funding level of activities
1	Measure the magnitude of various pollution sources	15	$1623K
2	Describe baseline conditions	11	$1425K
3	Develop capability to predict changes due to pollution	12	$ 982K
4	Develop a long term monitoring strategy	1 + data from baseline projects	$ 10K+
5	Evaluate risk from consuming contaminated fish	4 + data from national projects	$ 149K+
6	Develop techniques to enhance commercial fisheries	1	$ 100K

Even though the Narragansett Bay Project work plan was actually developed considerably before the workshop, the close agreement between the priorities assigned by workshop participants was not entirely coincidental. The five year plan was developed by the Narragansett Bay Project Management Committee which has scientific, regulatory and public membership. The public members represent fishermen, industrialists and environmentalists. The workshop forum was able to accommodate a larger and even more diverse group. In the final analysis, however, this larger group essentially endorsed the earlier efforts of the smaller, but similarly diverse, Project Management Committee.

The workshop participants (Keating, 1987) also suggested which impacts should be especially evaluated (see Table 6).

TABLE 5-6

Comparison of priority of impact assessment with level of activity by the Narragansett Bay Project

Rank by user workshop	Pollution impact	No. of Bay Project Activities	Funding level
1	Pollution impact on shellfishing	12	$559K
2	Pollution impact on finfishing	5	$155K
3	Pollution impact on swimming	3	$132K
unranked	Pollution impact on ecosystem	6	$489K

Again the emphasis directed by the Management Committee was endorsed by the workshop participants. Protection of shellfishing from water quality impacts was a primary concern expressed in all the surveys and workshops.

There are two elements of concern when discussing pollution impact on shellfishing resources. Rhode Island is well known for its shellfish, and shellfishing is an important source of economic livelihood for full time fishermen. In addition, 20% of the public interviewed in the telephone poll reported that they shellfish recreationally. Commercial shellfishing and recreational shellfishing are a part of the economic structure of the state but also a part of its cultural heritage as well . But Rhode Islanders are also consumers of shellfish products. 45% of the telephone poll respondents reported that they eat raw shellfish, and almost (62%) were aware of potential health problems. It is not surprising that the public wants to know what the risks are but they would also be willing to pay more for the product if the risks could be reduced. For example, 58%

would be willing to pay twice the cost of the shellfish if they could be assured that the product was uncontaminated. Legislators in their poll mirrored the public's concern about this issue when they ranked it the second highest priority goal of monitoring.

The Narragansett Bay Project funded three scientific projects on this issue in its first year. However, the concentrations of contaminants in shellfish could not be related to national standards because there are very few standards. Therefore, an inquiry about the lack of standards was made through the RI congressional delegation. The Food and Drug Administration admitted that establishment of standards for seafood was a low priority for the agency. The U.S. Environmental Protection Agency, however, has a different attitude about the priority, but finds itself without legislative authority. Therefore, the FDA and EPA have formed a joint task force to examine the methods used by the two agencies in terms of risk assessment and to examine what, if any, guidelines EPA can issue. In the meantime, each estuary project is left to deal with the situation individually. The proposed Narragansett Bay Project approach was discussed in an earlier chapter. What does the public prefer that the government do, if it should be found that consumption of seafood has some health risk associated with it. The majority of the telephone respondents (55%) suggested that the government simply warn the public. Another 37% suggested that the government strictly regulate sales. Only 1% wanted government to do nothing. The preference of the public for warnings rather than banning the product may come from recent interstate transportation bans affecting popular seafood such as swordfish which the public thought to be an over-reaction considering the nature of the data.

In summary, the Narragansett Bay Project work plan is consistent with the views of the public. Perhaps the only weakness relative to the strength of public concern is the issue of health risks from seafood consumption. This is an issue of significance not only to Narragansett Bay, but also to the nation as a whole. Federal cooperation and expertise will be necessary to help the local scientists begin to address this issue.

WATER USE ISSUES

The Narragansett Bay Project Management Committee recognized that sometimes the various uses of the Bay conflict with each other. Any Bay Management plan would have to make some tough decisions as to which uses should have precedence over the other uses if all the various uses could not be accommodated in the plan. Because the user groups affected by any decision of this kind would naturally be concerned, it was necessary to determine how the public at large would react to such a management decision.

Workshop participants (Keating, 1987) and legislators (Hoffman and Martin, 1988)were asked to rank the importance of the uses of the water (see Table 7).

Table 5-7

Rank of perceived importance of water uses of Narragansett Bay

Use	Rank by user workshop participants (Keating, 1987)	Rank by legislators (Hoffman, 1988)	Degree of public participation in the activity (Ward, 1987)
Shellfishing	1	1	20%
Swimming	2	2	64%
Finfishing	3	4	28%
Boating	4	3	32%
Aquaculture	5	5	-

The workshop participants and the legislators ranked the importance of the various uses in similar ways. But the ranks were not a simple measure of how frequently the Rhode Island public participates in these activities. The public through their poll choices confirmed the ranking orders of the users and legislators. The telephone poll of Brown University and Alpha Research gave the public a series of management choices. For example, the public was asked what if boating and marinas were found to harm shellfishing in an area. Which activity should be controlled? Overall, 78% replied that the boats should be controlled rather than the quahogging. And 76% of the boating enthusiasts among the public responding in the survey also agreed that boating should have controls rather than the shellfishermen. Even when the regulations might affect them personally, the public responded that the shellfishing use ought to be protected. This particular question did have some implications that marinas were a source of water pollution and considering the public's negative attitude about poor water quality in general, it could be conjectured that this aspect might have colored the results more than a simple choice between uses.

However, another question about use conflicts dealt simply with space rather than pollution. The public were asked, "Sometimes quahogging areas overlap with areas where sailors race. When this happens, who has more of a right to use these areas, the fishermen or the sailors?" Again shellfishing was the preferred use for the public at 77%. Again the sailors agreed, choosing the right to shellfish at 75% over their own rights as sailors. One would have to conclude that the public would support regulations to protect shellfishing even though they themselves might be the group regulated. The preference of shellfishing over all other uses was not absolute. The users were in favor of dredging to aid boating facilities in the long term, even if some temporary effects on fishing were felt.

DEVELOPMENT ISSUES

Development around the shoreline of the Bay is clearly a topic of great concern to the public and to the regulatory community. Both state and local officials have to grapple with this issue. The media reflects public interest in the topic. Shoreline development and basin land use topics constituted 13.2% of the media's attention to the Bay. A recent public opinion poll (Wolf and Fleming, 1987) contracted by a local TV station asked, "Should there be stronger restrictions on construction activity on the RI coastline?" Of the 500 people polled, 52% were in favor of stronger restrictions, and 38% were opposed. Therefore, the Narragansett Bay Project polls and workshops tried to dig deeper into this issue to assess the nature of public reaction to development issues.

It is not surprising that, given the strong public support for a clean Narragansett Bay, the public were in favor (74%) of limiting development if water quality were to suffer, even when reminded that such an alternative might result in fewer jobs and increased housing costs. Yet the public felt even more strongly (87%) that development should be curtailed if public access were limited. This clearly reflects self-interest because few people own water front property and thus access to the waterfront by the vast majority of non- waterfront dwellers was heavily supported by the poll respondents.

The results of the public opinion poll prompted the workshop participants to delve more deeply into shoreline development issues. What kinds of development were most appropriate for the shoreline (see Table 8)?

TABLE 5-8

Preferred uses of the shoreline of Narragansett Bay

Shoreline use	**Rank by workshop participants (Keating, 1987)**	**Rank by legislators (Hoffman, 1988)**
Recreational development (e.g. beaches, marinas)	1	1
Residential development	2	2
Water dependent industrial/ commercial development	3	3
Non-water dependent industrial/commercial development	4	4

The workshop participants and the legislators agreed on their preferences. The most preferred use for water front property was for recreational development (e.g. beaches and marinas). This is consistent with the public's desire for recreational access. Marina owners often point out that their marinas are a focal point for public access to the Bay. However, marinas, while providing visual access, are not genuine access points for the general public in the sense that the public is allowed to walk out on the piers. Providing such access may give marina owners an easier time at CRMC public hearings, since the public, in general, are supportive of these facilities (West, 1987d). The importance of this waterfront property use was endorsed by the workshop participants, legislators and, as a water dependent use, is also a preferred use in the RI Coastal Zone Management Plan.

The issue of public access again became important when workshop participants were asked if all shoreline residential development be conditioned to providing for public access. 77% of the workshop participants said yes, and 69% of the legislators said yes. (At the moment, the courts have responded no, citing private property ownership rights).

Bay users in the URI survey (West, 1987a,b) were asked to describe how the shoreline of the Bay should look (see Table 9). Descriptions relating to cleanliness were most often mentioned by all user groups. Over-development was referred to by several respondents as detracting from the optimum situation. Access was not a problem frequently mentioned. Of the user groups, access was mentioned most frequently by tourists. Presumably, the local residents were more aware where access was possible and easy. Perhaps the description of the perfect shoreline was similar to the description of perfect water. Cleanliness was the first concern, and user competition for space was of lesser concern, at least for the moment.

TABLE 5-9

What should the Narragansett Bay shoreline be in the optimum situation (West, 1987a,b)

Groups	clean & cared for	no garbage	no structures	picturesque	access	other
	% of total responses					
Tourists	3.0	27.3	22.8	10.6	9.0	nice sand
Beachgoers	22.8	20.6	4.4	5.1	2.9	nice sand
Boaters	23.9	12.0	9.8	16.3	4.4	diversity
Shellfishermen	4.2	37.5	16.7	2.8	4.2	natural
Residents	22.4	20.3	14.3	4.0	6.1	natural

But what about the future? The workshop participants (Keating, 1987) were asked "What percentage of the presently undeveloped shoreline of the Bay would you prefer to see developed between now and the year 2000?" The range of responses was 0 - 50%, but the average was a relatively low 12% of the shoreline. Legislators (Hoffman and Martin, 1988) had a similar response with a range of 0-75% averaging 17%. In conclusion, the polling and the workshops agreed that over-development of the shoreline was a problem for water quality and access reasons, and that uses which provide access to the Bay should be favored over other uses. This problem will be particularly difficult to solve since authority over shoreline use is divided between state and local jurisdiction. Because of private property rights, it could also prove costly to implement any limitations of development pressures.

ENFORCEMENT ISSUES

During the course of the user group surveys and user group workshops, enforcement of environmental regulations was identified as an issue of concern. The goal developed in the workshop was stated this way: "Develop effective local, state and federal governmental mechanisms and resources for enforcing clearly and consistently statutes and regulations pertinent to the Bay." There was a definite consensus that enforcement of existing law would have an immediate beneficial effect on water quality. Each different group was concerned about different areas of the law.

Pretreatment

In the workshop, environmentalist and industry representatives both felt industrial pretreatment regulations should be enforced to protect Bay water quality (Keating, 1987). Responsible industrial firms also felt that violators of the law gained unfair economic advantage and rigorous enforcement could serve as a tool to take away that advantage. The workshop participants would even support industries using toxic materials in their community if the industry met industrial pretreatment requirements (77% approval). The Brown public opinion poll also tended to support the concept of industries paying to clean up their own effluent. 76% said industry, rather than the state, should pay the cost of cleaning up their wastewater (Ward, 1987).

Although workshop participants were not opposed to industrial citings in Rhode Island, if pretreatment regulations were met, the state legislators were not convinced that this was a good idea. Although the reaction was mixed, 55% of the legislators polled said they would oppose citings of industries using toxic materials even if pretreatment regulations were met. The legislators probably had other things than water quality considerations on their minds concerning the problems associated with such industries. Such factors are frequent complaints about air quality, safety of working conditions and hazardous waste disposal and transportation. In conclusion, most industry, user groups and the public support enforcement of pretreatment regulations.

Fisheries enforcement

Both the fishermen leadership cited in the Brown University interviews (Ward, 1987) and the fishermen participants called for better enforcement of fisheries regulations. Ordinary quahoggers participating in the URI survey (West, 1987a,b) were not specifically asked about enforcement. But DEM was ranked by 29.6% of the quahoggers as an effective agency and yet another 15.6% said DEM was the least effective agency. The reasons for these results may or may not have anything to do with enforcement concerns. There is, however, a very strong possibility that the leadership of the shellfishing organizations may be much more critical of agency enforcement performance than the ordinary quahogger. The shellfishing organization leadership became supportive of a high-visibility enforcement program ever since a series of gastroenteritis attacks in New York implicated Rhode Island shellfish products. Even though a later investigation found that Narragansett Bay shellfish were not involved, the incidents depressed the shellfish prices for over 6 months. A rigorous and well-publicized enforcement campaign to allay public concerns was promoted by the fishing industry as a mechanism to restore faith in the Rhode Island product. The success of this enforcement activity, however, is disputed, depending on perspective.

At least part of the problem for the differences of opinion is the poor publicity of the fisheries enforcement activities. The data on this point are clear. During 1985, the Providence Journal reported 3 fisheries arrests, and the Shoreline, a local fisheries monthly, reported 8 arrests. However, during this period of time there were actually 258 arrests for these types of violations. During 1986, the Providence Journal reported 8 fisheries arrests and the Shoreline reported 12. Again the total arrests for these violations were 216. The fishing industry clearly supports the efforts of the fisheries enforcement officers, mainly because the economic viability of the industry depends on the public perception that the product that they buy is suitable for consumption. Public perception about enforcement success is based on what they read or hear in the media. While the enforcement activities themselves may be rigorous and certainly on a par with other neighboring states, the public's awareness of these activities is very poor.

At a minimum, the goals of fisheries enforcement would be more effectively met if these activities had more attention in the media. Two goals would be enhanced: public confidence in the fish products would increase and less responsible individuals in the fishing industry would be deterred in continuing their activities if the true extent of state activities were known.

DREDGING ISSUES

Marina owners, in particular, were concerned that sedimentation in their marinas and docking facilities would render part of their facilities unusable by boats in the future. Because there is no approved area for dredged material disposal, the marina owners have not been able to dredge their slips and approaches for ten years. The need for dredging, especially maintenance dredging, has been documented by surveys funded by the RI Marine Trades Association, and by the Coastal Resources Center of URI. However, the fishing industry, both offshore and inshore, have opposed dredging activities in the past.

The Army Corps of Engineers, the U.S. Environmental Protection Agency and the states of Rhode Island and Massachusetts have assembled an advisory group of the different user groups, governmental and academic specialists to determine (1) if dredging is needed; (2) if a dredged material disposal site or sites could be identified in a area which would be economically feasible for the marinas and other waterfront owners, which would also be acceptable to other user groups of the area, and which would be environmentally acceptable; and (3) if guidelines for use of each site and for dredging operations themselves could be developed which would further minimize impacts.

The Regional Dredging Advisory Group was structured using the concepts of the Bay Project's Management Committee and the user workshop forum. So far, the group has determined that there is ample evidence of the dredging needs and the group proceeded to the next and more difficult issues. Several Bay Project committee members, management representatives, and scientists were participating in this effort, providing expertise and assessing potential reaction to governmental plans.

The Bay Project user workshop did briefly discuss the dredging issue, however,and one of the questions of the workshop survey participants asked, "If providing a safe, environmentally acceptable disposal site for clean dredge materials in the Bay were to cause temporary (3 to 6 months) disruption of shellfishing and finfishing in an area of the Bay, would you still be in favor of dredging?" The users responded 79% in favor; the legislators responding to the same poll also approved by 80%. In conclusion, the users and legislators would be willing to accept temporary inconvenience to the fishing industry to aid the marina owners. The spirit of compromise among the various groups indicated that the Regional Dredging Advisory Group had a good chance of successful deliberations.

However, the group has now temporarily ceased deliberations. A controversy over dredged material disposal alternatives led to a premature end of discussions. One of the participating governmental agencies (the Army Corps of Engineers) refused to let the advisory group even consider upland disposal alternatives. The group responded by rejecting all versions of the other alternatives proposed by the Corps (water area disposal). Since then, the Army Corps has reconsidered its position and a scope of work is being prepared to evaluate all the alternatives. The Corps will examine the offshore alternatives and EPA, DEM, and CRMC will examine the nearshore and upland disposal alternatives. The Regional Dredging Advisory Group will be reconvened. Hopefully, the spirit of cooperation will survive and more progress toward resolution of the issue will be forthcoming. Further attitudes about dredging are detailed in the interim report (Army Corps of Engineers, 1987).

GOVERNANCE ISSUES

Aspects of public and user group reactions to governance issues have been covered in several of the preceding paragraphs. Based on the survey of the leadership of organized user groups conducted by Brown University (Ward, 1987), the patchwork of governing responsibilities especially in the land use and shoreline use aspects has led to confusion and outspoken anger at best, to a perception that the situation is so unworkable that violations and going around the laws are understandable. Violations of the law pose little risk even if noticed. The Bay Project public and user group leadership surveys yielded substantive evidence that there are problems with current governance of the Bay although these data are not sufficient to discover whether the problem comes from the legislation itself, the implementation of that legislation or the enforcement of it.

The URI Sea Grant user group surveys (West, 1987a) were somewhat more specific. A combined list of governmental agencies and private organizations was given to residents in the survey and they were asked first to check which organizations were involved in Bay Management and then rank them in order of effectiveness (see Table 10). Curiously, the residents recognized Save the Bay, an environmental organization, twice as frequently as DEM, and the RI Shellfishermens Association was recognized as frequently as CRMC.

TABLE 5-10

Agencies/organizations with interests in Narragansett Bay management (resident responses, West, 1987a)

Agency/organization	**order of recognition**	**order of effectiveness**
Save the Bay	1 (33%)	1 (41%)
RI Dept. of Environ. Mgt.	2 (16%)	3 (10%)
RI Shellfishermens Assoc.	3	5
RI Coastal Res. Mgt. Coun.	4	3
Narragansett Bay Comm.	5	7
US Environ. Prot. Agency	6	6
URI-Coastal Res. Center	7	11
URI-Sea Grant	7	2 (11%)
Ecology Action of RI	9	8
League of Women Voters	9	8
RI Port Authority	9	8
Coalition of Coastal Co.	12	13
RI Statewide Planning	12	13
Nat. Oceanic & Atm. Ad.	12	12

In terms of effectiveness, Save the Bay was recognized with an overwhelming plurality as the most effective agency or organization. URI Sea Grant can in second, slightly above DEM and CRMC which tied for third. Therefore, two non- regulatory groups, one environmental and one sponsoring scientific research, got higher marks for effectiveness in Bay management than the two state agencies with primary regulatory functions affecting the Bay. Federal agencies were even further down the list. There is a message here. Public perception of Bay management effectiveness, at least to the general public, may be more a function of public visibility than actual power or even accomplishment. The remedy of this situation would be better public relations of the state agencies. But, since effective Bay management is not really a function of visibility, this would only be a cosmetic solution for the benefit only of popularity. There is a place for improved communications with the public, but not simply to compete with Save the Bay for public affection.

Quahoggers, who feel the pinch of bay problems and governance more directly than any other user group, were asked a similar question. A list of agencies was not given. They spontaneously answered that they viewed the EPA had the greatest impact on Bay management (see Table 5-11). The quahoggers were not queried why the chose these agencies. Quahoggers, who seemed to have more knowledge about Bay governance than the other groups (West, 1987a), would have known about sewage treatment construction monies provided by EPA, and the enforcement action of EPA against Providence. The agency least effective in Bay governance, according to quahoggers, is the City of Providence, which until recently owned and operated the Fields Point Treatment Plant and 65 combined sewer overflows. The city's past performance in managing its pollution obviously did not impress the shellfishermen. The second least effective agency mentioned was the Governors Energy Office, probably mentioned because of its support of new power plants and fuel storage facilities along the coast of the Bay. Quahoggers have attended many public meetings in opposition to such projects, and, as a result, the Governors Energy Office is perceived to be pro- development and anti-quahogger. It is curious that 29.6% of the quahoggers listed DEM as the agency with the greatest impact on the Bay, but another 15.6% of them perceived DEM to be the least effective agency. As concluded by the URI investigator, "At the very least, this suggests that communication links between the quahoggers and DEM could be improved," (West, 1987a). In any event, there is clearly a mixture of opinion about DEM's effectiveness among quahoggers.

TABLE 5-11

Quahoggers' opinion of the relative impacts of governmental agencies on Bay management (West, 1987a)

Govt agency	Rank of agency with greatest impact on Bay management	Rank of agency with least effectiveness in Bay management
US Environ. Prot. Agency	1	-
RI Dept. of Environ. Mgt	2	3
RI Coastal Res. Mgt. Coun.	3	-
US Shellfish Sanitation	4	4
Coalition of Coastal Co.	5	6
City of Providence	6	1
RI Gov. Energy Office	7	1
Army Corps of Engineers	8	5
Nat. Mar. Fisheries Service	-	6
RI Statewide Planning	-	6

- means there was no mention at all of this agency in the category.

Over half of the boaters (56%) in the URI survey listed DEM as the most important agency in Bay governance and 76% ranked DEM as "effective" to "very effective". Only 3.3% replied that DEM was "not very effective". When asked where DEM could improve its performance, chemical pollution abatement (74%) and oil spills (26%) were specifically mentioned.

Thus there is a divergence of opinion about the quality of Bay governance among the various user groups. Some of these opinions may be formed simply by the volume of media coverage generated by the agency. Other groups have discovered weaknesses which have already been admitted. The impression here is that the leadership of the various user groups tend to be more critical of governmental performance than do the general membership, probably because the leadership has more frequent contacts with the agencies. Nonetheless, both surveys of the user group leaders and the users themselves can be useful for the Narragansett Bay Project and the cooperating agencies as they delve more deeply into problems with Bay governance in the future.

MEDIA COVERAGE OF ISSUES

For approximately one year, the Bay Project Administration collected, catalogued and categorized articles about the Bay and Bay activities as published by several local newspapers (Martin and Hoffman, 1987, see Table 5-12). The topics covered by the general daily newspaper, the Providence Journal, were quite diverse, reflecting the diversity of activities and diversity of readership. The topic receiving the most coverage by the Journal was recreational boating (11.9%), the bulk of which were regatta announcements, results of racing activities for sailboats, yachts, sculls, canoes, and sailboards. Recreational activities in general, such as recreational boating, shoreline recreation, recreational fishing and tourism together accounted for 29.0% of the Bay-related articles in the Journal.

The next most frequently covered topic was about sewage treatment (7.8%) and the articles usually dealt with sewage treatment plant problems, expansion of sewerage service, and disputes about user fees. Environmental topics in general, such as sewage treatment, incinerators, land use and hazardous waste together accounted for 21.5% of the articles. The third topic most covered by the Journal was shoreline development (7.5%). These articles usually dealt with hearings of zoning boards and CRMC with regard to shoreline development projects. Commercial aspects of bay life, such as development, fishing industry, shellfishing and transportation, totalled 22.1% of the Bay articles. The emphasis however was different for different publications.

The Providence Journal, the state's largest daily newspaper, has a statewide circulation. Its audience is the general public and the mixture of coverage reflects the diversity of readership. The Narragansett Times, a weekly, covers the towns in the southern part of the state. Again the readership is the general public and the mixture of coverage was diverse, although different than the Journal in coverage of specific issues. Soundings is a national monthly boating newspaper with a New England edition; coverage of recreational aspects of the Bay is obviously emphasized because the readership are boaters. The Shoreline is a monthly local commercial fishing newspaper and thus the coverage is heavily weighted toward the fishing and shellfishing industries. The Save the Bay Newsletter is a bimonthly newspaper for members of the state's largest environmental organization. They cover environmental issues more than the other newspapers but do not exclude the other aspects of Bay life.

In general, the printed media of Rhode Island cover a wide variety of Bay activities and issues, affording the Rhode Island citizenry with exposure not only to the problems of the Bay but also to the role the Bay plays in the everyday recreational and commercial life of the state.

TABLE 5-12

Media coverage of Bay activities (July 1985, to Dec. 1986)

Newspaper	Type	Audience	Percentage of coverage relative to total Bay activity articles*		
			recreation	environment	commercial
Providence Journal	daily general	statewide	29.0	21.5	22.1
Narragansett Times	weekly general	southern RI	33.1	15.8	29.0
Soundings	monthly	boaters	42.2	4.4	9.9
Shoreline	monthly	commercial	10.0	4.7	74.6
Save the Bay	bimonthly	environmental	11.8	29.7	19.1

***The total amount of space devoted to Bay activities relative to all other topics was not reported; other categories not listed here had minor amounts of coverage, such as marine science, history, sea rescues,etc.**

DOES THE PUBLIC REALLY WANT TO PARTICIPATE IN ENVIRONMENTAL DECISION-MAKING?

What makes us think that the public really wants to participate in environmental decisions? The record of attendance at public hearings on environmental topics has been mixed. Some hearings, such as on the trash incinerator at Quonset, have attracted hundreds of local citizens. But other hearings, such as on the DEM Water Resources work plan for 1988, was attended by only one citizen (who represented the League of Women Voters). The URI survey (West, 1987a) confirmed that most Bay users do not attend such meetings. The survey indicated that 86% of the residents, 80% of the boaters, and 50% of the quahoggers had not attended an environmental meeting in the last year.

However, Dr. Ward remarked that it was surprising to the pollsters that all the people contacted to participate in the telephone poll actually completed the questionnaire, even though 30-45 minutes was required. He concluded that this was another indicator of public interest in Narragansett Bay (Ward, 1987). Mr. Keating experienced a similar response when inviting people to participate in his workshops. Even though a nine hour commitment of time was required, all the invitees (except the legislators) agreed to participate (Keating, 1987). The conclusion here is that the public will participate if they are specially invited to do so. A simple advertisement in the newspaper would not have achieved these results.

The public will participate especially if they are personally contacted and invited to attend. This is feasible for the Narragansett Bay Project which has staff assigned to public participation. For governmental agencies, it will be necessary to commit staff for this purpose. The public interest is there.

KEYS TO THE SUCCESS OF THE BAY PROJECT PUBLIC PARTICIPATION PROCESS

The inclusion of user group representatives on the Management Committee of the Narragansett Bay Project was the first step in soliciting ideas of the public with regard to Narragansett Bay Project activities. The later surveys and workshops involving many more participants independently endorsed the emphasis priorities derived by the Management Committee. So although the committee had their own doubts about how well they could represent their own constituencies and how closely their impressions mimicked the general public, the committee's deliberations coincided with public and user group concerns. Therefore, the first success of the Bay Project in responding to the wishes of the public was the structure and composition of its own governing body, the Bay Project Management Committee.

The next way that the Bay Project sought advice from the user groups was to include the appropriate groups in with the scientists planning the various projects. The help in suggesting problems and issues facing their industries was followed then by aiding the scientific community with ideas about sampling stations and even help in collecting samples. This process planted the seeds of a network between the scientists, the Bay Project, and users. The willingness to incorporate public participants as equal partners in the working group forum forged relationships between the scientists and users which will last far after the Bay Project is over. Therefore, lasting relationships between groups such as the shellfishermen and scientists is evidence of the second success of public input to the Bay Project.

The success of the third activity in public participation, the user workshop forum, will depend on the continuation of the process beyond its initial effort. The potential for success is quite promising, because these individuals from diverse backgrounds showed a willingness to listen to each other and work together at least to resolve what should be the future of the Bay. This process could also work in the future to tackle specific issues of Bay management when more than one user group is involved.

But how can this initial success be continued into the future after the Bay Project is gone? What forms of public participation have been useful?

First, public opinion polls have accurately predicted the success of bond referenda. The administration and legislature might be well advised to conduct polls before bonding legislation is proposed to evaluate its potential success and to plan campaigns for passage. Polls can also aid government assess which issues the public feels are most important. This information is valuable in setting priorities and in planning.

Second, a well designed committee with broad representation is able to devise work plans and evaluate solutions in keeping with the desires of the public and the various user groups. The Bay Project Management Committee has been successful relative to other similar committees because discussion on any Bay-related topic has not been limited even if the topic was sensitive.

Third, task forces on more technical topics have proven successful both in the Bay Project and on other state environmental issues. Another example of this is DEM's Stormwater Management and Erosion Control Task Force.

The Bay Project has discovered, however, that the difference between real and perfunctory public participation programs is a function of attitude, not methodology. The first attitude which is detrimental to the success of public participation is combative defensiveness. The Bay Project recognizes that the public may offer opinions which are contrary to the prevailing regulatory or scientific logic on any given issue. And yet there could be simple reasons for the disagreement. The public, or the regulators, may be operating on absent, erroneous, or out-of-date information. In this case, educational efforts of one or both groups can resolve the differences. Or both groups may look at the same information and interpret it differently. Is the cup half-full or half-empty? This can be solved with discussion and compromise. So there are simple reasons for differences of opinion which have nothing to do with personal animosity, at least in the beginning. It is better to investigate the reasons for the disagreements than to engage in verbal combat.

The second attitude shown to be detrimental to public participation is limitation of areas open for discussion. There are several recent unfortunate examples of this. Limitation of discussions about alternatives led the Corps of Engineers Regional Dredging Advisory Group to disband, at least temporarily; limitation of discussion about the fate of monies in designated state accounts paralyzed the Quahog Committee of the RI Marine Fisheries Council for several months. Even the perception that governmental agencies have something to hide from the public can poison an otherwise productive working relationship.

A third attitude detrimental to public participation is the resistance of the bureaucracy to change. Accepting the possibility of change is no easier for a bureaucrat than for any other person.

There are two other problems associated with public participation. Most administrators do not appreciate the intrusion of the public into what had been their exclusive turf. They feel that the public doesn't fully understand their situation and, therefore, public participation requirements required by the Congress and the state legislature are viewed with annoyance. Legislatures have had to be sensitive to public concerns in order for their members to get re- elected. The bureaucracy, without this incentive, would rather not bother with public participation programs at all. This lack of excitement about public participation in general is a tough problem to overcome. It becomes the obligation of citizens who wish to participate to educate themselves and come prepared to discuss the issue intelligently and unemotionally. Only then will public participation be viewed as somewhat useful by administrators. As many of the public members of Bay Project committees found out, this is not easy. Government and scientific representatives viewed their participation in Bay Project activities as part of their regular jobs. However, participation by public members is voluntary and consumes time which could be spent elsewhere. It is hard to maintain a level of interest when discussions are dull, or centered on topics outside their main area of interest. Their commitment is hard and sometimes not fully appreciated by the committee itself or the constituency they represent.

Finally, others have pointed out that the public, regulators, scientists, and policy makers all travel in separate worlds (West, 1987c). Their language is different, and their approaches to problems are different. This situation only compounds the problem by making communication more difficult.

However, the Bay Project has proven that people from very diverse backgrounds can work together when all are committed to the same goal and when governmental agencies are willing to listen. The Bay Project has taken only the first few steps in starting cooperative efforts between user groups with different needs and different goals. The interaction of the various groups in the workshop forum, however, not only pointed out differences in philosophy, but also pointed out the many similarities. The key to success is providing not only a forum for exchange of ideas, but a mechanism for active participation. In the past, each user group felt that the only recourse for active participation has been in the legislative process through individual lobbying activities. This has led to patchwork legislation and has pitted one special interest against others in a controversial and confrontational atmosphere. Even more common is when the special interest finds itself pitted against the executive branch. The legislature becomes the arbitrator. All of this could be averted if the groups had an ongoing mechanism by which compromises could be reached in a friendly atmosphere long before the situation requires legislative remedy. The Bay Project can only start this process. The long term future of the Bay will depend on its continuation.

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APPENDIX A

DESCRIPTION AND MEMBERSHIP OF GOVERNANCE COMMITTEES

Executive Committee:

The executive committee of the Narragansett Bay Project is composed of two members: Michael Deland, EPA Regional Administrator of EPA's Region I (New England region) and Robert Bendick, director of the RI Department of Environmental Management. They are the final authority regarding policy, plans, activities, and disposition of the recommendations. In addition, they assign and supervise the staff of the Project. The staff of the Narragansett Bay Project is housed in two offices. During the first year, Dr. Michael Conner of EPA's Region I Water Quality Branch as assigned half-time to the Narragansett Bay Project. Following his departure from EPA, Katrina Kipp of this same office took over these duties. In general, their duties involved interaction between the Narragansett Bay Project and the EPA National Estuaries Office, EPA Regional Office, and other federal agencies (e.g. the National Oceanic and Atmospheric Administration, the US Geological Survey, and the Food and Drug Administration). The State of Rhode Island appointed Dr. Eva Hoffman, an oceanographer formerly with the University of Rhode Island, to serve as project manager from an office within the RI Department of Environmental Management. Following her departure in mid-1987, Dr. Hoffman was succeeded by Caroline Karp, an environmental lawyer. The state project managers were assigned full time to the Narragansett Bay Project. Other staff in this office during the first year included a full time public education specialist position filled by Chris Powell, a fisheries biologist and environmental activist, later by Judith Lawson, a science writer, and later by Trish Johnson, a public participation specialist. Part-time staff included two environmental scientists, Brooks Martin and Jennifer Martin, one marine affairs historian, Melissa Waterman and an office manager, Claire Aldrich. This office was responsible for interactions with the scientific community, the state and local governmental agencies, the scientific community, the various Project Committees and the public. Together with the EPA staff in Boston, the staff in the Narragansett Bay Project office is also responsible for implementing the decisions of the various Project governance committees.

Management Committee:

The Management Committee was appointed by the Executive Committee to provide advice concerning the policies and execution of the Bay Project. Although the Management Committee of the Chesapeake Bay Project was composed only of representatives of the various state and federal agencies, the Executive Committee felt that the Narragansett Bay Project Management Committee should have a broader base of representation. Therefore, representatives of the major universities of the area were invited to serve and representatives of economic and environmental interests were also included. The Management Committee, during its first meeting, thought this was a good idea and recommended that the concept of wider representation be even further expanded. Additional public members were appointed by the Executive Committee. The expanded Management Committee represented the state and federal agencies, like the previous model, but also included academic, industrial, fishing, and environmental interests as well. The Management Committee felt that relegating these representatives to a Citizens Advisory Committee did not adequately include their concerns in the decision process. If the Project's recommendations were to reflect a consensus of thought, these groups should participate in the development process. The composition of this committee, while departing from the only previous model, was later required of all estuary projects in the national Water Quality Act of 1987. Congress recognized that the logic was sound, and the Narragansett Bay Project Management Committee also proved to Congress that the composition mix was workable and productive.

The Management Committee appointed two committees and one subcommittee to help them in their planning and oversight responsibilities: the Science and Technical Committee, to be chaired by the director of the EPA Environmental Research Laboratory in Narragansett (a Management Committee member); the Public Education Committee to be chaired by the director of Save the Bay (also a Management Committee member); and the Ad-Hoc Policy and Management Issues Review Subcommittee, to be chaired by a volunteer from the Management Committee. The meetings of the Management Committee are held the last Wednesday of each month in the Conference Room of the Fields Point Wastewater Treatment Facility. They are open to the public and meeting notices are posted in the DEM and Fields Point lobbies in accordance with the provisions of the RI Open Meetings Act. The membership of the Management Committee during the first year is given in Table 1.

Science and Technical Committee:

The membership of the Science and Technical Committee was formed by its chairman with the advice of other Management Committee scientists and staff. The membership roster was designed to have equal representation of academic scientists and scientists from federal and state agencies and furthermore cover a cross section of scientific and engineering disciplines. Four additional criteria for membership were used by the chairman: (1) The members were to be recognized national and international experts in their field of interest to bring credibility to the group; (2) The members should have expertise in the whole field of marine and estuarine pollution and management issues; (3) The members should have proven ability to work with others in a committee setting; and (4) The members should have participated extensively in Narragansett Bay research in the past, and would therefore be knowledgeable about information already available, and projects currently underway with funding from non-Bay Project sources.

With staff support, this committee is responsible to the Management Committee for developing a scientific research agenda, developing requests for proposals, reviewing proposals, recommending contractors, and oversight of the progress of the scientific projects. Marathon meetings were common for this committee. Its membership is also given in Table 1.

Public Education Committee:

Because citizen and economic interests were included in the Management Committee itself, the Committee felt that a separate Citizens Advisory Committee was not needed at least in the beginning. Instead, a Public Education Committee was formed with the main goals of devising ways for the public to become educated about Bay issues being examined by the Project, later to inform the citizens about the results of the Project, and to devise a forum by which citizens could comment about Bay Project activities. The chairman, the director of Save the Bay, was chosen because Save the Bay, as the state's largest environmentalist organization, also had public education about Bay issues as a large portion of their efforts already.

Membership in this committee was designed to represent a broad cross- section of public information and education experts, media representatives, and public relation experts. In addition to aiding staff in organization of media events, press conferences, and participation in local festivals, the public education committee was also responsible in developing an agenda for interactions with the public, devising requests for proposals on workshops and surveys, reviewing proposals, recommending contractors and oversight of the progress of any of these projects. The membership roster of this committee is also given in Table 1.

Ad-Hoc Policy and Management Issues Review Subcommittee:

When the Management Committee decided to investigate governance and management issues, an area which the Management Committee itself had expertise, they created a subcommittee of its own members to develop agendas, review proposals, and oversee the progress of these projects. Membership and the chairmanship of the subcommittee came from volunteers from the Management Committee. (Later, this subcommittee was reorganized along the lines of the other committees and given the same status.) The membership of the original subcommittee is given in Table 1.

Working groups of the Science and Technical Committee:

Because the oversight and coordination responsibilities of the Science and Technical Committee proved to be particularly time consuming, this committee formed several working groups to aid them. Working Groups were formed initially on Water Quality and Living Resources. Later in the first year a working group on Brown Tide was formed and during the second year working groups on Data Management, Historical Assessments, and Monitoring Protocols were also formed. The chairmanship of these working groups was a volunteer from the Science and Technical Committee. The membership in these working groups was designed to be flexible depending on the issue but in general included representatives of the Science and Technical Committee, all the principal investigators dealing with the topic, technical experts from state and federal agencies with similar programs, and academic scientists with similar projects underway with funding from non-Bay Project sources. These groups also provided a forum to discuss technical issues and research needs for use by the Science and Technical Committee and staff in formulating the research agenda for the Project. Because the memberships were large, many diverse opinions were offered for the Management Committee to consider. The first year's membership roster for these groups in given in Table 2.

APPENDIX A

TABLE A-1

Narragansett Bay Project Committee Membership (first year)

EXECUTIVE COMMITTEE

Robert Bendick, Director of the Rhode Island Department of Environmental Management

Michael Deland, Regional Administrator, U.S. Environmental Protection Agency, New England Region.

MANAGEMENT COMMITTEE

William Brungs, Director, U.S. Environmental Protection Agency, Environmental Research Laboratory, Narragansett RI (Richard Garnas, alternate)

Stephen Cote, President of the Rhode Island Shellfishermens Association

Trudy Coxe, Executive Director of Save the Bay, Inc.

Richard Delaney, Director of the Massachusetts Coastal Zone Management Program (Steven Bliven, alternate)

David Fierra (Management Committee chairman), Division Director, Water Programs,U.S. Environmental Protection Agency, New England Region (Ronald Manfredonia, alternate)

Thomas Hall, President, Ocean State Fishermens Association

George Hawkins, Executive Director, RI Marine Trades Association and RI Boating Council

Eric Jankel, Executive Director, Narragansett Bay Water Quality Management District (Lynne Pike, alternate)

Patrick Kirby, Mayor, City of Newport (Roy Anderson, City Engineer, alternate)

John Knauss, Vice President for Marine Programs and Dean of the Graduate School of Oceanography, University of Rhode Island

Brian Knowles, Executive Director, Coalition of Coastal Communities

Dennis Ledbetter, Vice President, Armbrust Chain Co.

William Miner, Chairman and Executive Director of the Rhode Island Coastal Resources Management Council (George Seavey, alternate).

Erich Salomon, Past President of the Rhode Island-SE Massachusetts Electroplaters and Metal Finishers Society.

Kenneth Sherman, Director, National Marine Fisheries Service Laboratories in Narragansett RI (Larry Buckley, alternate)

Daniel Varin, Chief, Office of State Planning, RI Department of Administration (Scott Milar, alternate)

Harold Ward, Director of the Center of Environmental Studies, Brown University.

Thomas Wright, Assistant Director for Regulations, Rhode Island Department of Environmental Management (James Fester, alternate)

SCIENCE AND TECHNICAL COMMITTEE

Victor Bierman, U.S. Environmental Protection Agency, Narragansett

William Brungs (chairman), U.S. Environmental Protection Agency, Narragansett

Michael Connor, U.S. Environmental Protection Agency, New England Region

Richard Garnas, U.S. Environmental Protection Agency, Narragansett

Carmine Goneconte, Narragansett Water Pollution Control Association

John Musselman, U.S. Food and Drug Administration

Scott Nixon, Graduate School of Oceanography, University of Rhode Island, and RI Sea Grant Program

James Quinn, Graduate School of Oceanography, University of Rhode Island

Maria Rea, Rhode Island Department of Environmental Management

Kenneth Sherman, National Marine Fisheries Service, Narragansett

Theodore Smayda, Graduate School of Oceanography, University of Rhode Island.

Frank White, Department of Mechanical Engineering, University of Rhode Island.

PUBLIC EDUCATION COMMITTEE

Hank Bouchard, public affairs, WPRI-TV, Television Channel 12

Steve Cascione, weather, WLNE-TV, Television Channel 6

Trudy Coxe (Chairwoman), Save the Bay

Roger Greene, Rhode Island Department of Environmental Management

Lynne Hanson, Center for Ocean Management Studies, University of Rhode Island

Charles Hooker, Department of Radio and Television, University of Rhode Island

Brian Knowles, Coalition of Coastal Communities

Scott Millar, RI Office of State Planning

Steve Morin, RI Department of Environmental Management

Chris Powell, Save the Bay

Harold Ward, Center for Environmental Studies, Brown University

Charles Young, columnist, and Save the Bay.

AD-HOC POLICY AND MANAGEMENT ISSUES REVIEW COMMITTEE

Trudy Coxe, Save the Bay

Richard Delaney, Massachusetts Coastal Zone Management Program

James Fester, RI Department of Environmental Management

George Hawkins, RI Marine Trades Association

Brian Knowles, Coalition of Coastal Communities

Dennis Ledbetter, Armbrust Chain

William Miner, RI Coastal Resources Management Council

Lynne Pike, Narragansett Bay Water Quality District Commission

Erich Salomon (Chairman) RI Electroplaters Society

Curt Spaulding, U.S. Environmental Protection Agency, New England Region

James Thomas, National Oceanic and Atmospheric Administration

APPENDIX A

TABLE A-2

Working group membership

WATER QUALITY WORKING GROUP

Mike Annarummo, RI Dept. Environ. Mgt.
Vic Bierman (chair), Environ. Prot. Agency
Victor Cabelli, URI, Dept. of Microbiology
Mike Conner, Environ. Prot. Agency
Jim Fester, RI Dept. Environ. Mgt.
Dick Garnas, Environ. Prot. Agency
Carmine Goneconte, Narr. Water Pollution Cont. Assoc.
Carlton Hunt, URI, Oceanography
Scott Nixon, URI, Oceanography
Candace Oviatt, URI, Oceanography
Mike Pilson, URI, Oceanography
James Quinn, URI, Oceanography
Maria Rea, RI Dept. Environ. Mgt.
Peter Sampou, URI, Oceanography
Malcolm Spaulding, URI, Ocean Engineering
Craig Swanson, Applied Science Associates
Frank White, URI, Dept. of Mechanical Engineering
Ray Wright, URI, Dept. of Civil Engineering

LIVING RESOURCES WORKING GROUP

Larry Buckley, National Marine Fisheries Service
Victor Cabelli, URI, Dept. of Microbiology
Gerald Carvalho, Wickford Fishermens Alliance
Steve Cote, RI Shellfishermens Assoc.
Donald Gadbois, National Marine Fisheries Service
Rich Hittinger, Thibault Assoc.
John Musselman (chair) Food and Drug Adm.
Sheldon Pratt, URI, Oceanography
Aaron Rosenfeld, National Marine Fisheries Service
Saul Saila, URI, Oceanography, RI Marine Fisheries Council
Dick Sisson, RI Dept. of Environ. Mgt.
Ted Smayda, URI, Oceanography
John Stolgitis, RI Dept. of Environ. Mgt.

SPECIAL WORKING GROUP ON ALGAE BLOOMS

Al Beck, Environ. Prot. Agency
Bob Bendick, RI Dept. Environ. Mgt.
Vic Bierman, Environ. Prot. Agency

Bill Brungs, Environ. Prot. Agency
Larry Buckley, National Marine Fisheries Service
Bob Campbell, URI, Oceanography
Chris Campbell, RI Dept. Environ. Mgt.
Jay Cronan, RI Dept. Environ. Mgt.
Earl Davey, Environ. Prot. Agency
Peter Doering, URI Oceanography
Percy Donaghay, URI, Oceanography
Ann Durbin, URI, Oceanography
Ted Durbin, URI, Oceanography
James Fester, RI Dept. Environ. Mgt.
Paul Fofonoff, URI, Oceanography
Jeffrey Frithsen, URI, Oceanography
Dick Garnas, Environ. Prot. Agency
Paul Hargraves, URI, Oceanography
Eva Hoffman (Chair), Narr. Bay Project
John Karlsson, RI Dept. Environ. Mgt.
Skip Nelson, Environ. Prot. Agency
Scott Nixon, URI, Oceanography
Candace Oviatt, URI, Oceanography
Don Phelps, Environ. Prot. Agency
Chris Powell, RI Dept. Environ. Mgt.
Jan Prager, Environ. Prot. Agency
Robert Richardson, RI Dept. Environ. Mgt.
Jan Rines, URI, Oceanography
Dick Sisson, RI Dept. Environ. Mgt.
Ted Smayda, URI, Oceanography
Dick Steele, Environ. Prot. Agency
Tracy Villareal, URI, Oceanography
Hal Walker, Environ. Prot. Agency
Tom Wright, RI Dept. Environ. Mgt

APPENDIX B

POLICIES OF THE NARRAGANSETT BAY PROJECT

Since the Narragansett Bay Project was among the first projects of the EPA National Estuaries Office, there was no history of policy regarding funding, conflict of interest, review, or agency relationships (other than the general guidelines for all EPA grants). During the first year, several decisions were made by the Management Committee regarding these issues.

Funding principles:

The main principle guiding Project policy on funding is open competition for all Project contracts. For each element of the workplan, a request for proposals was to be widely distributed among academic experts of the region, federal and state agencies, and regional consulting firms. Judgments on funding were to based on (1) technical merit of approach and methods, (2) familiarity with the field of work, (3) clarity of proposal presentation, (4) probability that the project would accomplish the objectives, and (5) cost effectiveness. General level-of-effort contracts with one firm to do all of the work plan was rejected as a funding mechanism. Although this mechanism has less paper work and coordination is easier, it also limits participation by governmental agencies and the academic community. In addition, no preferential treatment would be given to any federal or state agency or academic group. Potential investigators were encouraged to find financial support from other agencies and examine the feasibility of joint efforts. Although a balance of governmental, academic and private participation was desired by the Management Committee, artificial division of funds prior to proposal evaluation was also rejected. In the first year, a balance was achieved through open competition without such pre -arranged constraints.

Conflict of interest in contractor selection

Conflict of interest was also a potential problem adddressed by the Management Committee. Because the experts in Narragansett Bay issues were the best qualified to serve on committees of the Project, it was quickly recognized that these same experts were also the kind of investigators highly qualified to participate as principal investigators with project funding. All the committees realized that a large number of the voluntary committee members would be unwilling to participate in this advisory role if they were thereby excluded from funding. Therefore, it was decided that members of the various committees would be excused and not allowed to participate or observe when the merits of their own proposals on those of competing proposals were discussed. Peer referees were used for evaluation of proposals in addition to committee review as an extra precaution to prevent even a perception of undue influence.

Review procedures of final reports

The review procedures of final reports submitted to the project were also debated. It was decided that before release of any report through Project offices, a series of reviews should be completed. Staff and committee review would determine if the report addressed satisfactorily the objectives of the scope of work, if the report contained the data in a form suitable for entry into the Project data management system, and if the QA/QC plan for each project was followed. Peer review of the report would particularly examine if the appropriate methods were used, if the data were clearly presented and discussed, and if the conclusions were reasonable outgrowths of the data. The subcommittees would examine all the reviewers' and referees' comments and return the draft report for any necessary revisions. Upon receipt of the final report, the subcommittee would check to see if the appropriate changes were made, then distribute the report to Management Committee members, and recommend acceptance or rejection of the report by the Management Committee.

There would be two levels of positive action by the Management Committee: "endorsement" would indicate that not only is the report itself acceptable for the purpose of fulfilling the requirements of the grant, but also the Management Committee is completely comfortable with the conclusions and recommendations; "acceptance" means that the report is acceptable for the purpose of fulfilling the requirements of the grant, but the Management Committee is not ready to fully endorse the recommendations without further investigation or discussion of other factors. The other factors could include economic, social, or political feasibility. After endorsement or acceptance, the report would be referred to the Public Education Committee, along with the nature of the approval included on the cover page of the report. The Public Education Committee would then decide about the methods to be used in releasing the report. The first report was released in a press conference with the principal investigator and Robert Bendick.

The Management Committee also decided that principal investigators could present their data at any time to professional or public meetings with the understanding that the opinions expressed were their own and did not reflect the views of the NBP, EPA, or DEM. This concept is the policy of most federal agencies which support scientific studies.

Relationship of NBP and other governmental agencies:

One policy which was established by the Management Committee regarding relationships to other governmental agencies included the concept that should acute situations develop where immediate action should be taken by any state or federal governmental agency, immediate notification directly to that agency should take place even if the research was still in progress. Although NBP staff was instructed to keep the appropriate agencies informed of Bay Project results, NBP investigators were encouraged to interact with these agencies or public groups on their own should they have information to share or were seeking advice. In the first year, the Brown Tide situation in the summer of 1985 led to several meetings of Bay Project investigators with scientists and managers of government agencies to share latest findings and discuss theories. The Working Group on Algae Blooms was formed in response to this emergency situation. Later Bay Project cooperation led to three enforcement actions. Intrusion of NBP into normal operations of agency functions was minimal and participation was limited to issues where NBP aid was specifically requested by the agency involved.

Policy formulation for the project is not static. As new issues arise, policies are developed to respond. Not only is the present situation examined, but future impacts on the conduct of the project are considered in the policy formulation process.

PLANNING PRINCIPLES

At the beginning of the Narragansett Bay Project, it was highly uncertain how long the project funding would continue. The special appropriations act of June 1984 included funding for only one year but a second year of funding looked promising. Beyond that, continuing efforts were not quaranteed, especially in an atmosphere of administration and Congressional efforts to reduce the federal budget.

Several approaches were discussed in the Executive, Management, and Science and Technical Committees. There were two main approaches. The NBP could have many small projects of long term duration on a wide variety of issues, which would produce results after a 4 or 5 year period, or the NBP could fund fewer intensive projects of short duration which would produce results on fewer issues in one or two years. The advantage of the long term approach would be a stable team of investigators committed for the long haul; however, action recommendations would come in a flurry at the end of 4 or 5 years. The advantage of the short term projects with intensive focus on only a few issues would be the production of quick results; however, principal investigators could experience intense personnel shortages when gearing up and potential lay- offs at the end.

The committees all agreed that the latter approach was the more appropriate because (1) funding beyond one or two years was uncertain; (2) quick results were necessary to convince the administration and Congress that the Project was worthwhile and deserved continuation; and (3) a few completed projects on priority issues were preferable to a series of half-finished projects should funding suddenly cease. It was also felt that if the fewer efforts included projects utilizing a variety of disciplines each year, the personnel problems could be minimized. For example, the planning approach which called for a first year of exclusively chemistry projects and a second year of exclusively modelling projects was rejected on this basis. Then came the challenge for the committees: Which of the many issues of Narragansett Bay management should be considered first. Generally, three criteria were used is these deliberations: (1) the priority of the issue to the public and to governmental regulators; (2) the feasibility of timely success; and (3) availability of non-Bay Project funding to aid the investigation.

APPENDIX C

The First Year's Work Plan and Justification

A. Modelling projects

The modelling section of the work plan included two projects: (1) a Mt. Hope Bay hydrographic model which would be a necessary first step to any future water quality modelling of this region of the Bay; and (2) expansion of an existing ecosystem model to include oxygen dynamics and a sediment component. The Mt. Hope Bay project was a high priority of state regulators from both Rhode Island and Massachusetts since the state line bisects this section of the Narragansett Bay system. It was a high priority of the fishing industry because the area had been closed to shellfishing for a number of years and they were interested in what further abatement might be necessary to reopen the area. The project was feasible; a similar project had been completed for the Providence River and upper Narragansett Bay and was already in frequent use to evaluate abatement alternatives in this area. And URI Sea Grant was willing to join with the Bay Project for this effort and fund half of its cost. The full cost was too expensive for either group to fund on its own. The expanded eutrophication model was a high priority to the scientific community because of its potential to separate man-made effects from natural events. Because of its basic scientific research nature (a usable product for regulators could not be guaranteed), again URI Sea Grant was willing to fund half the cost of the effort.

B. Water quality monitoring projects.

In terms of water quality investigations, it was decided to devote the first two years of NBP activities on point sources, primarily sewage treatment plants, and their impacts on Bay water quality. It was fully recognized that point sources and non-point sources both contribute pollutants to the Bay, but point sources were targetted for investigation first. Providence's sewer authority, the Narragansett Bay Commission was already in the process of studying non-point contributions and impacts from combined sewer overflows into the Bay at a cost of $2-3 million of bond issue monies. The Blackstone Valley District Commission and the City of Fall River also had plans to conduct similar investigations in their jurisdictions. These studies were due for completion by 1988. Based on these results, any follow-up studies necessary could be considered at that time. Since the impact of the non-point sources would also be superimposed on a background of point source impacts, it made sense to examine the point source impacts, the background, before examining the extra, more complex, non-point problems.

All the water quality projects were, therefore, to emphasize dry weather conditions to minimize non-point contributions. The point source theme included two areas of interest. Tributaries are clearly a major source of some of the pollutants entering the Bay system. Already the States of Rhode Island and Massachusetts had begun efforts to study the Pawtuxet and the Ten Mile Rivers to determine the levels of toxic pollutants in these rivers and the magnitude of the various sources. The data were to be used for waste load allocation for the various pollution sources on these rivers to protect the rivers themselves and Narragansett Bay. The Blackstone River, the largest freshwater source to the Bay, had not been studied. The Blackstone River water quality survey was a high priority to Rhode Island water quality managers. The Project was feasible because the same techniques and model developed for other Rhode Island rivers could be adapted for use in the Blackstone.

The second area was a complete survey of Narragansett Bay water quality. There had been surveys of Narragansett Bay water quality before but these were prior to installation of industrial toxics pretreatment programs, and there was not much toxics data available at all in Mt. Hope Bay, the East Passage, or in the Sakonnet River sections of the Bay. A comprehensive series of surveys during the same stage of the tide with data for oxygen, nutrients, metals, organics and fecal indicators was a high priority to both the academic community and the regulatory community. The data could be used to evaluate the present condition of Bay water quality and later could be used to calibrate water quality models for use in waste load allocation. The project was feasible because state of the art analytical methodology and sample collection methods had already been developed in earlier projects. State and local government employees also volunteered services to aid this endeavor, thereby reducing labor costs.

C. Biological and fisheries resources projects

The biological portion of the workplan included a series of projects about quahogs, a shellfish of economic importance to the Narragansett Bay region. The quahog package was of high priority to state regulators, the academic community, the shellfishing industry and the public. The projects were feasible using existing methods updated with new checks. The RI Department of Environmental Management volunteered services to this project providing personnel and boats to aid in sample collection. Later volunteers from the fishing industry aided scientists collect samples from shallow areas in Mt. Hope Bay. Another biological investigation concerned planktonic components of the Bay ecosystem. This was a high priority among academic investigators since plankton form a low rung on the ecosystem ladder and the distribution as a function of nutrient concentrations was hoped to provide information about possible eutrophic conditions in the Bay. There was a 25 year record of Bay plankton at one location but a wider geographic spread was necessary. The project was feasible using pre-existing methodology and because of the basic scientific nature of the study, URI Sea Grant was willing to fund half of its cost.

D. Policy Projects

The Management Committee felt that scientific investigations were not the only kinds of studies needed in the Bay. Two projects on policy issues were also included in the workplan. One project was to survey special interest groups to examine their needs and goals for improved management, and then later to survey the general public about these issues. The project was a high priority to the Management Committee and its public and industry representatives. It was feasible and cost-sharing was arranged with the Brown University Foundation. The other project was a preliminary investigation of legislatively derived overlaps and gaps in Bay governance. This investigation wanted to examine who is responsible for what. The project also had a high priority among Management Committee members, it was feasible and the agencies all promised cooperation with the contractor.

APPENDIX C

TABLE C-1

First year projects

Modelling projects:

1. "Development of a one-dimensional water quality model for the Blackstone River" James Quinn and Raymond Wright, Graduate School of Oceanography and College of Engineering, respectively, University of Rhode Island. Described in Chapter 2, this report.

2. "Circulation dynamics in Mt. Hope Bay and Taunton River" Malcolm Spaulding and Frank White, Ocean Engineering, University of Rhode Island. Will be described in the second year report.

3. "Ecosystem modelling effort" Scott Nixon and James Kremer, Graduate School of Oceanography, University of Rhode Island, and Biology Department, University of Southern California, respectively. Will be described in second year report.

Water quality projects:

4. "Narragansett Bay Water Quality Monitoring Program" Michael Pilson, Candace Oviatt, Scott Nixon, and Carleton Hunt, Graduate School of Oceanography, University of Rhode Island. Described in Chapter 3, this report.

5. "Collection and archival of water samples from Narragansett Bay for organic analysis" James Quinn, Graduate School of Oceanography, University of Rhode Island. Will be described in second year report.

6. "Development of monitoring data on microbial indicators in Narragansett Bay, Victor Cabelli, Department of Microbiology, University of Rhode Island. Described in Chapter 3, this report.

Quahog projects:

7. "Status of quahog fishery resources in closed areas of Narragansett Bay" Saul Saila, Sheldon Pratt, Brooks Martin, John Stolgitis, and Richard Sisson, Graduate School of Oceanography, University of Rhode Island (SS,SP,BM), and RI Department of Environmental Management Division of Fish and Wildlife (JS,RS).

Described in Chapter 4, this report.

8. "Determination of levels of metals in quahog clam meats as a function of location" Richard Beach and Richard Hittinger, Thibault Associates. Described in Chapter 4, this report.

9. "Extractable Toxic Organic Compounds in Quahogs" Richard Pruell, Science Applications International. Will be described in second year report.

10. "Quahog histopathology studies" Fred Kern, National Marine Fisheries Service, Oxford Biological Laboratory. Described in Chapter 4, this report.

11. "Status of the quahog fishery in Narragansett Bay" Sheldon Pratt and Saul Saila, Graduate School of Oceanography, University of Rhode Island, portions described in Chapter 4, this report, the rest in the second year report.

Plankton project:

12. "Historical trends assessment of Narragansett Bay Ecosystem" Theodore Smayda, Graduate School of Oceanography, University of Rhode Island. Will be described in second year report.

Policy and Management Studies:

13. "Towards the management of Narragansett Bay: an Institutional Analysis" Glenn Kumekawa, Intergovernmental Policy Analysis Program, University of Rhode Island. This study is complete but will be described in second year report along with a follow-up study.

14. "Public perceptions of Bay Management", Harold Ward, Brown University, Center for Environmental Studies. Described in Chapter 5, this report.

Project Administration:

15. Narragansett Bay Project Office, "Media Survey of Bay uses and issues" Jennifer Martin and Eva Hoffman, described in Chapter 5; general activities described in Chapter 1 of this report.

Second year projects included in this report:

1. "Preliminary health risk assessment regarding metals in quahogs" Halina Brown, Clark University. Described in Chapter 4, this report.

2. "Management goals for Narragansett Bay" J. Michael Keating, Tillinghast, Collins and Graham. Described in Chapter 5, this report.

3. "RI State Legislators: Their suggestions to the Narragansett Bay Project regarding priorities" Eva J Hoffman, Consultant. Described in Chapter 5, this report.

APPENDIX D

TABLE D-1

Comparison of Narragansett Bay Project Treatment Plant monitoring results with Self-monitoring records submitted to the states

Nickel (ug/l)

Treatment Facility	Bay Project mean - std dev	Bay Project range	State records mean - std dev	State records range
Bristol	10.3 - 20.5	0 - 41	<55	<55
BVDC	128.3 - 71.9	58 - 225	163 - 53	91 - 246
E.Green	51.5 - 26.4	27 - 86	40 - 1	40 - 50
E.Prov	72.5 - 68.8	0 - 166	73 - 34	36 - 140
Fall Riv	20.5 - 29.7	0 - 63	No data	No data
Fields Pt	414.0 - 303	36 - 691	613 - 191	329 - 1120
Jamestown	0	0	No data	No data
Newport	20.0 - 31.3	0 - 66	No data	No data
Quonset	43.7 - 58.2	0 - 123	119 - 176	<40 - 870
Warren	45.3 - 33.4	0 - 72	<40	<40

TABLE D-2

Comparison of Narragansett Bay Project Treatment Plant monitoring results with Self-monitoring records submitted to the states

Copper (ug/l)

Treatment Facility	Bay Project mean - std dev	Bay Project range	State records mean - std dev	State records range
Bristol	22.8 - 26.2	0 - 46	85 - 30	60 - 120
BVDC	64.5 - 78.6	0 - 179	146 - 187	12 - 600
E. Green	158.3 - 86.5	0 - 258	179 - 75	80 - 370
E. Prov	7.7 - 10.0	0 - 21	28 - 8	17 - 40
Fall Riv	23.7 - 27.7	0 - 53	74 - 60	30 - 260
Fields Pt	383.0 - 205.8	185 - 682	527 - 279	23 - 1510
Jamestown	0	0	no data	no data
Newport	46.5 - 31.5	0 - 70	no data	no data
Quonset	47.7 - 70.8	0 - 150	185 - 90	70 - 540
Warren	90.3 - 56.0	29 - 163	40 - 40	<20 - 100

TABLE D-3

Comparison of Narragansett Bay Project Treatment Plant monitoring results with Self-monitoring records submitted to the states

Chromium (ug/1)

Treatment Facility	Bay Project mean - std dev	Bay Project range	State records mean - std dev	State records range
Bristol	16.3 - 26.2	0 - 55	<50	<50
BVDC	31.5 - 21.2	0 - 46	258 - 247	30 - 753
E. Green	34.3 - 30.2	0 - 72	66 - 38	10 - 150
E. Prov	10.8 - 12.4	0 - 22	2.0 - 1.8	<1 - 5
Fall Riv	18.8 - 15.6	0 - 34	<10	0 - 50
Fields Pt	67.3 - 25.8	41 - 97	no data	no data
Jamestown	3.5 - 7.0	0 - 14	no data	no data
Newport	39.5 - 35.0	0 - 78	no data	no data
Quonset	31.3 - 38.8	0 - 80	100 - 167	<50 - 610
Warren	11.2 - 8.4	0 - 19	<50	<50

TABLE D-4

Comparison of Narragansett Bay Project Treatment Plant monitoring results with Self-monitoring records submitted to the states

Cadmium (ug/l)

Treatment Facility	Bay Project mean - std dev	range	State records mean - std dev	range
Bristol	11.5 - 15.5	0 - 34	<5	<5
BVDC	7.3 - 7.4	0 - 15	no data	no data
E. Green	6.0 - 7.6	0 - 17	14 - 39	0.0 - 200
E. Prov	4.8 - 7.6	0 - 16	3.1 - 4.3	<1 - 15
Fall Riv	7.0 - 9.6	0 - 21	no data	no data
Fields Pt.	6.5 - 11.	0 - 23	7 - 4	2 - 23
Jamestown	2.3 - 4.5	0 - 9	no data	no data
Newport	19.5 - 10.1	6 - 29	no data	no data
Quonset	2.5 - 5.0	0 - 10	4.6 - 4.6	<5 - 12
Warren	5.7 - 11.	0 - 23	<5	<5