CLEANING UP OUR COASTAL WATERS: An Unfinished Agenda

The New York-New Jersey Harbor Estuary Program

NEW YORK BIGHT RESTORATION PLAN

LONG ISLAND SOUND STUDY

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A REGIONAL CONFERENCE

March 12-14, 1990

CLEANING UP OUR COASTAL WATERS: An Unfinished Agenda

A Regional Conference Co-Sponsored by Manhattan College and
The Management Conferences for the Long Island Sound Study (LISS),
The New York-New Jersey Harbor Estuary Program (HEP), and
The New York Bight Restoration Plan (NYBRP)

March 12-14, 1990
Riverdale, New York

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There is a direct relationship between the success of any endeavor and the quality and quantity of work put into it. For this reason, the productive outcome of this conference is due, in large part, to the diligence of those who expended so much of their own time and effort. It would be remiss not to acknowledge the individuals who contributed to the success of this conference.

First, a Steering Committee composed of representatives from Federal, State, and local governments; citizens' groups; the scientific and technical communities; and Manhattan College alumni developed the themes and format for this conference. We wish to thank the following individuals for their participation in the Steering Committee meetings:

Nicholas Bartilucci	Dvirka & Bartilucci
Albert Bromberg	New York State Dept. of Environmental Conservation
Al Buff	New York State Dept. of Environmental Conservation
Br. James Collins	Manhattan College
Philip DeGaetano	New York State Dept. of Environmental Conservation
Eugenia Flatow	Coalition for the Bight
Angelika Forndran	New York City Dept. of Environmental Protection
Shing-Fu Hsueh	New Jersey Dept. of Environmental Protection
Peg Kocher	League of Women Voters
John Jeris	Manhattan College
John Lawler	Lawler, Matusky & Skelly
Janice Rollwagen	U.S. EPA, Region II
Gwen Ruta	U.S. EPA, Region I
Robert Smith	Connecticut Dept. of Environmental Protection
Donald Squires	University of Connecticut
Thomas Steinke	Town of Fairfield
Dennis Suszkowski	Hudson River Foundation
R. Lawrence Swanson	Waste Management Institute
Edward Wagner	New York City Dept. of Environmental Protection

Second, even with all the hard work of the Steering Committee, the conference would not have been a success had it not been for the quality of the papers presented. Each speaker did an outstanding job conveying his or her viewpoint on the individual topic assigned. In addition, all speakers expended additional time and effort preparing the papers contained in these proceedings. We wish to commend them for their efforts.

Next, we wish to commend for their contribution to the conference all members of the Policy and Management Committees of the three studies who participated in the opening charge to the conference and the final panel discussion. Their presence at the conference signifies their agencies' dedication as well as their own personal dedication to the successful completion of the studies.

The facilitators who guided and focused the group discussions and who reported back to the conference participants on the outcome of the breakout groups deserve special commendation for their outstanding efforts:

Seth Ausubel	U.S. EPA, Region II
Susan Beede	U.S. EPA, Region I
John Connolly	Manhattan College
Philip DeGaetano	New York State Dept. of Environmental Conservation
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Dominic Di Toro	Manhattan College
Barbara Finazzo	U.S. EPA, Region II
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John Jeris	Manhattan College
John Lawler	Lawler, Matusky & Skelly
Brian Molloy	Piper & Marbury
Rosemary Monahan	U.S. EPA, Region I
Robert Runyon	New Jersey Dept. of Environmental Protection

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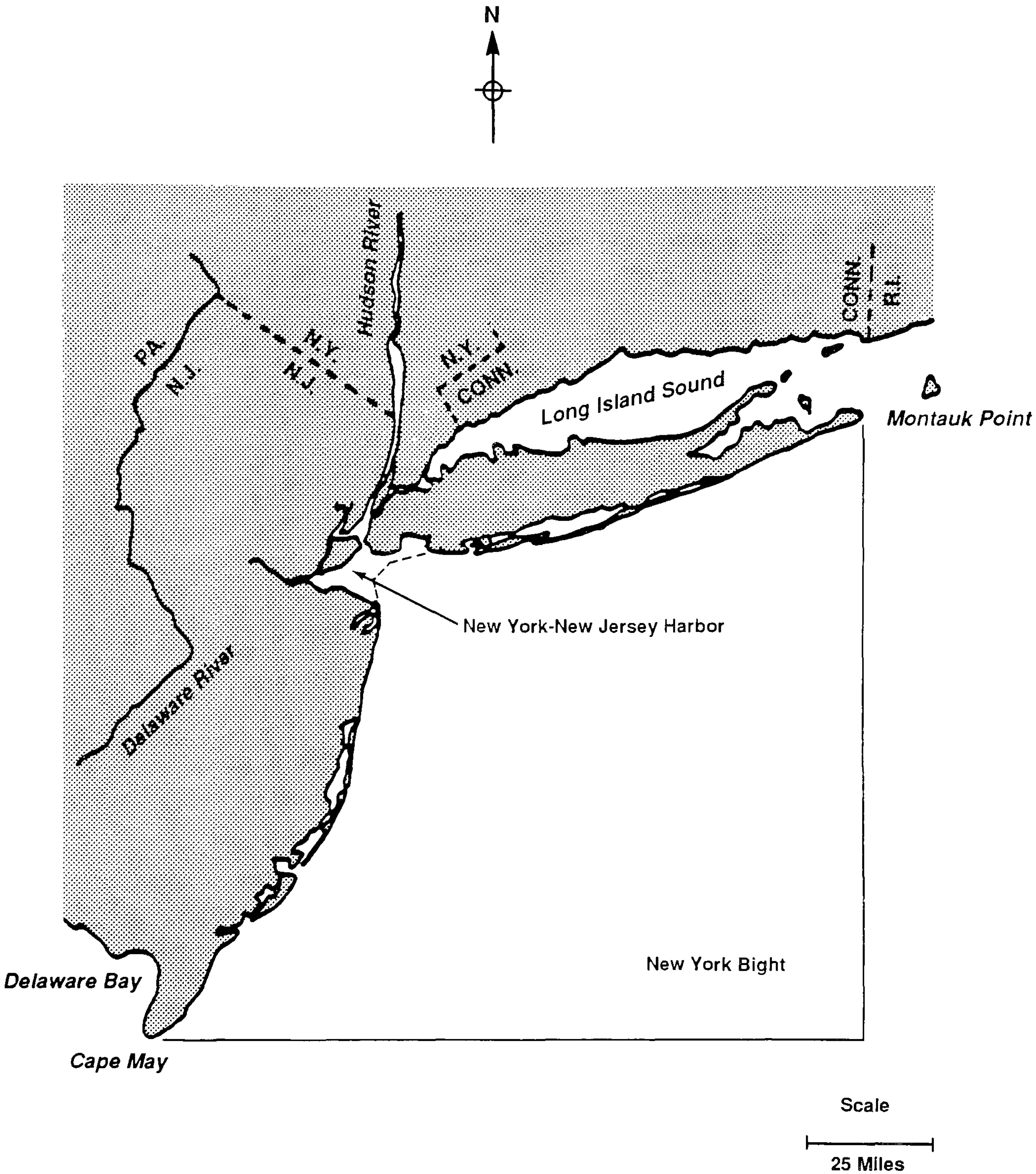
Finally, we wish to acknowledge the conference participants who attended the plenary sessions and workgroup sessions. Without their insight into the issues discussed and their recommendations for the future course of the studies, the conference would not have been the success that it was.

CONTENTS

Page



Map of the New York-New Jersey-Connecticut Coastal Region

CONFERENCE SUMMARY AND RECOMMENDATIONS

INTRODUCTION

The U.S. Environmental Protection Agency is currently funding three major water quality management planning efforts for the coastal waters in the New York-New Jersey-Connecticut region:

- The Long Island Sound Study;
- The New York-New Jersey Harbor Estuary Program; and
- The New York Bight Restoration Plan.

Each of these efforts is overseen by a Management Conference established by the Administrator of the Agency.

Since the Sound, Harbor, and Bight function, in many respects, as a single ecosystem, and since the regulated community will be required to implement provisions contained in all three plans, there is a compelling need for inter-plan coordination. For this reason, on March 12-14, 1990, the Management Conferences, in conjunction with Manhattan College and their 50th anniversary of environmental engineering, sponsored the regional conference: "Cleaning Up Our Coastal Waters: An Unfinished Agenda."

The ultimate purpose of the conference was to guide the continued deliberations of the Management Conferences overseeing the Long Island Sound Study, the New York-New Jersey Harbor Estuary Program, and the New York Bight Restoration Plan.

CONFERENCE FORMAT

On the morning of the first day, conference participants convened in a plenary session to hear speakers who set the direction for the conference:

- Brother Thomas Scanlan, President of Manhattan College, delivered a welcoming address.
- William K. Reilly, EPA Administrator, delivered a keynote address providing a national perspective on coastal issues.
- The Management Conference Policy Committees presented the charge to the conference.

On the afternoon of the first day, conference participants reconvened in plenary session to hear a historical perspective on coastal issues from Manhattan College Professor Dr. Donald J. O'Connor. They then began a three-phase workshop process.

Phase I Workshops -- During the first set of workshops, conference participants defined the following:

- The primary factors causing use impairments and other adverse ecosystem impacts in the Sound-Harbor-Bight system (based upon readily available information);

- The relative ecological and economic significance of these factors (based upon readily available information); and

- The major gaps in our information base that limit the confidence that we have in identifying these primary factors and in estimating their relative significance.

During this phase, priorities were established without regard to the costs of implementation.

Phase II Workshops -- During the second set of workshops, participants were divided into the following six issue-oriented groups:

- Nutrient/organic enrichment;

- Pathogens/floatables;

- Toxics;

- Habitat;

- Seafood safety; and

- Ocean disposal.

Within each group, participants focused narrowly on the single issue before them, attempting to develop ranked lists of recommended short- and long-term planning and implementation actions. In this phase of the workshops, conference participants considered the costs of addressing the factors causing use impairments and selected remedies for each factor based on cost-effectiveness.

Phase III Workshops -- During the third set of workshops, conference participants were asked to forge a single, integrated agenda from the six issue-specific agendas developed during Phase II. The participants were asked to balance the costs and benefits of addressing the individual factors in terms of overall ecological and economic significance, and were asked to factor into their discussions a sensitivity to the total burden being placed on the regulated community.

In each phase of the workshop process, conference participants began by listening to expert speakers. Having heard the presentations, conference participants were divided into smaller groups with facilitators to discuss the management questions that had been prepared by the conference steering committee in an "Issues for Discussion" document.

Each evening, the facilitators met to synthesize the results of workgroup discussions. The following day, delegated facilitators reported the results of workgroup deliberations in plenary session.

At the end of the conference, a distinguished panel was asked to react to the results of the workshop deliberations.

CONFERENCE RESULTS: THE PROCEEDINGS

These proceedings contain a wealth of information that can serve to guide the continued deliberations of the three Management Conferences. Particular attention should be paid to the brief reports made by designated facilitators summarizing the conclusions of the workshop sessions.

- On page 195, J. Frederick Grassle presents "Preliminary Conclusions on the Condition of Our Coastal Waters: Status, Trends, and Causes."

- Beginning on page 581, six facilitators present preliminary conclusions on "The Primary Factors Causing Use Impairment and Other Adverse Ecosystem Impacts."

    -- John Lawler addresses nutrient/organic enrichment.

    -- Robert Runyon addresses pathogens/floatables.

    -- John P. Connolly addresses toxics.

    -- Allan Hirsch addresses habitat.

    -- Rosemary Monahan addresses seafood safety.

    -- Philip DeGaetano addresses ocean disposal.

- On page 603, Dominic Di Toro presents preliminary conclusions on "An Integrated Agenda for Cleaning Up Our Coastal Waters."

We strongly encourage each conference participant and other interested parties to read the proceedings and to draw his or her own conclusions on how best to integrate pollution prevention and control measures in the Sound-Harbor-Bight system.

NEXT STEPS

As conference co-chairmen, our objectives were to begin a dialogue on how best to integrate our efforts to clean up our coastal waters and to provide the impetus for initiating discrete activities to move us toward that elusive target.

The proceedings provide clear evidence that the dialogue has begun. We would like to focus on three initiatives that are ripe for immediate followup.

Influencing Individual Behavior

One of the most striking conclusions of the conference was the overwhelming consensus on the need to influence individual behavior if we are to meet our environmental goals. The issue was highlighted in one form or another in each of the facilitator reports. We are therefore pleased to report that both the Harbor/Bight and Sound programs are preparing to move ahead aggressively in this area over the coming year.

- The Harbor program was recently awarded $75,000 from the EPA Office of Marine and Estuarine Protection for an Action Plan Demonstration Project to develop a public education strategy. The centerpiece of the project will be an "Environmental Lifestyle Guide" designed to provide pertinent information on how to act in an environmentally responsible manner in the highly urbanized New York-New Jersey metropolitan region. Full implementation of this strategy will involve coordination of numerous private initiatives and donations for efforts to expand upon the themes developed in the guide.

- The New York Power Authority has put up $100,000 in response to its proposed Long Island Sound Cable Crossing for projects that would benefit the Sound. Approximately 45 proposals were submitted, some of which dealt with public outreach and influencing behavior. The final funding decision will be made shortly, and it is likely that at least some of the money will be spent on education.

Analyze As One Ecosystem

Another theme that recurred throughout the conference was the need to analyze the Sound-Harbor-Bight system as a single interactive ecosystem. This theme emerged in particularly strong form in discussion on the mathematical modeling of pollutant fate in the system. Since inputs of waste residuals and decisions on control affect all of the systems in an interactive way, it is essential that this issue be addressed in the short term. We, therefore, recommend the following:

- A joint meeting of the Modeling Evaluation Groups for the three studies should be convened as soon as possible;
- Presentations should be made on all modeling efforts; and
- Proposals should be developed for integrated systems analyses.

Habitat As a Priority Systemwide

As Dominic Di Toro observed, conference participants really did discriminate in identifying priority problems. It is, therefore, particularly striking that, as Fred Grassle reports, the destruction and degradation of aquatic habitat was identified by conference participants as a high-priority problem in the Sound, in the Harbor, and in the Bight. A review of the workplans and budgets for the three ongoing planning efforts reveals that habitat is receiving priority attention in the Harbor and Bight studies but not in the Sound study. We therefore recommend that during the FY91 workplan and budget process for the Long Island Sound Study, consideration be given to elevating the priority given to habitat-related issues.

Followup Conferences

Furthermore, having begun the efforts to integrate three major ongoing planning efforts, we should not stop now. We recommend that the Management Conferences, acting together, solicit proposals from nonprofit and/or academic institutions to co-sponsor a followup conference that builds on what we have learned to date, and that moves us toward a truly integrated agenda for cleaning up coastal waters.

Kevin Bricke
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OPENING ADDRESSES

WELCOME

Br. Thomas Scanlan
President, Manhattan College

Good Morning, ladies and gentlemen, honored guests.

It is indeed a pleasure to welcome you today to this special symposium on improving the quality of New York's coastal waters. There could not have been a more opportune time to explore this subject together.

In one respect -- the most obvious one -- this symposium is timely in its relationship to the Fiftieth Anniversary of Manhattan College's distinguished program in environmental engineering. In light of the program's achievements -- with which most of you are familiar -- it is clearly an occasion worth celebrating. And, considering the scores of faculty and alumni who have pioneered the science of improving water quality, the topic is indeed appropriate.

I am delighted, therefore, to welcome our guests from the Environmental Protection Agency, particularly the Honorable William K. Reilly, the EPA's Chief Administrator. And I want to thank the Long Island Sound Study, the New York-New Jersey Harbor Estuary Program, and the New York Bight Restoration Plan for cohosting this symposium.

Yet, honored as we are by your presence, we realize that so many busy professionals would not be gathered here on ceremony alone. Which brings me to the second reason why our conference is indeed so timely -- even vital.

Today, we are only a decade away from a new millennium. In this decade, our world will face challenges that will determine the quality of life on this planet for that millennium. The problems are self-evident; the solutions are not.

What sort of world will we bequeath to future generations? Clearly, present conditions do make most forecasts look rather bleak. Global warming, acid rain, deforestation, chemically fouled rivers and bays -- this dismal litany, culled from today's headlines, attests to the sorry state of our environment.

Not long ago, the ramifications of these problems seemed remote. Many people actually believed that the Earth could endure any assault, absorb any amount of sewage, smoke, or toxic chemicals. We thought the oceans, rivers, and winds could forever wash away the impurities that we carelessly pump into our planet.

Today, we have discovered that Earth's capacity for self-renewal is indeed finite, as are the resources we continue to tax. Our waters can absorb only so much chemical waste before becoming inhospitable to marine life -- and to us. We can chop down only so much rain forest before irreparably damaging an ancient ecosystem. For the past few decades, scientists and environmentalists have known this, and they have sounded the alarm. But lately, the alarm has grown more strident.

Some authorities even warn that time is running out. Consider, for example, the recent findings of the Worldwatch Institute, a Washington-based research group. In its annual "State of the World Report," Worldwatch predicted that we have roughly forty years to build an environmentally sustainable, global economy. If we should fail, then environmental deterioration will be so severe that acute economic and political decline will surely follow.

Such warnings serve as effective reminders that we had better do something fast. Yet even without such reminders, people grow increasingly aware that something is wrong. For example, oil spills continue to blacken our beaches and pollute our rivers, prompting everyone from Hollywood stars to average citizens to demand more stringent regulations for oil companies.

Incredibly, there are still skeptics, those who are unwilling or unable to accurately gauge the crisis. Casting aside the daily evidence of our environment's degradation, they sometimes charge that we overestimate the danger. "Calm down," they say, "things are not that bad. Trying to remedy the situation will take too much work, cost too much money, and slow our nation's industrial engines."

What do we do? Everyone knows that there's some sort of problem but not everybody can agree upon an appropriate course of action.

It is useless to point fingers, to divide the players into heroes or villains, friends or foes of the environment. For none of us actually wants to harm the planet that gives us life. Our chances for success depend upon our ability to bring divergent forces together. What we need is not conflict, but cooperation. Even without consensus, we must have teamwork.

One of the most dedicated -- and successful -- adherents to this view happens to be with us today. Since his appointment by President Bush as Director of the EPA, William K. Reilly has continued to build upon his reputation as a forceful conservationist. Yet he has accomplished this without sparking confrontation between environmentalists and corporate leaders.

Mr. Reilly is widely known for the conciliatory spirit that has won results throughout his career. And he has proven, time and again, that conciliation is not concession. Rather, it is the acknowledgment that reasonable people must work together. Thus, his message is an important one: whether you are an environmentalist, a government official, or a corporate leader, you have a vested interest in maintaining the Earth as a livable planet.

This kind of approach will prove valuable as we increasingly look abroad for help in improving the quality of life on this planet. More than ever, we realize that cleaning up the environment will take much more than unilateral action by the United States -- or any one nation. The sheer scope of environmental distress makes this abundantly clear. The crisis we face must bring us together, for we all stand to gain -- or lose -- by the outcome.

At first glance, this may seem like a large order. Actually, we should find the challenge as exhilarating as it is sobering. Our need for collective action underscores the fundamental unity, the intrinsic interdependency, of all human beings. The fact is, we, as Earth's most highly developed inhabitants, bear collective responsibility for the stewardship of the planet.

This point was eloquently made by the Jesuit paleontologist and philosopher, Pierre Teilhard de Chardin. He believed that the genius of our species lies in its capacity to grow in understanding with each successive generation. In this way, building upon the foundation bequeathed by our ancestors, we alone of all species have acquired the know-how to alter the Earth. For better or worse, we can intervene in the course of its natural development. Today, with the dizzying velocity of our technological advances, what we do will determine the quality of life on Earth for all of our descendants, just as the achievements and failures of our ancestors shaped the quality of our own lives.

As Tielhard wrote (and I quote): "Owing to the progress of science and of thoughts, our actions today...will have repercussions through countless centuries and upon countless human beings." Tielhard wrote that passage back in 1920. Considering the technological strides we have made since then, how much truer do his words ring today? Although profound, Tielhard's message is remarkably straightforward: Of those who are given much, much is expected. We human beings are endowed with incredible abilities. Our responsibilities are equally great.

This emphasis on responsibility has guided the work of environmental engineers for generations. Combining scientific theory with a desire to make the world a better place to live, these professionals have studied the effects of pollution on our atmosphere and our waters. Then, armed with that knowledge, they have designed methods for controlling the damage that can inadvertently follow progress.

For the past fifty years, the program in environmental engineering at Manhattan College has prepared professionals to do just that. The program began inauspiciously enough in 1939, when it was dubbed the undergraduate "sanitary option" in our School of

Engineering. Yet, at that time of burgeoning growth, it was one of the few courses of study in the country that trained engineers to develop new, safe methods of discharging municipal and industrial waste.

Since then, the "sanitary option" has grown into our internationally recognized Graduate Program in Environmental Engineering. The Federal Government funded the creation of the graduate program in 1962. It is widely known that this program has propelled an astounding number of environmental engineers on to prominent positions in academia, government, and industry. Actually, the names of many of our faculty and alumni would form a veritable **Who's Who** in the field.

Today, there are similar programs at universities throughout the country. But our program, I believe, retains a quality that makes it unique. I will go further: this unique quality is one of the main reasons for the striking success of so many of our alumni. That quality consists of our traditional emphasis on achieving academic excellence while striving to make the world a better place for other people.

Today, you who are participating in this conference will prove the durability of this tradition by renewing your pledge to use your training, your expertise, and your hearts in a concerted effort to improve the quality of our waters. This conference, then, forms an important part of our present and future efforts to leave this Earth better than we found it.

Thank you all very much. And now, I am pleased to present our Master of Ceremonies.

SAVING OUR COASTAL WATERS THROUGH SUSTAINABLE DEVELOPMENT

Hon. William K. Reilly
Administrator, U.S. EPA

Thank you very much, Connie. I wasn't sure what to expect when you started down that road. Connie and I have, among other things, spent nights in hammocks in the Amazon together. Not the same hammocks, but the same Amazon. I appreciate that introduction. I should point out to those who felt that the mention of a lawyer is a bit of a dig, Connie is himself a lawyer. And, I'm not telling any lawyer jokes this morning.

I also acknowledge you, Br. Thomas. I thought that the statement that you made on the environment a few minutes ago was as eloquent and stirring as any I've heard. Last spring, when I gave the commencement address at Providence College, I called on the bishops of the Catholic Church to follow up their very influential pastoral statements on nuclear arms and poverty with a pastoral on the environment. And this is something that I first mentioned to Cardinal Bernardin at the White House after having been lobbied there by several cardinals to reconsider some of the elements of our quite extensive asbestos requirements for schools. I thought, well I'm going to do some lobbying of my own. And they have apparently taken that suggestion seriously. I had spoken last month to the committee of the bishops considering that statement and I would very strongly urge them to consult with Br. Thomas in its preparation.

I'm delighted to be able to share my thoughts with this assemblage of professionals and government officials concerned about our coastal waters, and I want to express special thanks to the Management Conference participants, and particularly to Manhattan College, for inviting me to address this important regional conference.

Manhattan College provides EPA with some of our very best and brightest specialists and engineers. I was pleased to meet outside, just a few moments ago, the two founders of the new Environmental Club here, as well. My own memories of Manhattan go back into my freshman year in college, when I attended mixers here.

I happened to read yesterday in The New York Times (so it must be true) a story about a person who specializes in giving speech instruction to businessmen; and it included the advice that one should emulate Churchill. There was a particular anecdote that this speech instructor tells about Churchill having met a Mrs. Ruddick, a prominent Labourite critical of Churchill who said to Churchill, late one evening at a party, "You, sir, are drunk. And, if I may say so, quite disgustingly drunk." To which Winston Churchill is said to have replied, "And you, madam, are ugly. And, if I may say so, quite disgustingly ugly. And the difference between you and me is that tomorrow morning I shall be sober."

The other well known story of the same type about Churchill is the remark that Mrs. Astor is supposed to have made to him when she found herself unhappily seated next to him at dinner one evening. She said to him, "If I were your wife I would put poison in your coffee." To which Churchill is supposed to have replied, "And if I, madam, were your husband I would drink it." I'm not sure why this speech consultant carries stories like this to business leaders, possibly to help them in their communication with the regulatory agencies which oversee their activities. It doesn't sound like the new look that we've been encouraging among our friends in business, but one piece of advice that the speech consultant apparently routinely gives is get right into it. So, let me do that.

I want to say it is a very special privilege to address the very first conference of what is intended to be a continuing series of annual conferences. We, at EPA, have given considerable thought to the work that lies ahead to save the Long Island Sound, the New York/New Jersey Harbor Estuary, and the New York Bight. These coastal areas, like so many other aspects of the environment, are a mixture of good news and bad news.

The United States is blessed with immense marine and coastal resources. For many years, we assumed they would last forever. We have, during the past twenty years, by many measures, brought them back through large investments in cleaning up wastewater. EPA has presided over the expenditure of some $52 billion in wastewater treatment construction grants to some 7,000 specific grants and contracts.

Nevertheless, coastal pollution and development, oil spills, loss of wetlands, and trash and medical wastes on beaches have produced another wave -- a tidal wave of indignation among Americans. I have, on occasions, visited major oil spills and witnessed the familiar and depressing apparatus of response. The slicks and the streamers, the skimmers and the booms that just never measure up to the losses. We now average one oil spill a day in these United States.

But after years of abusing our coasts, we are now increasingly aware that for too long there has been an imbalance in favor of development over protection of our nation's coastal areas. We now know that we must tip the scales in favor of ecological protection.

An approach to development designed to do that, the kind of development that is consistent with the survival and the protection of the coastal resources now so stressed by millions of people, is called "sustainable development." This notion of sustainable development was coined, was invented really, to address the special problems of developing countries. But I think that it is just as apt and urgently needed for the developed nations as well for the Great Lakes, for the Chesapeake, for Narragansett Bay (where I was yesterday), and for Long Island Sound.

As many of you may know, in 1983 the United Nations General Assembly sought an answer to the conflict between economic development and the environment. The United Nations General Assembly established a special independent World Commission on Environmental Development, under the chairmanship of Gro Harlem Brundtland, then the Prime Minister of Norway. They produced a report, the Brundtland Commission, entitled "Our Common Future." The Brundtland Commission defined sustainable development as development that meets the needs of the present populations without compromising the ability of future populations to meet their needs.

Another way to think about sustainable development is to use an analogy from banking. Think of the Earth's environment as a huge trust fund left to us by wealthy grandparents. The fund contains a large but finite sum of capital -- the principal. Yet instead of money, the principal is the ability of the Earth's air and water to cleanse our wastes and provide the resources that sustain life -- the climate, the air, the waters, and the soils. The fund is big enough that if we act responsibly, we could live off the interest on this principal forever. But, instead, we have been profligate heirs. We've spent all of the interest and lately we have been encroaching on the principal as well. We're writing checks against the principal at such a rate that some of them are beginning to bounce.

I am, nevertheless, hopeful. People, I think, are finally beginning to realize that a conflict between the economy and the environment is a fight to the death in which everybody dies. And so it is this new convergence of environmental and economic concerns -- this new sense we have that good environmental health and good economic health reinforce one another in positive ways -- that gives me hope for the environment and for the Northeast and mid-Atlantic coastal waters.

Consider, for the moment, our coastal regions. They are beset by a constellation of problems: those oil spills I mentioned; untreated urban runoff and sewage from combined sewer overflows; nonpoint source runoff from shoreline development; the discharge of toxics; discharges from recreational boats; atmospheric deposition from contaminants coming out of automobile emissions (which now account for more than half of the air toxics in the urban environment); and the accumulated ecological stress of the watershed with a population equal to that of Spain. The EPA-funded Management Conference is currently documenting the harsh realities of coastal waters in this region. Harsh realities that you will no doubt hear in more detail from the many fine speakers and specialists scheduled to speak after me at this conference.

Allow me to offer four practical applications of sustainable development that should help save our coastal waters. First, EPA must continue to improve our control of point source discharges of conventional and toxic pollution -- the stuff that comes from out of the pipe. In fact, as far as coastal waters are concerned, we at EPA are going to start enforcing like Captain Bligh. A year ago, I told a meeting of the Association of Attorneys General that EPA would prosecute polluters to the full extent of the law. Since that meeting during the first year of the Bush administration, EPA broke records in virtually every area of EPA enforcement. Criminal prosecutions were at a record high. Administrative compliance orders were at record high of four thousand orders; this is up 33%. And Superfund enforcement was at a record high, up 34% over the previous year. Our new enforcement first policy, I think, has finally caused lawyers to begin to advise their clients that it is no longer safe to lie back in the weeds; it is necessary to come forward and settle. As a result, we had a record number of Superfund settlements last year and recovered from private parties for clean-up more than a billion dollars -- substantially up from the year before.

Even more pertinent to our concerns today, EPA has initiated a massive two-tiered Clean Water Act enforcement effort. First, we are bringing municipal wastewater treatment systems into compliance with their discharge permits. Doesn't sound like much really. But it is vitally important; it is our charge, and we will carry it out.

Second, we are assuring that municipalities implement their pre-treatment programs to keep toxic chemicals out of our waterways. Last fall, Attorney General Dick Thornburg and I announced enforcement actions against 61 municipalities for failure to implement their pre-treatment programs. Some heavy metals and organic contaminants going into coastal waters have decreased due to better implementation of local pre-treatment programs, due to improvement in local wastewater treatment plants, and due to the Federal actions carried out in the last decade that involved the elimination of leaded gasoline and PCBs.

EPA has reduced the ocean and coastal discharges of 10,000 major industrial wastewater treatment facilities. We have virtually eliminated ocean dumping of raw sewage or sewage sludge through outfall pipes. Deep sea dumping of municipal sludge is being phased out. I'm pleased to announce that shortly the EPA will issue a report to Congress detailing how we are assuring that all communities dumping sludge into the ocean are on schedule to end dumping by December 31, 1991, or in the case of New York City, by June 30, 1992. We have finally closed the ocean to industrial dumping, to waste incineration, and to radioactive waste disposal.

I'm not content with this; last month I told EPA's enforcement office that next year I expect enforcement numbers to go through the roof. And now I'll add this, if the enforcement numbers don't go through the roof, the EPA Administrator will.

There is another harsh reality that must be addressed before we can really dull the point of point source discharges. We must upgrade the hundreds of coastal cities that have combined sewer overflow systems. In most east coast cities, a good rainstorm sweeps sewage, street oils, and urban debris right into the nearest coastal waters. Solving the combined sewer overflow problem is going to cost big bucks. We must orchestrate a partnership of Federal, State, and local resources to bring these antiquated CSO systems into the 20th century. EPA is in the midst of a massive effort to bring approximately 20,000 combined sewer overflow points of discharge into the permitting system. So that's some of what EPA is doing or trying to do, more or less on its own.

We are also working with other Federal agencies to ensure coordinated, consistent Federal action. We have formulated a National Coastal and Marine Policy that aims to protect, restore, and maintain the nation's coastal and marine resources. Specifically, the policy commits the Agency to achieve the following goals: (1) restore and protect our shellfisheries, saltwater fisheries, and other wildlife habitat by controlling pollution and getting at the causes of habitat loss; and (2) restore the recreational use of all our shores, beaches, and coastal waters by reducing sources of contamination, plastics, and debris.

I recently had occasion to visit a cleaned up water, one in which -- by all the measures that focus on the water itself (the nutrients, the algae, the fecal coliform) -- the great investments the country has made really had paid off, and we had substantially cleaner water in that river than in anyone's living memory. But, after I waded into this river, one could scarcely see the bottom because of all the plastic, the styrofoam cups, the paper, and the debris floating down that river. We've got to get a grip on that. I think we've made as effective an effort in this area as any and we will continue our effort. But in that effort, we need to recognize that the job is not fundamentally one of collection -- the job is one of pollution prevention, of reducing the enormous amount of waste that this society generates, which is orders of magnitude more than that of other internationally competitive, successful economic nations.

The EPA's coastal and marine policy also lists a set of actions that taken together are a kind of blueprint for action by all levels of government -- EPA, other Federal agencies, and State and local governments. When actions are the sole responsibility of EPA, we will move aggressively. And when actions are the shared responsibility of different Federal agencies, we will work with them to coordinate our approach. In that connection, I'm pleased to announce that this Friday I signed and forwarded to my colleagues at the National Oceanic and Atmospheric Administration (John Knauss) and the Coast Guard (Commandant Paul Yost) a Memorandum of Agreement that helps to fulfill the present pledge to end ocean dumping. The agreement delineates the responsibilities to each of our agencies and pools monitoring and surveillance efforts to end ocean dumping in law, but more importantly, in fact.

But if we are to achieve truly sustainable development, then State and local governments must do something more. They must address growth and land use issues, to reduce nonpoint source runoff, habitat destruction, and aesthetic degradation. EPA will back them up wherever we can. But we cannot solve -- EPA cannot solve -- our coastal problems without the help of State and local governments. We can work hard to persuade, encourage, and support State coastal protection efforts, but the reality of sustainable development means that State and local governments have much more work to do on land use issues -- issues of runoff from city streets, construction sites, highways, industrial parks, suburban development, and fading septic systems. Combined, the nonpoint source pollution of these land uses surpasses, in many cases significantly, the damage done to the coast by point sources -- the stuff that comes from pipes. In fact, almost every wave of pollution problems that laps at our shores can be traced to uncontrolled development and huge population increases in the nation's coastal area. Some 75% of the nation's population now lives within 50 miles of the coastline.

When I accepted the chairmanship of the Chesapeake Bay Executive Council in December, I expressed support for the recommendations that they report on land use in the "2020 Report." That report recommended that State and local governments establish buffer zones, filter strips, and greenways around all sensitive natural resources and areas, even in developed areas. This is a direction I would strongly encourage in this region as well.

I must say I am, as you are, appalled by the recurrent nightmares of careless oil spills in the Arthur Kill Channel. I strongly support a comprehensive review of all petroleum handling practices and systems in this area before it is too late.

Well, those are some of the initiatives that we need to develop and address with energy and imagination to resolve our coastal pollution problems. Let me conclude by turning, for a moment, to the international scene. I had the great privilege of accompanying President Bush to the economic summit of the seven major industrialized countries last year in Paris. As many of you may know, the President has chosen to give the environment a major priority, not simply in our domestic policy but also in the matter of foreign policy. And, so, this was the first time any head of government had ever brought an environmental minister or adviser to that economic summit.

In discussions with the people there on the range of environmental problems, both in the countries represented and, perhaps even more to the point, in the developed world and in eastern Europe, I was struck by the sense of beginning -- the relatively primitive capacity of the Earth's international institutions for environmental management to do for the environment what the very sophisticated and well-developed economic system has done in the post-war period for economic relations.

Now we have some new and important opportunities. Just look at the stunning changes that are taking place around the world -- from Latin America to eastern Europe and now the Soviet Union. In many places, those in the vanguard of political leadership come out of the environmental movement and have environmental concerns. The fortunate congruence for those of us concerned about the environment -- the stunning reforms now sweeping the socialist world -- make it possible, I think, for us to lessen our post-war preoccupation with global military competition and to refocus our energy and our resources from the preoccupations of defense and security in war to the preoccupations of peace. And, foremost among them, to environmental protection, to the growing global threat to the natural systems that sustain life on this planet. That we now can consider this transition is a great testimony to our free enterprise system and our military alliances. I believe that the next great challenge to the creativity and resourcefulness of our free societies will be to secure the ecological base on which long-term economic prosperity fundamentally depends.

I recently had breakfast with the Prime Minister of Czechoslovakia. The environmental problems he described, the degree of assistance that he requested are off the scale. Incidentally, the question arose about the sophistication and experience in coordination of the new leaders of Czechoslovakia, many of them not having been politicians, and the President, of course, having been a poet. And the President responded that what they may lack in experience, they make up for in close coordination because the President and his Foreign Minister had many years together as cellmates in jail. It occurred to me that that would be an interesting preparation to ensure coordination in a cabinet in the government. But it's one that they are looking to, to reinforce their solidarity in the face of the problems that they confront.

Well this, in short, is freedom's moment. It must also be a moment for celebrating the Earth and for deepening our commitment to the protection of our coasts and our waters and to the protection of our planet. In just a few minutes, I'm going to invite other officials here today to join me in signing a pledge to protect and restore our coastal waters. It's only one page but it means a lot. To me it's a kind of pledge of allegiance -- the pledge of allegiance to America, the beautiful. Let us pledge to work together to make sustainable development with all that it needs a reality from sea to shining sea.

Thank you.

QUESTIONS AND ANSWERS

Q. *You gave a terrific speech. And you talked about a lot of things, about enforcement, about how ocean disposal is going to be stopped. Do you have any suggestions about how the local counties are going to pay for all of this?*

A. This message I recognize comes at a time when resources, particularly in the Northeast, are very constrained. Yesterday, I was in a town in Massachusetts, where I was told -- I find this hard to believe -- the deficit facing the city of Falls River, Massachusetts, is $800 million. That may be wrong, but that's what a State senator told me it was. And we have issued an administrative order on combined sewer overflows that gives that community until October to get us some detailed plans on implementation. The questions that arise have to do with peace dividends, and as we turn from some of these preoccupations of defense and security to those of peace, to what extent we can anticipate one for the environment.

I think that we have in this budget substantial resources that in the current budget climate are relatively significant. The President provided in his budget request some $2 billion more for the environment, and that includes a particularly important piece for EPA -- $230 million more for our operating fund. The water quality request, which is $1.6 billion for the State financing and State revolving funds, is far less than sufficient to meet the needs of this country. We estimate that those needs are in the range of $80 billion, and there is no way that the Federal Government at this time is capable of making a substantial dent in that need. All I can say is that we will work very carefully and closely with the States and localities to try to ensure that the priorities we are responsible for enforcing really do make sense (for example, the calls on local resources that only go up -- they're going to go up for water, they're going to go up for waste management, they're going to go up for air quality -- very significantly to a portion of our gross national product that is higher than that of virtually all of our competitors). We have to ensure that these expenditures make sense, and we have to make sure that the people regard them as worthwhile. I think if they do, the United States does not really want for resources, whether it's one level or the other, and finally those resources will be there. I take it as my responsibility to ensure that we do the best with the money that we do have, and we'll work cooperatively with the States and localities to ensure that they do the same. That's the best we can do in the face of the combined sewer overflow problem -- it's far short of what's needed.

Q. *I was wondering how you see people making personal sacrifices and changes in their personal lifestyle and coping with the various changes that are to come in the next 10, 20, or 30 years? For example, the automobile. We've become very accustomed to its 300-mile range. We may have to go to an electric automobile with a 100- to 150-mile range. Do you think people will sacrifice? Are they willing to? How are we going to teach them to change?*

A. You know, I am reasonably confident about the capacity of people to make changes that they decide are useful or important. I was on an airplane recently with a lady going to

Washington. Both of us were late for appointments. And after sitting on the runway for some time, the pilot announced that we were going to suffer another delay necessary to engage in a deicing process. It was interesting that nobody on that flight groaned or complained. All of us remembered the Air Florida crash of some years ago -- the plane had not been deiced immediately prior to departure. In the same way, we put up with security at airports that I think would have been unimaginable 25 years ago for most travelers.

We are making a number of decisions, certainly made in the Environmental Protection Agency, that have the combined effect of removing options for disposing of wastes in traditional ways, and increasing the cost of what waste disposal is still possible. And those costs have gone steadily up and they will continue to do so as up to a third of the landfills close over the next five years, and as the oceans and rivers are no longer available for the many wastes that used to go into them. People, I think, will be prepared to make many of those changes.

When you come to the automobile, you touch something fundamental and basic. There was an article yesterday, I think it was in the business section of the New York Times News of the Week in Review, to the effect that at least we might look for some light at the end of the tunnel because we now have 1.7 vehicles for every two people, and as soon as we approach two to two, at least things will probably not get any worse until automobiles learn to drive themselves, which in this country should not be ruled out. We are going to reduce very substantially air pollution from the automobile. We brought it down 96% in the last 20 years, and we are going to go back and do it again. We are going to change the fuels in areas like this one, to achieve orders of magnitude reductions in pollution.

Honestly, I suspect that congestion will have a lot more to do with the change in lifestyle in this area, with respect to the car, than pollution because I think we will make a substantial dent in the pollution when we begin to get that part of the problem under control. But the problem, as you suggest, is a much broader one and we have not begun to address the steadily worsening problem of congestion and the concomitant land use changes that bring with them the problems associated with the automobile. We will address those things. We will address them incrementally, as the problems become more and more unavoidable to more and more people.

I think that the burgeoning environmental ethic and sensitivity in this country should give us considerable ground for hope. What I would suggest to an audience like this is to help the politicians to identify the new options. Particularly, begin to work with those who make key decisions that influence where growth goes and how dense it is and whether it's serviced by mass transportation, before those decisions set in motion a process that is irresistible and that results in simply exacerbating the problem.

Q. Good morning, Mr. Reilly, my name is Dan Fagan, reporter for Newsday. *Could you give us a little more detail on your thinking regarding the spill in the Arthur Kill in the past* *couple of weeks, beyond simply supporting a review of shipping operations. What else should Federal EPA and local regulators do to prevent the likelihood of these spills happening again?*

A. There are two kinds of things I think we've got to do. We've got to diminish the length of transport -- and there are a full range of responses necessary to do that, that have to do with better harbor guidance systems, escort requirements in some places such as Prince William Sound and particularly sensitive ecosystem areas, and better control and training of the human resources and the management skills of people responsible for these enormous, potentially destructive tankers. I must say that all of the spills that I visited in my first year as Administrator of EPA were caused by human error, and that must give us concern about the limits of intervention. And that must probably lead us to the conclusion that as we continue to bring oil into this country (roughly half of our oil needs now are imported), we will continue to have spills with us. The response capability for oil spills is, in my view, primitive. When we mount the response action, steamers go to work, booms are laid out, and invariably they are inadequate to the problems. We do not have anything like the sophistication and technology that it seems to me we should have in 1990. I am very pleased that some portion of the new oil liability legislation, raising liability standards, is absolutely crucial to this and will create incentives in the industry to take what has happened far more seriously and put more resources into it. That new legislation does provide more resources, and the oil industry itself has made a decision to put substantially more funds into response, into repositioning equipment, and into technology.

We have, in my view, utterly failed to develop adequately the potential of bio-remediation and biotechnology as ways to clean up oil spills. The single most promising aspect of the response in the last spill was EPA's application of nutrients to the soil microbes on some 75 miles of shore, which was all we could cover in the time that we had. We had not, before that time, had on the shelf these kinds of response materials. It could have made a much greater difference and it looks, according to our scientists, as though they will cut about in half the time it takes for that sound to restore itself. I think we need turn to the biotechnology industry for some of these petroleum-related contamination problems, to increase the priority it gives to oil spills and perhaps in doing so, to begin to reassure some of their most skeptical critics about the possibility of this technology to clean the country up.

Q. Peg Kocher representing League of Women Voters in the tristate metropolitan area. *Have you any idea who in the task force like the one you just mentioned, will address the problem of government agencies being the worst polluters.*

A. Let me say that going back to my period in the Council on Environmental Quality in the early '70s, I think virtually every President has made a commitment to try to clean up Federal facilities. It is an interesting lesson that it is far more difficult to do that than to get General Motors into compliance. What we're talking about -- and EPA is invariably the Agency that's brought up in Congress and criticized for not doing more -- is essentially diverting some of the resources in other agency budgets to give a higher priority to things environmental. Now that often is difficult, if not impossible. President Bush committed in his campaign to make Federal facilities comply with the same standards and requirements that are required for the private sector. It is necessary to our credibility and it's only fair. We have currently got, I think, 189 interagency agreements for cleanup of Federal facilities. We expect to review 110 facilities this year. And, in each case, the 189 have entered into agreements between the Federal agency, EPA, and the States to put them on schedules with specific time tables and with actual enforceable agreements. The magnitude of some of the Federal agency problems is huge. The Hanford facility, for example, in Washington will take us 30 years to work through. It's a 500-mile facility that's contaminated throughout from years and years of neglect and accumulation of radioactive and hazardous waste. But we are working to make some progress, and our commitment is greater than it has ever been under any President. We're certainly committed to continue.

Q. **Frank Flood from Nassau County.** *I'd like to ask the Administrator to comment on the stormwater regulations. The Clean Water Act requires municipalities to submit applications, I think in February, and we really don't have any regulations yet. What's your comment in terms of the prognosis.*

A. **Richard Caspe EPA Region II:** I can do that one for you, Frank. I can do it now while the Administrator is here. I can just say briefly that there are draft regulations still moving on that. The issue is that as you start developing regulations governing what will and won't be permitted, the workload for municipalities as well as for EPA and the States could prove enormous. So that's still being debated somewhat on exactly how that system will be designed and set up, but I really don't want to take the time now.

William Reilly: I suspect there is more to that and the other shoe is going to fall with Nassau County; I'd be interested to know the particular concerns you might have about those regulations.

Q. *My name is O'Brien from the New York Chapter of the Sierra Club. I was just wondering if you might touch briefly on plans on wetlands use, especially due to the fact that there's a controversy about it.*

A. You all recall that in the period prior to the campaign in 1988, the National Wetlands Policy Board sponsored by the Conservation Foundation and chaired by Governor Kean recommended a policy of no net loss of wetlands in a proposal to President Bush. We have had under way for more than a year a task force of domestic policy counselors reviewing that pledge and looking for ways to implement it.

As part of that effort, EPA and the Corps of Engineers finally succeeded in doing what all these many years of administering the Clean Water Act Section 404 together we had never done. And what we did, which many critics had urged us to do, is that we integrated, we came into agreement on how to administer that law. It turns out that it scared the daylights out of all those folks who had been telling us we'd never get together.

At any rate, we did. And, as many of you may know, this occasions a very strong negative reaction from energy interests, from transportation interests throughout the country, and from groups in Alaska concerned about excessively rigid application of mitigation requirements. When I looked into the history of how we have, in fact, applied Section 404, in Alaska, which is 58% wetland -- and that happens to be the developable flat part of the State -- I discovered that 9 out of 10 of the permits that we granted last year had no mitigation requirements. The reason for that was that our regional office could find no possibilities of wetlands to restore in this area that is wetland rich. In other words, we were administering the law in a reasonable and responsible way. When there were no practical alternatives to a project and no way to mitigate or apply to wetlands we made those accommodations. Nevertheless, we put into a revised memorandum of understanding to the Corps, a specific agreement that where the Corps and EPA together agree that there are no mitigation opportunities present, because of a large amount of wetlands in an area, we will in those cases, which we expect to be very few, not require mitigation.

Now, I want to say two things about this agreement. First, it is to all who worked in the wetlands area for any length of time a very significant advance over previous policy. It's not an advance from the environmental point of view over the draft that we signed last November, but it's a much greater advance over the pre-existing policy that was in effect for many, many years. Second, the role of a number of people, in particular the Chief of Staff John Sununu, and the conflicting concerns of the various interests were, it strikes me, perfectly normal and appropriate. In fact, it was testimony to the very high priority the environment has in this administration. My predecessor, I was told after all this took place, Lee Thomas, made five telephone calls to Don Regan, Chief of Staff under President Reagan, to find out and to discuss with the Chief of Staff what the President should do about the Clean Water Act, which was presented by the Congress for his signature -- the President's signature. And, he never received a call back until someone let him know that the President had, in fact, vetoed the bill. That is unthinkable in this administration. We are engaged and we are involved at very high levels, and both the Governor and the President reaffirmed their support for no net loss of wetlands in this process. We continue to work on that and we give it a very high priority. It's one of the most specific pledges the President made in his campaign and when he defined for me what he meant by it, the memorandum would more than satisfy any concerned environmentalist about the 300,000 to 500,000 acres of wetlands we are losing every year in this country. We do, however, have to continue to keep the public informed about the function of productive wetlands. I was disappointed that we could not have that kind of support. I think I talked to 15 governors about that memorandum. And secondly, we've got to be sensitive to practical and serious ways to implement these policies. We've got to know how to separate the important from the insignificant. To the extent that we do that, I think we will have the consistent support -- more support -- than we have, particularly at EPA.

Q. *Can you comment on the administration's draft on the fate of sludge, CSO, and floatables washing upon beaches.*

A. On the CSO problem and sludge -- I'm aware that there have been a great many concerns expressed about our sludge regulations, and we have had a considerable number of comments made and we have scheduled to review them. The reuse of sludge material is something we want very much to continue to make possible and encourage. It is, in my view, fully consistent with sustainable development. We will get those out in the near future and I think there will be responses to some of the problems. On the CSO problem generally, I don't have a lot of answers in terms of resources to make available at this time. I think I addressed that issue to some degree in the morning. The only thing I would say is, it probably is important that you understand the attitude on this. We have a continuing argument with the Congress about the adequacy of resources in the quest for clean water and wastewater treatment. We are asking, as I mentioned, $1.6 billion for these State revolving funds to capitalize State capacities to maintain their own responsibility in the future investments in this area. That is $400 million less than the Congress appropriated last year -- $600 million more than was ever appropriated for State revolving funds. There was an understanding reached some years ago, to phase out, both through the Reagan Administration and the Congress, the Federal role in wastewater treatment. Now, having reached some $52 billion as I mentioned, it's not seen as a permanent commitment of the Federal Government to support. I know that poses some very difficult problems in this area, and I know that when we finally reach the end of the line, within the next year or so, we will find the Congress very reluctant to acknowledge that that agreement means what the administration thinks it means. We will continue the dialogue and take further stock of the situation at that time and see where we are.

My own sense with regard to water pollution is that the really crying need against which we have made wholly inadequate response is the nonpoint source part of the problem. It is responsible for more than half of the surface water problem in the country now. We have, for the first time, gotten the Federal establishment, the Executive Branch, to make a commitment to provide some funds for nonpoint source control -- $14 billion. Last year, I think, there was three times that amount committed by the Congress. It's primarily a State and local problem, as the land use part of it, I think, must continue to be. We will work very closely with each of the States and localities to try to give aid and respect the nonpoint source programs. Also, to bring on the new technologies -- soil nitrates testing, better control of pesticides, to find other ways of proposing this year 2.5 million acres of new land in the Conservation Reserve Program. This is the program in which farmers are actually paid to take land out of production. We want to concentrate those investments now on filter strips, buffer strips, wetlands resources, and other areas vital to conservation and protecting wetlands and groundwater, and to protecting our water quality program. We are committed to work very closely with the U.S. Department of Agriculture in developing these initiatives, to make them dovetail to serve a number of objectives at the same time.

Thank you.

SIGNING OF THE COASTAL WATERS PLEDGE

Morning Speakers and Invited Elected Officials

ADDITIONAL SIGNERS OF THE PLEDGE

William J. Hughes
U.S. House of Representatives
2nd District, New Jersey

Dean Gallo
State Representative
District 11
New Jersey

Guy V. Molinari
Borough President
Staten Island

James H. Scheuer
U.S. House of Representatives
8th District, New York

Andrew P. O'Rourke
County Executive
Westchester County

PLEDGE FOR

OUR COASTAL WATERS

Including

NEW YORK BIGHT, NEW YORK / NEW JERSEY HARBOR, AND LONG ISLAND SOUND

March 12, 1990

We, the undersigned, find and declare that...

Our estuaries and coastal waters are important natural resources that have provided incomparable beauty and significant recreational and commercial benefits;

The living resources, water quality and aesthetic character of these waters have been altered and degraded from rapid development, over-exploitation and other human uses;

Restoration and protection of the environmental quality of our coastal waters requires focused management by a partnership of federal, state and local governments, affected industries, academia and the public.

We therefore pledge to support the goals of the Management Conferences overseeing the development of the Long Island Sound Study, the New York/New Jersey Harbor Estuary Project and the New York Bight Restoration Plan, and we commit to restore and protect the environmental quality of our coastal waters through the implementation of the Comprehensive Conservation and Management Plans developed by these Management Conferences.

Administrator

Management Conference Policy Committee Members

Leslie Carothers

Julie Belaga by David Fierra

President, Manhattan College

Elected Officials

Nita M. Lowey
Rep 20th Cong District

NYS Senate 4th DIST

Eliot L Engel
US Rep 19th Cong District

Mayor, Village of Mamaroneck

THE CHARGE TO THE CONFERENCE

THE CHARGE TO THE CONFERENCE

Judith A. Yaskin
Commissioner, N.J. Department of Environmental Protection

My follow administrators of environmental protection programs and ladies and gentlemen. Every time we start one of these conferences, and I've attended many over my years as a public official, I always feel that you who are the work horses, the technicians, the experts, are really ready to go into your workshops and get started, while we continue to have speeches. I will make mine short and thank you for having me here today. I'm the newest member of the regulatory officers and administrators here today. I've been in the office 60 days and I've made four trips to the Arthur Kill, so at least I have that record. I also have a very bad cold as a result of that.

As many of you know, Tom Druid and I have been talking to -- and around March 23 will be meeting with -- the petroleum industry. Letters are being exchanged with regard to what has been happening with the petroleum industry and the Kill. The Arthur Kill has been the scene of many accidents. The Administrator said that all the accidents that he's observed were human error. We haven't reached that conclusion with regard to the incidents at Arthur Kill; certainly human error contributed, but we are also concerned about metal fatigue, boat inspection, piloting, and concerned about the very nature of the pipeline -- that was the initial accident that occurred in January.

We want to meet with the industry because our primary goal is pollution prevention. For the most part, our responses to the Kill have been satisfactory. I give a high compliment to the Coast Guard. But once filled, there's no question the estuary has been affected, that the marsh in the area has been affected, and that we are faced with a continued cleanup and examination of the degradation of that estuary. The main thrust of that meeting will be prevention and where do we go from here. And, of course, to examine with some federal representatives heard from today and New Jersey's representatives, where our jurisdictions begin and end. It is not satisfactory that the federal government has a preemption in the governance and responsibility for pipeline safety, but that if a particular pipeline is a three-quarters of an inch smaller than their jurisdiction or is exempted from their jurisdiction, it appears that that is an unregulated, uninspected pipeline.

Of the complex issues we are facing in this estuary, the New York/New Jersey Harbor, I've been asked to address the development and land use in this estuary. As we know, the complex issues that are facing us are because the estuary, which is rich and productive, has intensively used habitats -- not only by human beings but by birds and other creatures as well as fish -- and accommodates fishing, commercial shipping, tourism, the waste disposal industry, waterfront development, wildlife, and people. The estuary finds itself dealing with these varied sources of pollution, and the solutions to clean up are extraordinarily complex.

New Jersey is a part of two national estuary programs. On the north, of course, with our neighbor New York in this project, and our entire west coast and the south of New Jersey is involved in the Delaware Estuary Program. So, there is not an inch of New Jersey's coast -- east, west, north, or south -- that is not confronting an estuary problem. Many people have said that New Jersey is in the forefront of environmental regulation and law -- I answer because it has to be. As one of the most densely populated states in this country, we have some of the most complex environmental problems that any state confronts. We need to identify the factors and the relationships that impact the estuary and to develop comprehensive strategies -- that's what you and I are here for today. While other panels will speak to the concerns of waste management and to pollution, one of the things that I'm concerned about is planning development in these areas.

The environmental goals have been translated by the New Jersey Department of Environmental Protection into a vast set of rules and regulations currently under implementation by the Department. Today, our New Jersey legislature will be passing an even more stringent clean water enforcement act. These regulations cover an array of treatments from coastal land use and planning, to nonpoint pollution, to NJPDES or discharge permits, and many of these programs also regulate the infrastructure associated with development such as wastewater treatment facilities, sewer lines, and water supplies. Certainly, all of those regulatory programs are intended to protect environmental resources, including the coastal areas and our estuaries. No matter how well designed these programs and regulations and enforcement seem to be, and the State of New Jersey has already imposed $42 million worth of fines and has 160 municipalities and whole counties on sewer ban, when we look at our estuaries, which are some of our most sensitive areas, there are shortcomings. The programs designed to protect our water and our coastal communities have not been that effective in providing remediation and preventing ongoing pollution. You have heard about some of the reasons -- treatment plant failures, high-level contaminants from nonpoint source pollution, combined sewer overflow, and loss of environmentally sensitive areas due to increased development pressures, loss of wetlands, filling in, and drainage -- all in affected sensitive areas. These are areas where new approaches in environmental protection are needed. These are some of the new approaches and strategies New Jersey is contemplating.

In the past, the question of whether or not to approve a new or expanded domestic wastewater treatment facility dealt mainly with the engineering and technical aspects of the system's design and the physical limitations of the receiving waters and groundwater. Today, we are beginning to look more at the regional and secondary impacts of new domestic wastewater treatment facilities. It is not enough to accept as sound the environmental planning or the technical wastewater treatment capacity. We need to address whether a new facility is needed to provide for planned and future growth or whether the facility is really a poorly planned venture that will spur environmentally unsound development.

We have had the experience in our state recently with the Great Swamp. Some of you may have read about it in the New York newspapers and New Jersey newspapers. It was clear that our Division of Water Resources came to the conclusion that engineering and technical solutions could be found to extend the sewer lines and create greater capacity in the wastewater treatment plant that was involved. The problem was that those extended lines would spur development near a national wildlife habitat. The question then became how do we resolve and why do we have the split of what itself is called a philosophy. We had our people in natural resources, in the wildlife programs, in habitat programs, and our regulatory people in wetlands coming to grips and confronting the technical achievement of the engineers. It is interesting to me that not only were many of these people in three different divisions, but they had three different assistant commissioners to whom they reported. It seems to me that as a regulatory body one of the things we need to do to provide sound policy is to restructure the department and our functions so that we look at the totality of the impact of such a plan. Whether such environmentally sound wastewater treatment plants will spur environmentally unsound development, of course, is one of the real economic issues that confronts the state.

We have a state planning mechanism, and I intend as Commissioner, as does the Department, to come and work with that state plan before we approve new wastewater treatment plants or extension of sewer lines so that we will look not only at the treatment plant for its adverse impact on receiving waters, but also at the potential adverse impact to surrounding areas including environmentally sensitive areas and coastal areas. We can no longer consider just the immediate effect of a proposed facility. We must look at long-term and cumulative effects.

Through water quality treatment planning, the Department has been able to coordinate wastewater management decisions with the water quality management planning provided in the statewide and areawide water quality management plans. In October, the Department adopted new statewide water quality management planning rules that, among other things, will require smaller-scale wastewater management plans.

Atlantic County and Cape May County -- although these are not in the area of the New York Harbor -- also are deeply concerned with what we do in this harbor, because planning and what occurs here deeply affect all of their beaches. New Jersey will have a floatable plan and a water surveillance quality plan again this year. We will be working with the New York authorities to develop a cooperative effort for the cleanup of the Harbor and for the beaches of Sandy Hook, assuming the Federal Government gives the waiver that we need to do our work there. We are using Department of Corrections labor, Department of Transportation equipment, and I have managed to get funds to do this. Like New York, New Jersey is suffering from a tremendous budget crunch. The Administrator spoke about the problem of resources. Our state has a $550 million deficit for this fiscal year that it must balance by June. Nonetheless, our Governor and this Department have been able to allocate $1.1 million for beach cleanup and for floatables.

In addition to statewide water quality management planning rules, the Department recently is developing a nonpoint source assessment and management program with the EPA. This is, of course, a question of education and one which we all agree is vital. If the estimates are accurate, 65% of all the pollution of our surface and groundwater, including the New York Harbor, is a result of nonpoint source pollution control.

The other aspect of planning in which the Department is involved and will be working on with New York, is the development of the Skylands Project to protect our watershed and the Palisades between the rivers of New York and New Jersey. This is because it is not just what goes on in the Harbor but the quality of the water and the protection of the water supply that need to be considered. In other words, it is not just the estuary but what gets into the estuary, what development occurs that will impact on the estuary. New York and New Jersey have come to realize that we must plan and we must manage. In addition, New Jersey has a moratorium on the conveyance of lands utilized for the protection of public water supply reservoirs. My department will continue to support a moratorium so that we can develop recommendations concerning buffer zones around public water supply reservoirs. This report and the application of multi-zone buffers throughout watersheds associated with public water supply intakes and tributaries was submitted in December, right before I took office in January. I've met with the legislature and they are anxious to work on developing such buffer zones for all the watersheds, particularly those that affect New York and New Jersey, in what I call the Skylands Territory --the Palisades, Sterling Forest, and all of that precious area north of here.

This multi-zone buffer approach is particularly relevant to watersheds that drain into New York Harbor and other estuaries. Since the buffer zones would be applied to public water supply reservoirs, intakes, and tributaries, the downstream estuaries will be the beneficiaries of upstream nonpoint source pollution controls and regulated development. Our state has developed a seven-tier plan of development. It's now being worked on with the counties in what's called a Cross-Acceptance Program.

Let me give you an example of regulatory failure. New York, like New Jersey, has a coastal areas facility review plan (CAFRA). One of the greatest loopholes that has gone on in New Jersey has been the numerous attempts to close and change the way in which CAFRA operates, from the proposal of commissions in the last administration to a dune act, which failed 15 years ago in a previous administration. Right now communities still are not regulating developments if the developments are less than 24 units. The thought was that individual homes should be free of control, of planning, and of regulation. So, if you were a major corporation and you have four or five subsidiaries you can build 24 or less units in the same area, which has occurred in this state. This is a loophole that needs to be fixed. In addition to the coastal areas review, you have the overlap with the Pinelands Commission, and the state plan does not apply to any of the coastal counties because of CAFRA and the existence of another regulatory body called Pinelands. The result is that our coastal counties, other than their own planning resources, are not examining regional planning. This is a proposal that will come into effect and I have spoken with the Governor about how to provide regional planning to protect our water supplies and to protect the counties as they develop. In the next year or two, I think, this will be one of the principal concerns of my Department as it affects our coast and our estuaries to ensure that planning can be carried on a careful way -- careful of our habitat and careful of our water supplies. We are already experiencing saltwater intrusion into our aquifers. Without the aquifers, no matter how many houses are built, there will be no water supply for human habitation. The Department ultimately foresees correlating water supply needs of the area with its wastewater management needs.

Other members of this panel will speak about the problem of wastewater discharge. Clearly, one of the most pressing problems we have is CSOs. My state has thus far put forth $2 million for planning and mapping of CSOs. We have another approximately $40 million available for distribution for design for this fiscal year. Next year I hope for, and will press for, additional millions of dollars depending on the deficit. In New Jersey, to fix CSOs alone will probably cost upwards of $150 million. Nonetheless, the counties, the federal government, and the state will continue to dedicate funds through the Wastewater Treatment Fund, through state appropriations, and through Federal grants -- monies for this project that is critical to all our estuaries and all our coast.

New Jersey appreciates being allowed to participate in the development of a comprehensive management plan. It is significant for our state that we are surrounded by sensitive estuaries. We understand New Jersey's responsibility in polluting those estuaries and we understand our responsibility for helping to clean them. I look forward to working with this conference and with the Management Conference.

THE CHARGE TO THE CONFERENCE: DEVELOPING THE POLITICAL WILL FOR COASTAL CLEANUP

Leslie Carothers
Commissioner, Connecticut Department of Environmental Protection

My assigned topic today is developing the political will to carry out the cleanup of our coastal waters. I think there are three major ingredients in the recipe for creating the energy -- the sustained energy -- to do the job.

- Good science
- Public understanding and activism
- Leadership by policymakers, especially elected officials

I will use the example of Long Island Sound because that's the case I know best.

Good Science

For several years, New York, Connecticut, and EPA Regions I and II and many research organizations have been at work on the Long Island Sound Estuary Study.

The task of the scientists and analysts is to diagnose the Sound's problems, and to array the evidence in a way that points clearly and convincingly to the remedies. One thing they have shown us is that excessive nitrogen in Long Island Sound water is increasing algae that take up precious oxygen as they die. Dissolved oxygen at the bottom of the western sound is so low it shows we are in danger of creating a Dead Sea.

All of our three states have the legal tools, or most of them, to control pollution, such as wasteload allocations and permits. What we need from science is the analysis that we can plug into our regulatory systems to require action.

Because those actions will be costly, we will need as much precision as the state of the science affords to tell us what reductions in nitrogen are needed and where they are needed to get results. And we will need the ability to translate that information into terms that are understandable and credible to the public.

Public Understanding and Activism

Nothing much gets done in politics unless somebody cares and somebody pushes.

Well, believe me, the public cares about coastal resources and amenities. On Long Island Sound, we have over 200,000 registered boats whose operators care about the quality of the water and the shore. Commercial and recreational fishermen, beachgoers, bird-watchers, harbor dwellers, tourists -- they all care, too.

In Connecticut, we have a growing number of organizations, alliances, educational institutions, and individual activists all focusing attention on Long Island Sound. Saturday night, I went to a lecture at the Mystic Aquarium by Terry Backer, the Soundkeeper, a watchdog for the sound. He drew a large and attentive audience. They had to be attentive, too, because there were several obstreperous whales in the pool behind the podium, giving the whale's rendition of a Bronx cheer whenever Terry paused. I conclude that the whales are with us and the people are, too. They want to see an agenda and hear what they can do.

I want to add that the press is an extremely important factor in increasing public understanding and concern. The sound has received excellent coverage of issues -- good reporting on the tough technical issues of the science as well as some racier stuff on syringes. The scientists, we bureaucrats, and the politicians need to keep the information flowing so the press can help us keep the issue before the public over the long time it will take to address the problems.

The Policymakers

Governors, legislators, and their staffs normally respond to the facts and to public concern. But we and they must do more than react. We must lead.

In Connecticut, the Governor and our department are already taking action in anticipation of a new agenda for Long Island Sound.

Because we expect nitrogen removal to be required at some of our plants affecting the Sound, we are requiring that phase of treatment to be included in upgrading plans. We are also piloting nitrogen removal options at our Norwalk plant and working on ways to fund interim, operational measures that can cut nutrient loadings.

This year, Governor O'Neill has proposed to raise the state's annual contribution to our Clean Water Fund from $40 million to $100 million. The impact of this will be to accelerate the construction of all of our projects and allow leveraged financing, both of which will save a lot of money -- hundreds of millions of dollars -- that can be directed to nutrient removal for the Sound.

Our legislators are now working with their New York State counterparts on the new Bi-State Commission on Long Island Sound. They are identifying common issues like oil spill prevention to lay the groundwork for coordinated action. The members will also help to build the bridges we need for both states to work together on funding.

But the cleanup and preservation of our coastal waters are surely not solely a state responsibility, nor should New York and Connecticut be regarded as the exclusive stewards of Long Island Sound.

The Long Island Sound Study is a state-Federal effort of our states and EPA. The constructive collaboration that has occurred would be continued under a Long Island Sound office proposed in legislation by Senator Lieberman. We need a framework for cooperative action as well as analysis.

More than that, we need national leadership and Federal money to help clean up our coasts. The states are ready to do our share, but the multiple social and environmental burdens of our coastal cities -- Newark, Bridgeport, New York, to name a few -- greatly complicate the task.

Considering that, it surely defies reason that we are phasing out Federal clean water funding in the next two years.

We aren't phasing out the Federal highway program, are we? In recent weeks, the Administration proposed not to eliminate it but to redirect it to routes and projects of national importance.

Why not do the same with the Clean Water funding program? Keep it, but redirect it to pollution problems of national priority. Surely restoration of our nation's precious coastal waters ranks at the top of the list.

I recognize Washington thinks only governors and state legislators should get to raise taxes. But I note that we are somehow scraping up $160 billion and counting to bail out greedy and incompetent officials of deregulated savings and loans. So don't tell me we can't find the money to continue a Federal share of coastal cleanup. We're talking about political will here. And so let us press on to get the facts and make our case. Let us do our best to keep the growing constituency for coastal cleanup informed and engaged.

And let us <u>demand</u> that public policymakers at <u>all</u> levels of government make the commitment to clean up our coats and to make great strides by the year 2000. All we ask is their attention, their energy, and their willingness to make hard decisions. And if the public officials we have can't do it, we should find some new ones who can.

THE CHARGE TO THE CONFERENCE

Langdon Marsh
Deputy Commissioner
New York State Department of Environmental Conservation

Thank you, Rich. Well, the conference is only a couple of hours old and already one statement that has been made clearly needs correction, and that is that not everything you read in the New York Times is true. I speak particularly of the allegation that the State of New York is the largest polluter of the waters of this state, which is an allegation made by a couple of upstate Assemblymen, and as I have testified before them that is a gross misstatement or distortion of the facts. Nevertheless, the New York Times does print what people say.

Well, it's great to be here together with my colleagues on this panel. We represent a veritable bouillabaisse of regulatory jurisdiction. And, it is fitting that this group try to make and blend a fish stew of all of the various programs and initiatives that we have to contend with because only by recognizing the interdependence of the Long Island Sound, the Bight, the New York/New Jersey Harbor, and the issues and problems and potential solutions that are available, can we come up with an action plan -- an action program -- that will truly work. I think that the coming together of these three programs and efforts with the help of Manhattan College and EPA is good evidence of a growing recognition by people along the coast of their own interdependence and of the interdependence of the various problems that we have to deal with. I think this is part of a growing movement toward addressing the problems of coastal waters. Last week, for example, I testified before Congressman Studds, and some members of his panel of the Committee of Merchant Marine Fisheries, on the coastal defense initiative that he has drafted to upgrade the water quality standards applicable to the coastal waters, and also to coordinate better between coastal management programs and coastal water quality programs. While there are some defects in the particulars of his approach, overall the thrust of that initiative is a very good one, in recognition that there is a strong constituency and a strong need to deal with the problem of coastal water quality.

The particular portion of the program that I'm supposed to address is on the evaluation of the benefits and burdens of the estuary plans and the recommendations that will ultimately come from them -- what burdens will be on the regulated communities. So, let me put before you some questions I think the conference will need to address over the next couple of days.

We have 20 million people living in proximity to these estuaries. Meeting all the best usages of the water that is in that community is going to be a true challenge. Whether we can meet all of the uses for all of these people is what we're about today. Of course, these uses include recreational opportunities, shell fishing, and the propagation and survival of ecologically important species. So, what sorts of impacts and burdens will achieving those objectives have on the regulated communities from New York City to a rural community in the Connecticut Valley, for example? Because we can't do everything that we want to all at the same time, we need to prioritize and put in some kind of reasonable framework those actions that we can reasonably expect to accomplish. How do we define those priorities among all the recognized needs that are out there? Well, by examining the considerable cost of the increased regulatory requirements that Commissioner Carothers has outlined.

Take New York City, for example. Look at some of the environmental issues that are already being addressed by the City, either on a voluntary or a mandated basis. Their total capital expenses planned just for projects that are on the State Revolving Fund priority list amount to $6.7 billion. The City is faced with a number of major expenditures -- expansion of treatment plants to treat excess flows, regulator and pump station improvement programs, combined sewer overflow abatement -- that in itself is expected to cost about $1.5 billion -- getting sludge out of the ocean, flow reduction at various POTWs, inflow infiltration assessment and correction, and so on. On top of that, you have the extremely expensive problem of solid waste disposal and water supply development. When you put it all together -- about $10 billion worth of water quality needs alone plus billions more for solid waste, water supply, and so on -- there is a tremendous economic burden. This is all before you get to issues like nutrient removal, which is indicated as the major improvement from the Long Island Sound study. If $6 billion is truly the price tag just from Long Island Sound, what more will there be for the other estuary programs? As Commissioner Carothers outlined, it is clear that we are facing a tremendous financing problem, and we have to set that against all the other local needs for financing such as public housing, medical care, social services, and of course, infrastructure repair -- bridges, roads, and so on. Local communities are going to be extremely stressed over the next 10 or so years as they begin to address the kinds of problems that the estuary programs are beginning to identify.

Now, in order to deal with this, there are a couple of things that I believe need to be done. First of all, we need to document the impact of doing the various things that are recommended -- the various management options. We need to get information to identify the incremental costs of improved water use and the potential under different options. It is going to present us with some very hard choices. For example, we need to evaluate the effects on recreational and commercial fisheries and various dissolved oxygen levels with the various nutrient control options and costs to try to come up with a proper balance and sequence of improvements to be made. We need to understand the economic and human health significance of increased openings of shellfish areas relative to the costs of combined sewer overflow abatement, stormwater control measures, and new sewering. We need to evaluate the cost-effectiveness of prevention programs versus remediation. Where do we hold the line? What kind of improvements can we afford? What is feasible? This is not to say that we need to give up on any particular objective. We need not assume that there won't be enough money to do the things that need to be done. I was heartened to hear that perhaps unlike other members of his administration, Administrator Reilly did talk about the possibility of a peace dividend. There can be a peace dividend and there can be dollars made available by extension of the revolving fund program or otherwise to cover the costs of these needed improvements. But nevertheless, even with additional money, it is never going to be enough for us to do everything all at once. So we need to define the problems. We need to identify which things we can do right away and which things will have to be done later on.

We face two different kinds of problems. Those which are controllable with the existing technology, and for which publicly accepted management options already exist. Things we know how to do and have done for many years but at the moment just lack the resources to do. Controlling pathogens, for example, dealing with combined sewer overflows and stormwater control -- there are proven and well accepted technologies available. But then there are those problems for which there is no easy social, political, economic, or technological solution. There is no agreement on what has to be done, or how it will be done, or how it will affect the communities that are involved. What do we do with sediments, for example? How do we remediate them? What kind of disposal or treatment technology do we use? Where do we put it? And a host of other questions. What is the role of biotechnology, which Administrator Reilly is very laudably pushing as a technique or control? But until we can achieve some level of consensus of how to deal with problems like sediments, it will be very difficult to move forward.

Now, municipalities throughout this three-state region are achieving higher levels of wastewater treatment, they are implementing pretreatment programs, disposing of solid waste, and developing sewage sludge disposal techniques. But we must recognize that these municipalities are not the generators of the waste, they are simply the recipients of it and are asked to pass on the problem or to deal with it themselves. So, one of the questions that I think has already been put to you in various forms this morning is to what extent should we place more emphasis on estuarywide waste reduction, reuse, and recycling programs? What kinds of programs are suitable for cooperation among the various jurisdictions and how do we implement them? What kind of institutions? What kind of education? What kind of financing can we provide for these kinds of programs?

And secondly, of course, we need to intensify our educational efforts on individual's responsibilities to relieve these municipalities of the burdens that have been placed upon them. How do these affect us as citizens, as taxpayers, as consumers? We heard some discussions this morning about the motor car and the kinds of changes that will be required for its use in this metropolitan area to improve air quality over the next 10 or 15 years. We have to face the same kind of issues with respect to waste reduction in other areas -- in solid waste, the kinds of products we consume and how we throw away or recycle them -- and in our use of the wastewater treatment system as a way of disposal.

So, in closing, I'd like to urge you to accept the very considerable challenge that you have. We need to take dramatic steps to improve our water quality. They are expensive but they are possible, and we need to sort out how we can accomplish them. We need to recognize the total burdens put on our regulated communities in order to meet those objectives. We have to define our goals precisely and develop priorities that are achievable.

THE CHARGE TO THE CONFERENCE

David Fierra
U.S. EPA, Region I

Thank you, Rich. Julie Belaga wanted to express her regrets for not being here and I can truly tell you that she is a very strong advocate of the coastal issues. She would have liked to have been here, but she couldn't.

When a friend of mine who works for NOAA found out I was coming to the conference to speak, he sent me a copy of a report on which he has been working. The report is to the United Nations, the second report dealing with issues on coastal waters in the world. He sent me a letter that highlighted some of the things in the report. I think that I'd just like to summarize a couple of those things to reinforce what a lot of others have already mentioned here this morning. This is the second United Nations report. It has looked at thousands of studies worldwide. The consensus is that it is not individual pollutants or activities that are causing the major problems in coastal areas, but it is the result of the sum total of all of the contaminants plus physical effects together from both point and nonpoint sources. I think that the conclusions from the report are that only when people become concerned with contaminants -- ranging from dog feces on streets to exotic chemicals coming out of modern internal combustion engines, spreading over the streets and washing into the sea -- can we begin to do something about issues. It's easy to end ocean dumping, although some in this room may not agree with that, or to move it farther offshore. It's far harder to get the general citizenry to do those things that must be done to improve and maintain environmental quality in the cities bordering the coastal zone. Well, I think that's just another voice worldwide that is indicating what the Administrator, Brother Scanlan, and all the other speakers have talked about in terms of the problems we are facing. We must reduce the loadings to the environment, particularly to the coastal areas where they tend to accumulate, causing real problems.

My charge to this group, this morning, is to talk about pollution prevention. As was alluded to earlier by at least one of the questioners, I'd like to define pollution prevention because talking about changing lifestyles or changing the way that we do business means putting the environment first in the way we make those changes. Who are the people that need to participate? My feeling is, and I think a lot of the other speakers have mentioned this, that everyone has a role. Industry certainly has a role. They must reduce the chemicals they use. We must reduce packaging. Obviously, agriculture has a major role. Developers need to stop destroying wetlands and habitat. Citizens must be much more cognizant. The local, state, and the federal governments all have roles, significant roles that should be more proactive. We need to look at legislation. We need to look at incentives. We need to look at technical assistance -- working with people. Obviously, advocacy groups have a significant role as Leslie Carothers mentioned. They must push everyone harder. And we all have a responsibility to educate our peers and the citizens, as Commissioner Carothers said, in terms of what are we really doing to our environment and what can we do to change it?

The changes are not going to come easily. In many cases, they are inconvenient. There are institutional barriers that need to be dealt with -- and, in some cases, they're costly. But as Dr. Jack Pierce from NOAA said, "these are the things we must work on if we are going to make a difference." The cost of not making these changes, as people have said, is overwhelming. Many of things we are doing now are irreversible in terms of our overall ecosystem.

I would like to talk for just a couple of minutes about a few examples of some of these ongoing changes that I am aware of and things that this group should think about in terms of their applicability to the estuaries that we are talking about today. Cape Cod, Massachusetts, where I happen to live, is about to pass or ratify a local land use regulatory agency. That is a tremendous challenge in New England, and in Massachusetts, where local government is so strong and so autonomous. They've finally come to the realization that the ecosystem is a regional -- geographically regional -- activity and does not honor town boundaries. I expect that it will pass by probably 3 to 1 or better, because the citizens did vote it in by 3 to 1 on a non-binding referendum a year ago last fall.

The Narragansett Bay Project -- some of things we are doing there. One of the projects we're funding through the bay project is working with industry, doing environmental audits and helping industry to reduce the waste that it actually uses and in many cases going to closed systems.

In the Long Island Sound Project on the Housatonic River, we're funding some work. We are working with local farmers to try and minimize the amount of nutrients that they need to place on the land. I know in the New York area, although I'm not personally involved in it, Region II is dealing with the marine debris issue and trying to control the management of it while ultimately looking to minimize the utilization of it.

I think that the message that I'd like to leave with you is that all sectors -- every person -- need to deal with this issue and can make a difference. The motivation must be there. Like Leslie Carothers said, we need to educate the people about what the consequences are. I think this can be done. I was at a meeting yesterday in Rhode Island at which Administrator Reilly spoke. It was their annual Save the Bay Meeting, and there were 1,200 people present. Every Congressman from Rhode Island was there with one exception, and he sent a letter -- they don't dare not be there. Save the Bay has the major impact on politics in Rhode Island and they have made a major difference. I think that can occur elsewhere.

I think this group of people should let their imaginations run over the next two days and come up with very strong and sensible but far-reaching recommendations to the Policy Committee on all ways of reducing pollutant inputs into the environment. As Langdon Marsh mentioned, it is going to be very difficult setting priorities on some problems. This is true, but we should work on all fronts right now to reduce pollutant loadings. Thank you.

THE CHARGE TO THE CONFERENCE

Constantine Sidamon-Eristoff
Regional Administrator, U.S. EPA, Region II

Thank you, Rich. No, I'm not mad because I'm going last; however, I am looking forward to lunch. So, I won't be too long. One of the difficulties of going last, of batting cleanup, of course, is the fact that many of the previous speakers have made the same points that I was and am prepared to make. However, never mind. I will go ahead anyway.

Part of our problem, and my assignment, is to talk about what we can do now. I believe part of our problem is that people in our region and this country are not really sure that governments collectively can improve things. I think we have a lot of credibility to restore on our collective ability to do something. This table represents a collective partnership table -- the State of New York, the State of New Jersey, the State of Connecticut, Region II, and Region I of EPA. Can we get some visible results? In the interim, in the period between the time we identify the many problems that we really know already, and the time we complete and implement a long-term management plan to resolve these problems, wherever we can, we need to begin removing some of the factors contributing to the problems, while we are trying to figure out how to resolve them comprehensively. In this way, we can keep many of the effects of the problems in check while we look for permanent solutions.

We know, as Commissioner Carothers said, that the public cares. The public, however, needs to be lead. You know, politics and rhetoric can be very harmful. It doesn't really accomplish very much to blame either the states, or the federal government, or the cities, or the localities because that kind of convenient bashing of other jurisdictions doesn't accomplish anything. It's hard to convince people in one part of the country that they should put resources -- tax dollars -- into coastal areas or another part of the country. That's a given fact. What we at the federal government, on the administrative side, can do is try to make sure that those resources for which we are responsible are spent wisely and effectively. However, I think we have to come up with some things that we can do now that are really feasible and that can show the public that it is worthwhile to expend their resources on improving the conditions in our estuaries, our water bodies, and our coastal areas today. Discretion is obviously the better part of valor. And before you implement any interim plan of action you must have a reasonable basis for whatever temporary solutions you are offering.

I want to touch on five or so specific problem areas that we have identified and how we are now either implementing or could implement an "action now" agenda to deal with them. The first one is the floatables area. We mentioned earlier that an early product of the New York Bight Restoration Plan was the short-term Floatables Action Plan that was implemented last summer. This was, I think, extraordinarily successful evidence of how jurisdictions can, in fact, work together. This plan was developed in cooperation with the U.S. Army Corps of Engineers, the Coast Guard, the New Jersey Department of Environmental Protection, the New York State Department of Environmental Conservation, and the New York City Departments of Sanitation and Environmental Protection. The purpose was to combat floatable debris and washups on beaches. As you all know, washups had created an enormous problem and a disaster area for our coastal regions the summer before last. An economic hit of enormous magnitude. Last summer the plan, and what was done according to it, virtually stopped beach closings with a couple of exceptions. It is an example of how a short-term solution, an action now agenda, can be effective. The same group that developed the floatables action plan is currently working on long-term solutions for the Bight. Skimmer boats will be bought by the City of New York and put into service in skimming, when the money is made available through grants to be made by the region in the next couple of months. The boats will not necessarily be available this summer. Meanwhile, the plan and the program will go back into effect -- and have already started to go back into effect -- this summer. But what new things can we start to do in the same general area of floatables that can begin to attack the problem directly, visibly, and immediately? That is the charge that we would like to have you all think about during this three-day conference.

Another area is pathogens. Bursting sewage pipes and other accidents contribute to the ruination of shellfish beds, make waters unswimable, and hurt tourism. Accidents do happen but, to a great extent, these things could be avoided through better maintenance of sewage systems. We need to move, with the states, to ensure that the penalty for these accidents is swift and sure and that, working through the media, we create a clear disincentive for future accidents. In Mamaroneck Harbor, for example, beach closures after periods of rainfall are frequently attributed to the surcharging of sanitary sewers and to discharges of contaminated stormwater. The state is addressing the surcharging issue through enforcement actions. Now, we're attempting to address the contaminated stormwater issue through the Mamaroneck Harbor Action Plan. We are examining alternatives, ranging from increased street sweeping to detention and treatment of stormwater discharges in order to reduce the bacterial load reaching the area's beaches. We will work with the states to incorporate the results in reasonable stormwater discharge permits. What else should we be doing, now, to improve that kind of situation?

Toxics -- this problem appears much larger in the New York Harbor than in the Sound or in the Bight. So, we're looking to fast track the schedule for waste load allocations for toxics so that we can finalize plans to further reduce toxic discharges well before the 1994 deadline for the harbor plan. We'd like to know what else we can do and what else can be done by other jurisdictions.

Habitat -- we are looking at advanced identification or added plans in the Hackensack Meadowlands area of New Jersey and on both sides of the Hudson River. Our only word to the developer and the constituencies if they are represented here is, when it comes to things like wetlands, as Mark Twain said, "It's a lot easier to stay out than to get out."

Nutrients -- this problem is much more severe in the Sound than in the Harbor or Bight. It is a good example of where we need to find a reasonable basis for action. For a long time, we did not have enough technical data to implement an "action now" agenda. We did not even know which nutrient -- nitrogen or phosphorus -- was causing the problem. Now, we see that the culprit is nitrogen. The Long Island Sound study is publicly committed to producing a preliminary nutrient management plan by September 30th of this year, 14 months prior to the completion of the final plan. We need to ensure that we come forward with an "action now" agenda for the control of nutrients at that time. Actions that we should be considering include requiring the owners and operators of municipal treatment plants to begin facility planning now for nutrient control, imposing a freeze on nutrient inputs to ensure that the problem does not get worse as we continue studying it, and initiating nutrient management plans for critical watersheds by targeting the heaviest contributors to the problem. If we hope to regain some of our credibility, we certainly must be prepared to act more quickly than we have in the past.

I can't help thinking that while it took a certain number of years to send a man to the moon it has taken probably twice that long to build one sewage treatment plant in the North River. It's not quite totally in operation for secondary treatment as yet, as far as I know. It takes a long time to get this kind of project done or under way. But, in order to be able to develop the constituency -- the political constituency -- that we have to have to get the money to do the things we all know need to be done, we have to be able to show some direct and immediate visible results now. So, that is my charge to you all. Please tell us what we should be doing now, during these next 2½ days. Thank you very much.

A HISTORICAL PERSPECTIVE ENGINEERING AND SCIENTIFIC

Donald J. O'Connor
Professor, Manhattan College,
and Principal Consultant, HydroQual, Inc.

This paper is an introduction to the major issues of the conference -- Nutrient and Organic Enrichment, Pathogens and Floatables, Ocean Disposal, Toxics, Habitat and Seafood Safety. The first three issues, which affect in large measure the latter two and to a lesser degree ocean disposal, are primarily addressed. A historical perspective of water quality in the New York-New Jersey Harbor is presented, indicating the conditions before construction of the treatment plants and the progressive improvements that have occurred as additional facilities have been placed into operation. Present levels (1989) of water quality are evaluated in light of existing standards and the various projects in the planning and design stages. Comparable, but less extensive, discussions of the Long Island Sound and New York Bight follow discussion of the Harbor. The locations and boundaries of three regions are shown in Figure 1. Scientific and engineering advances and the development and utility of water quality models are briefly discussed. The concluding section summarizes the progress made and the steps to be taken in the overall goal of improving water quality in the metropolitan area, and offers some general observations and recommendations applicable to this and other estuarine projects in the country.

HISTORICAL BACKGROUND

The collection of wastewater and the construction of the sewerage system in New York City began in early 1696. The major portion of the system in lower and central Manhattan was begun approximately in 1830 and completed in 1870. The first wastewater treatment plant was constructed in 1886 to protect the bathing beaches of Coney Island. As the other boroughs of the city and the adjoining metropolitan and urban areas in New Jersey expanded, during the immigration in the latter part of the 19th century and the early decades of the 20th century, so too did the wastewater collection system.

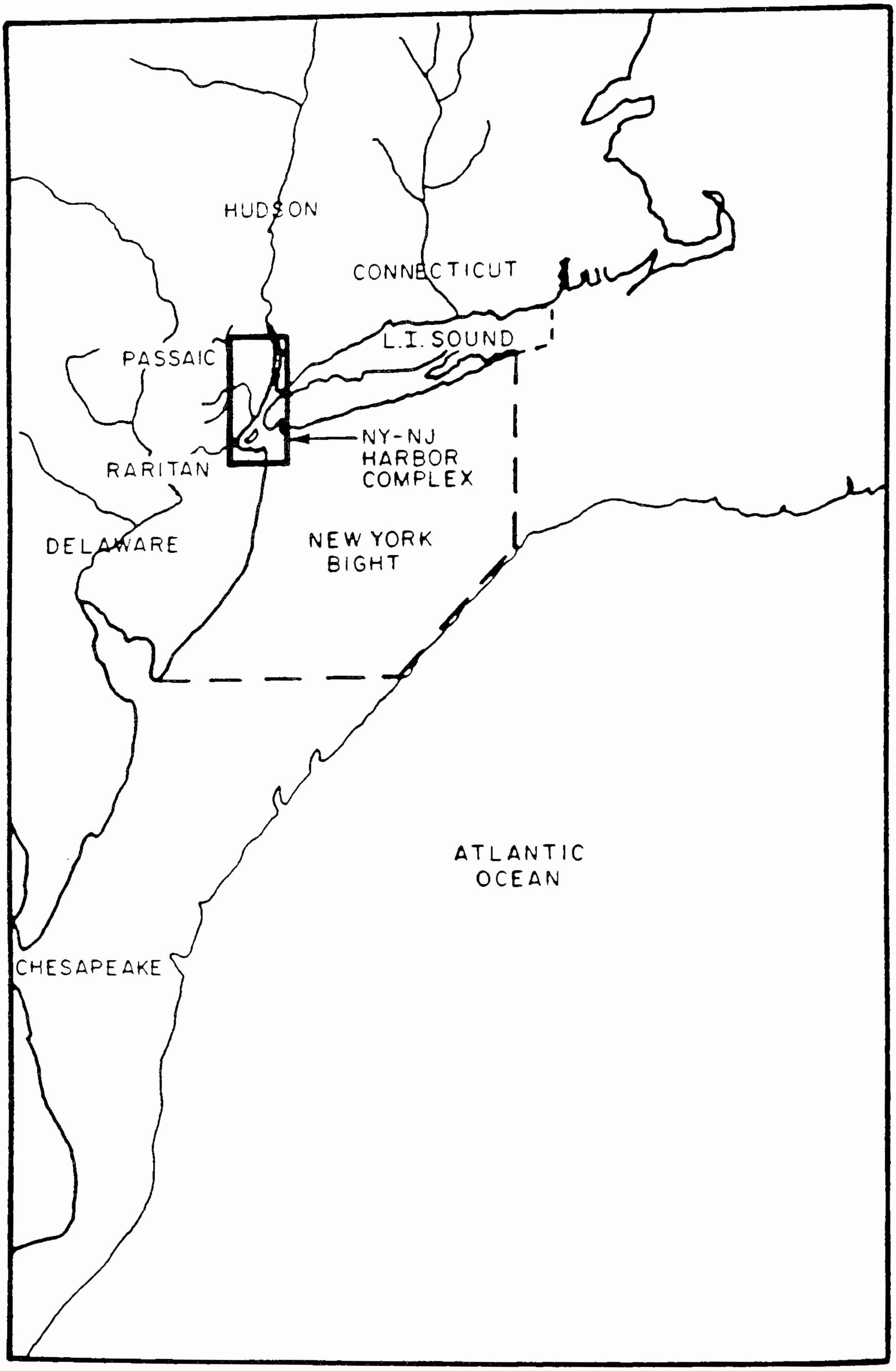

Figure 1. New York-New Jersey Harbor and contiguous coastal zones.

The discharge of the increasing quantities of sewage associated with population growth caused a depression in water quality in the Harbor and the North and East Rivers. This condition, in conjunction with many other public health issues, led to the establishment of a Sanitary Commission in 1904 to develop a master plan for sewage treatment in New York City. Implementation of the Commission's report, completed in 1910, did not occur until 1929, due in part to the first World War in the late teens and presumably due to lack of public awareness during the economic prosperity of the decade of the twenties. Despite the collapse of the stock market and the ensuing financial depression in the early thirties, aggravated by the extreme drought in the Midwest, a construction program was initiated in 1931 in New York City. The first regional treatment plant, Coney Island, was placed into operation in 1935, three additional plants on the East River were activated by the end of the end of the decade, and two plants discharging to Jamaica Bay were operating early in the following decade. Passaic Valley, the largest plant in New Jersey, which discharges to the Upper Harbor, also began operations during this period.

The construction program, which included the installation of new facilities as well as efforts to increase the treatment efficiency of the existing plants, was renewed following the second World War. By 1967, 12 major plants were in operation in New York City, including Newtown Creek, the largest plant in the metropolitan complex. Comparable programs of treatment plant construction in the seventies and eighties were effected in the states of New Jersey and Connecticut and Westchester County, and the City's program was completed. Thus, virtually all of the wastewaters presently discharging to the New York-New Jersey Harbor Complex receive treatment. The locations and capacities of the plants, which discharge directly to the Upper Harbor and the North and East Rivers, are shown in Figure 2. Additional facilities, not shown, are located in Staten Island, New Jersey, and Connecticut.

New York City was one of the first large metropolitan areas to design, construct, and operate biological treatment processes; this provided the basis for subsequent application both nationally and worldwide. Noteworthy is the research and development of treatment processes conducted by the Department of Public Works that were initiated in the thirties and carried on for the next two or three decades. During this period, the role of the federal government was purely advisory through the Public Health Service. A significant contribution, however, was made by a public works program, instituted during the Roosevelt administration, to relieve the effects of the depression. Financial support for the construction of many of the treatment plants was thereby provided. The authority to establish water quality standards, however, resided in the individual states. In light of the regional nature of water quality problems in the Harbor Complex, the States of New York, New Jersey, and Connecticut signed an interstate pact, establishing the Interstate Sanitation Commission. Common water quality standards were agreed on, and the Commission reports annually on the progress of treatment plant construction and upgrading to achieve these standards.

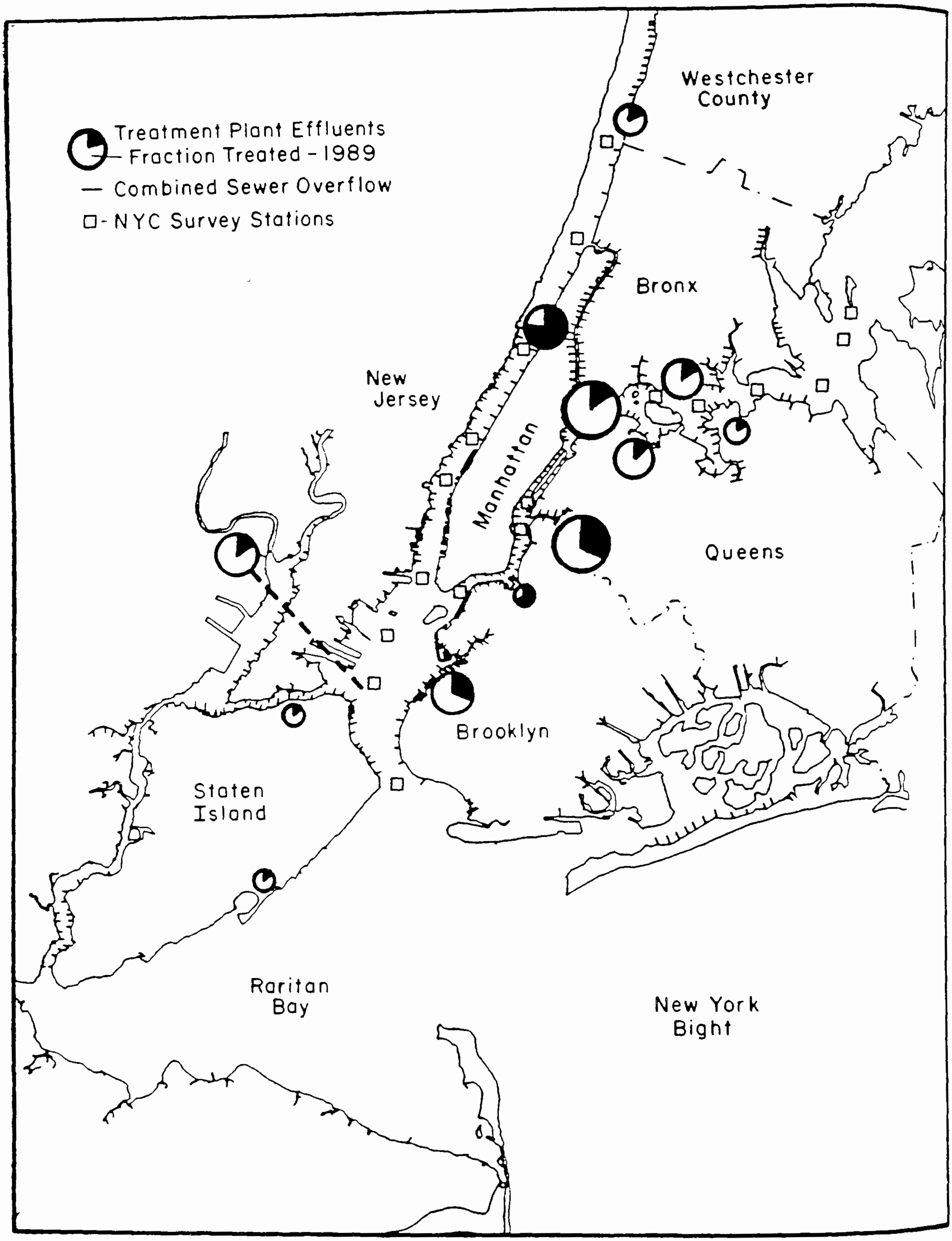

Figure 2. New York-New Jersey Harbor complex.

In the period following the second World War, the federal government played an increasing role in the abatement of water pollution. In the sixties, the Federal Water Pollution Control Agency was created, which thereafter became the Federal Water Quality Agency. Under its auspices, in conjunction with the states and the City, the first comprehensive study of the Harbor Complex was conducted -- The Hudson River-Metropolitan Complex Program. One of the significant features of this program was the application of a mathematical model of water quality to a regional management plant. The development of the model occurred during the previous decade through research grants from the National Science Foundation and the United States Public Health Service.

Increasing awareness of the quality of all phases of the environment -- air, water, and land -- led to the formation of the Environmental Protection Agency in 1970. The Construction Grants Program of the Agency supplied funding for the construction of additional treatment plants. Under the nationwide EPA 208 program in the seventies, a comprehensive study of the Harbor waters was conducted to assess the effectiveness of the treatment facilities in achieving water quality goals and the significance of pollution from nonpoint sources. The mathematical model was extended upstream to the limit of the salinity intrusion in the Hudson River, to the western region of Long Island Sound and to the apex of New York Bight. The water quality model was used to evaluate various management alternatives to reduce the effect of combined sewer overflows, in conjunction with increased levels of treatment of the point sources. It subsequently was employed in a number of regional planning studies. In the seventies and eighties, a water quality program for New York Bight was conducted by the National Oceanic and Atmospheric Administration, which was established at the same time as the EPA. In the past few years, a study of water quality of Long Island was undertaken under the EPA Estuaries Program and, under separate congressional authorization, a similar study of the New York Bight was conducted. Over this period, incremental improvements of the mathematical model were effected, culminating in the present state of the art for the Long Island Sound Study.

WATER QUALITY ISSUES

The constituents in untreated municipal wastewaters, which adversely affect the quality of receiving waters, are the following: suspended and floatable solids, bacteria, organic carbon, nitrogen, and phosphorus and toxic substances, which include heavy metals, synthetic organic chemicals, and radionuclides. Some or all of these constituents are also present in treatment plant effluents, combined sewer overflows, urban runoff, industrial wastes, tributary inflows, and atmospheric deposition. Although each of these sources contributes to the total mass rate of discharge of the constituents, the plant effluent constitutes the major fraction.

The treatment plants are designed to remove primarily, and operate accordingly, the solids, bacteria, and organic carbon. Some reduction of nutrients and toxic substances is incidentally effected in the treatment processes. One of the major issues is the treatment of the latter constituents required to meet water quality standards. In defining this level of treatment, consideration should simultaneously be given to the relative effects and potential modifications of the other sources.

NEW YORK-NEW JERSEY HARBOR

Coliform bacteria, indicators of pathogenic organisms, are substantially reduced by the various processes that comprise the treatment system. The effect of treatment is seen in the dramatic reduction of the bacterial concentration in the East and North Rivers over the past few decades (Figure 3). The concentration of the fecal coliform bacteria, a less ambiguous criterion, is also presented. Notable is the similarity of the long-term trends in each region of the harbor system, the magnitude of the concentration being proportional to the respective mass discharges. The anomalous increase in the fifties and sixties and the short-term rise in the seventies in the North River require further analysis. The present levels of coliform bacteria are primarily due to combined sewer overflows, urban runoff, and tributary inflows.

In the past decade, a program of pretreatment of industrial wastewaters has been initiated, specifically directed to the removal of heavy metals. The concentrations of these substances have also diminished, examples of which are shown in Figure 4 for copper and lead. While, in some cases, the other heavy metals, such as cadmium and chromium, have not decreased as significantly, the present concentrations are within water quality standards. Presently under way is a citywide combined sewer overflow study. The implementation of the program, following this study, will further reduce the levels of both bacteria and heavy metals, as well as particulate organic carbon and nutrients.

Organic enrichment refers specifically to the organic carbon complexes in wastewater, which are assimilated by bacteria as a food source and simultaneously utilize dissolved oxygen. Inorganic nitrogen and phosphorus are absorbed by phytoplankton, whose carbon source is carbon dioxide. The algae, however, produce oxygen during daylight and consume it at night. On senescence and decay of these microorganisms, organic carbon and nutrients are released and the cycle is repeated. The common denominator is dissolved oxygen, required by both the bacteria and algae, as well as the higher forms of aquatic life. The oxygen utilized by these respiratory processes is replaced by the photosynthetic activity of the algae and from the vast reservoir of oxygen in the atmosphere. In a balanced ecosystem, the microorganisms work cooperatively, supplying each other with food and nutrients. More important, they establish the basis of the aquatic food chain. The intermediate organisms predate on the lower forms and in turn are consumed by the higher aquatic and terrestrial predators and ultimately by humans. Each link in the food chain returns organic carbon and nutrients through respiration, elimination, and decay.

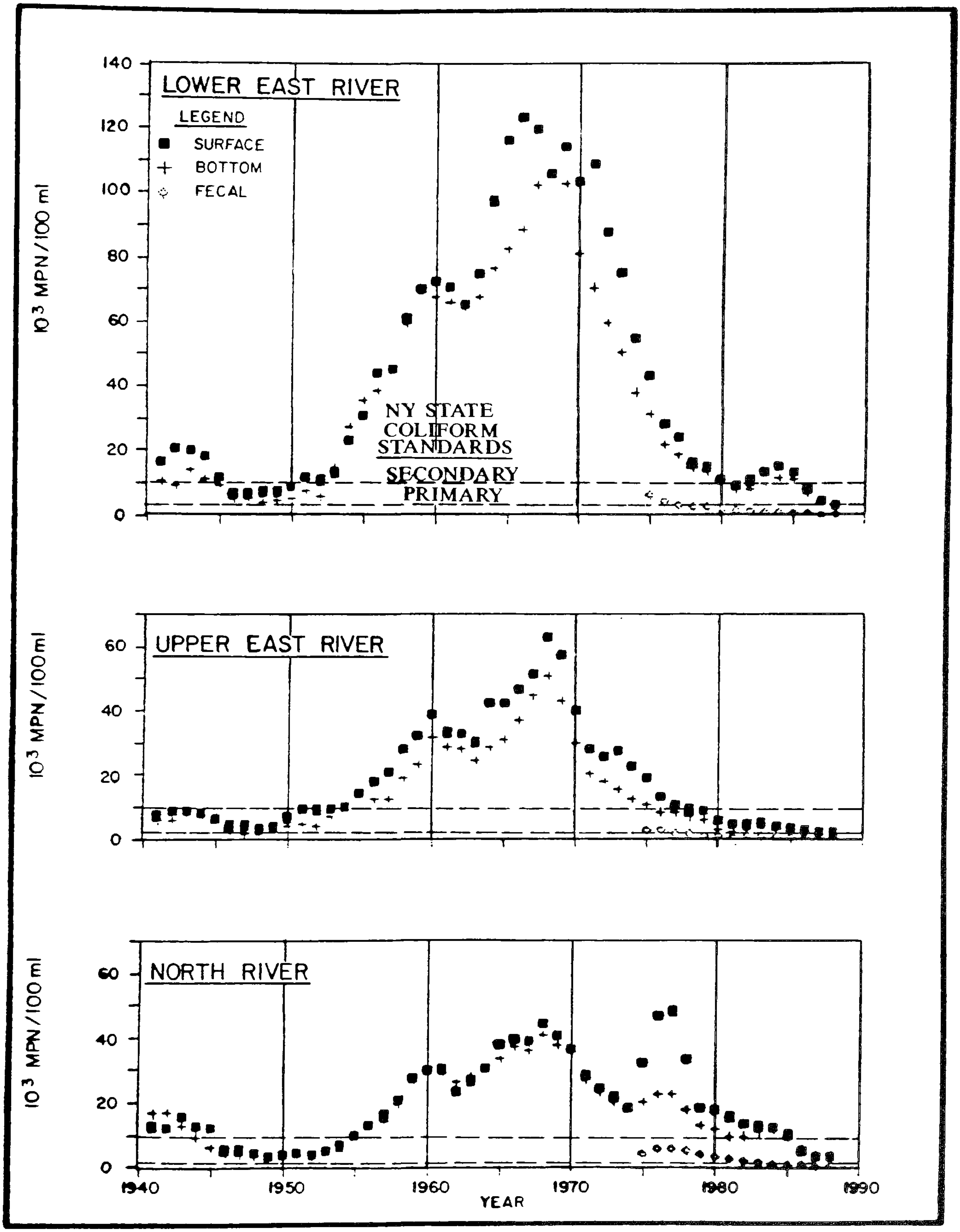

Figure 3. Summer average coliform and fecal bacteria.

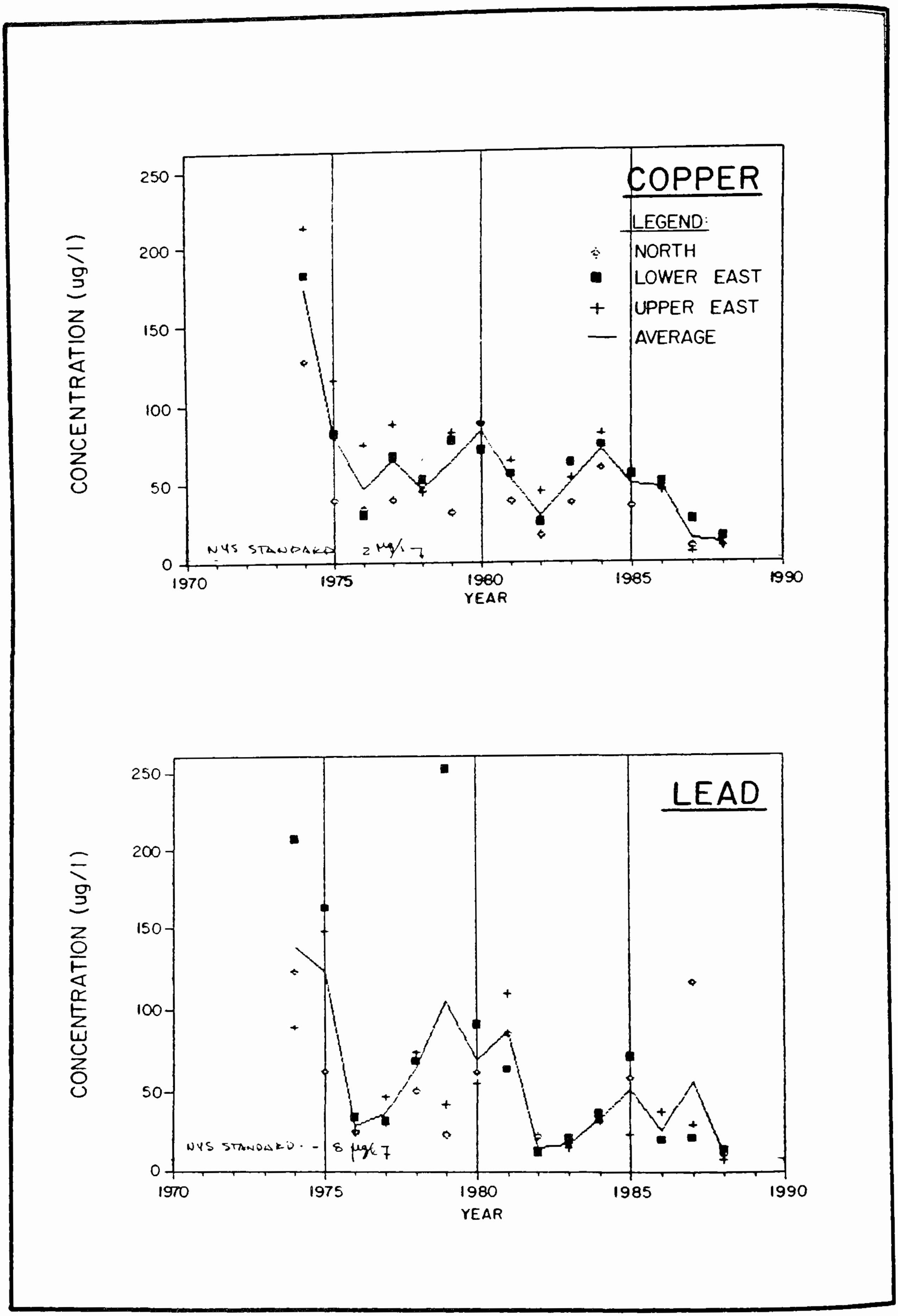
COPPER
LEGEND:
NORTH
LOWER EAST
UPPER EAST
AVERAGE
CONCENTRATION (ug/l)
YEAR
LEAD
CONCENTRATION (ug/l)
YEAR

Figure 4.

This ecological balance is distributed when excessive amounts of organic carbon and nutrients are discharged to the receiving waters. In this case, the bacteria and algae, instead of working a parallel mode, operate in a sequential and an apparently more deterministic manner. When untreated wastes, containing a high organic carbon content, are released to a natural water body, bacterial growth is initially predominant and the dissolved oxygen is depressed. Water quality models were first developed to define this process. The conversion of carbon to bacterial cells and the restoration of dissolved oxygen establish an environment more conducive to the growth and potential proliferation of algae. The latter is related to the concentration of nitrogen and phosphorous as well as to light and temperature levels. Subsequent development of mathematical models incorporated these phenomena. The final repository of the cellular production of both the bacteria and algae is in the bed of the river, estuary, or coastal zone. Oxygen is required for the decomposition of this material, releasing nutrients, some of which are returned to the water column. The latest developments in water quality modeling include these significant mechanisms.

Initial efforts in the field of environmental engineering and science were accordingly directed to the removal of organic carbon to restore dissolved oxygen levels, and later efforts were directed to the removal of nutrients to control the growth of phytoplankton. The treatment facilities in the New York-New Jersey Harbor and throughout the country have been designed primarily to remove the organic carbon. The effect of nutrient discharges has not been evident in the Harbor water, but rather in the contiguous regions of western Long Island Sound in the mid to late eighties and the New York Bight during the mid-seventies. During these periods, extremely low dissolved oxygen and anoxic conditions have been observed. One of the most significant questions, which the mathematical models are presently being used to address, is the degree of nutrient removal required to maintain water quality standards. Of equal and possibly greater importance is the relative significance of the anthropogenic sources of nutrients by contrast to the effects of natural phenomena -- rainfall, runoff, winds, temperature, stratification, and the circulation associated with these factors.

The role of dissolved oxygen, critical in the ecological balance, is one of the primary criteria by which the state of the aquatic ecosystem is evaluated. The reduction in the mass discharge of organic carbon as the treatment plants were placed in operation resulted in gradual improvement in the dissolved oxygen concentrations in the North and Lower East River, as shown in Figure 5. Sampling of the Harbors was initiated in 1910 and has been regularly conducted to the present -- a testimony to the environmental awareness and scientific foresight of New York City administration and personnel. It represents the longest historical record of water quality in the country and one of the longest in the world, the London County Council in England having begun regular sampling in the Thames River in 1895.

The dissolved oxygen data in Figure 5 are summer average values, with the solid line drawn through the three-year moving averages. The North River data are representative of the concentration in the surface layer. The dissolved oxygen values in the lower layer are

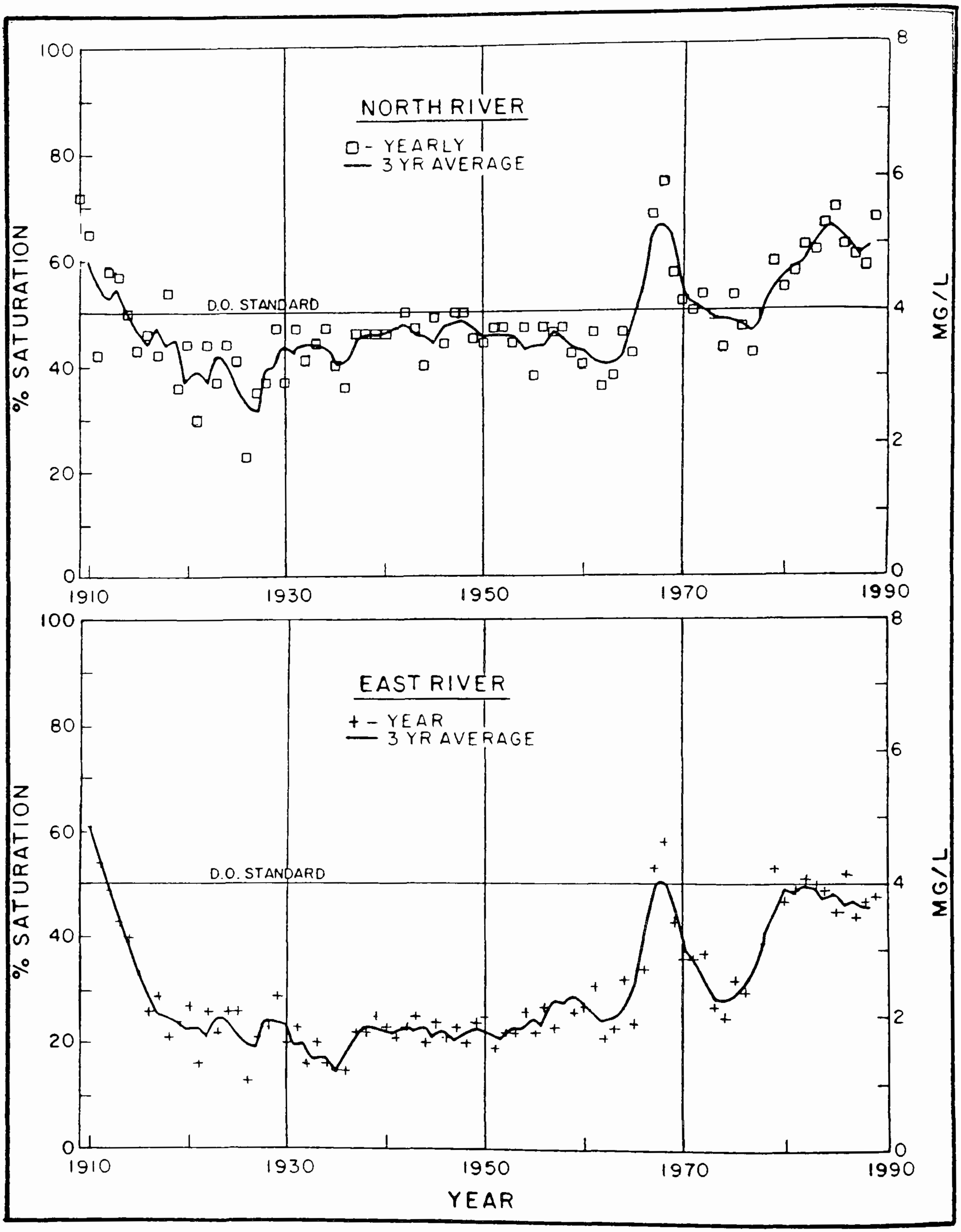

Figure 5. Summer average dissolved oxygen.

1 or 2 mg/L less. The East River is approximately vertically homogeneous and the data are depth average values. The improvement in the dissolved oxygen concentration is evident from the late thirties, when the first treatment plant on the East River was placed in operation. The relatively rapid decrease in dissolved oxygen occurred from 1910 to 1920, when the population increased and a major portion of the sewerage system was completed. In the following 20 to 30 years, the Harbor waters assimilated the untreated wastewater of more than 5 million people and sustained an approximate steady-state condition. It is remarkable that the dissolved oxygen never dropped to zero in the major waterways, as occurred in other estuarine systems serving large metropolitan areas. Noteworthy are the similar responses of the North and East Rivers, as well as the pronounced oscillation in concentration, rising in the late sixties and falling in the early seventies. In the eighties, the concentration is approximately constant in the East River, while it continued to rise in the North River.

In Figure 6, the historical records of dissolved oxygen in the Lower and Upper East Rivers are presented, in conjunction with the total population of the area draining to the East River and the contributing population. The difference between the two is the equivalent population receiving treatment. The locations of vertical lines indicate the year in which the various plants went into operation, with each displacement representing the approximate magnitude of the facility. The "untreated" value in 1989 represents the equivalent population of the residual mass in the plant effluents. It is ironic that in the years following the construction of the Newton Creek plant (1967), the concentration of dissolved oxygen decreased.

A comparable depression in the dissolved oxygen occurred in the North River as shown in Figure 7, which also presents the timing and magnitude of the treatment plant construction. The dashed lines in the two upper panels are parallel long-term trends. The Hudson River flow and the New York City rainfall are presented in the lower panel. The correlation between the rainfall and runoff is evident. Also to be noted is the inverse relation between these parameters and the dissolved oxygen -- the maximum concentration occurring at the end of the dry period in the late sixties and the reverse in the mid to late seventies. From this graphical and qualitative correlation, it may be inferred that the maximum concentration of dissolved oxygen is due to reduction in the combined sewer overflows and the related benthal demand, an increase in the photosynthetic activity of the algae and minimum salinity stratification during the dry period, followed by a reversal of these factors resulting in a minimum concentration of dissolved oxygen in the wet period. The minimum and maximum flows of the eighty-year record of the Hudson occurred respectively at these times.

LONG ISLAND SOUND

The historical records of dissolved oxygen in the upper and lower layers of western Long Island Sound at Hart Island are shown in Figure 8. The individual points are average

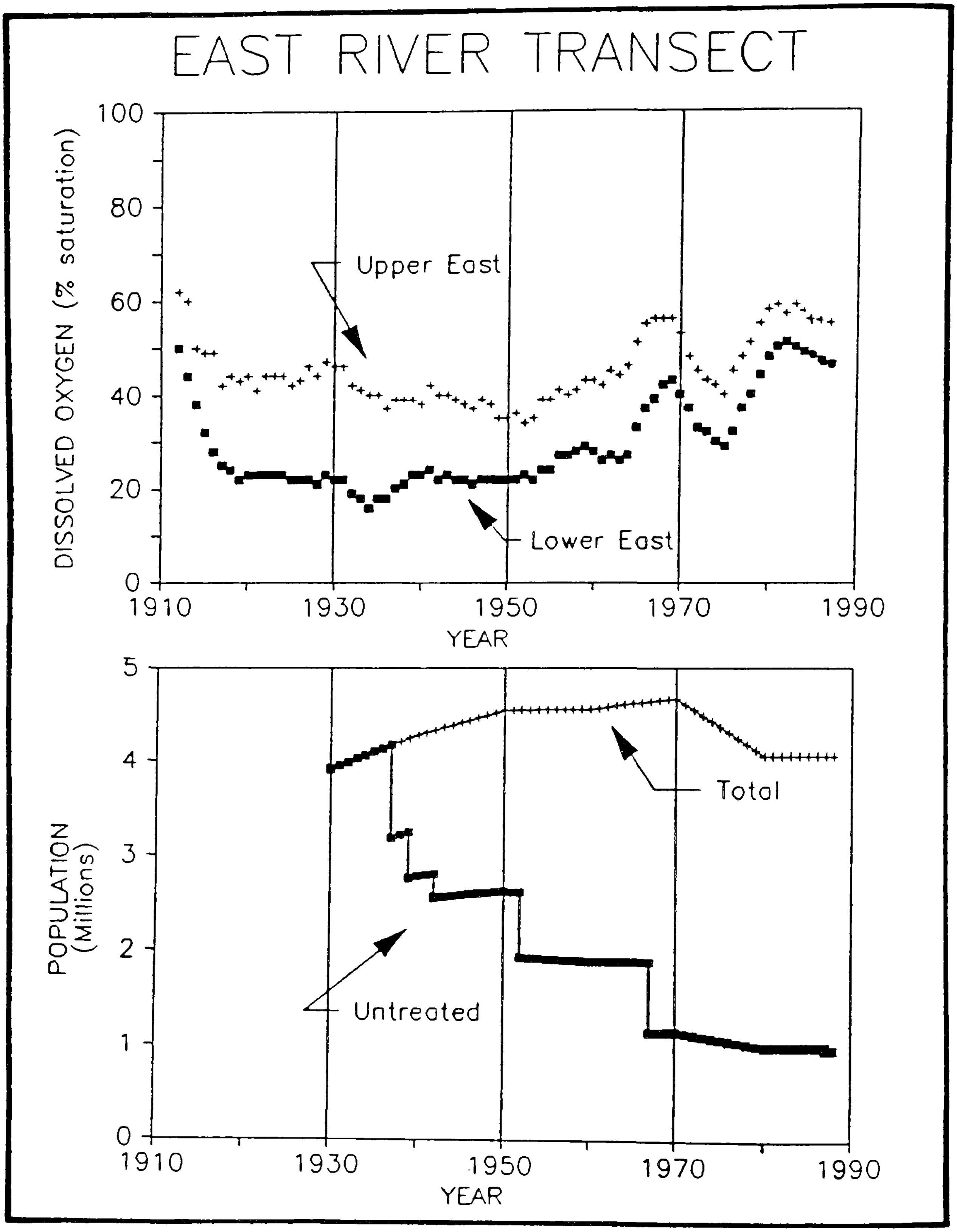
EAST RIVER TRANSECT
DISSOLVED OXYGEN (% saturation)
100
80
60
40
20
0
Upper East
Lower East
1910
1930
1950
1970
1990
YEAR
POPULATION (Millions)
5
4
3
2
1
0
Total
Untreated
1910
1930
1950
1970
1990
YEAR

Figure 6.

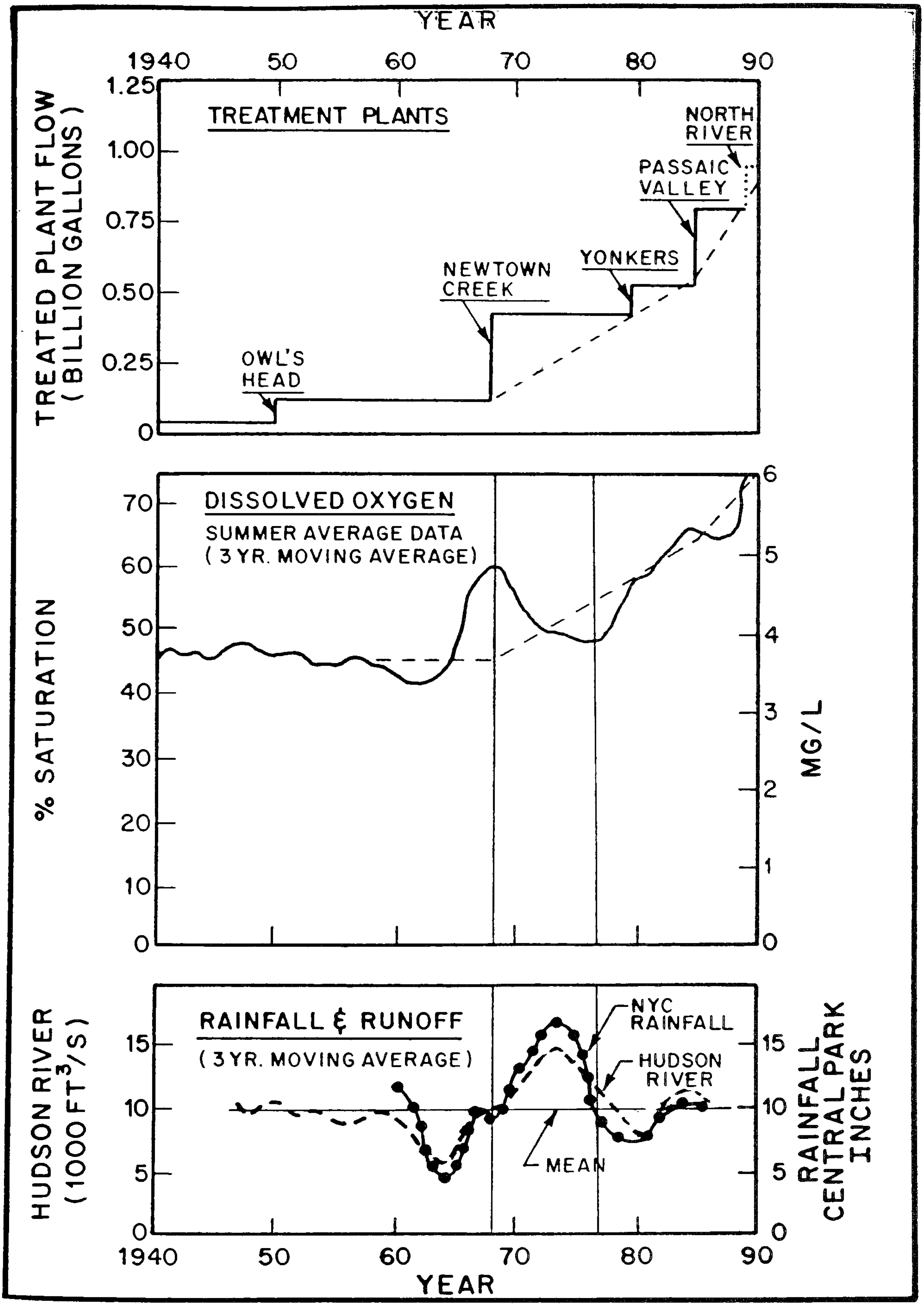

Figure 7. North River.

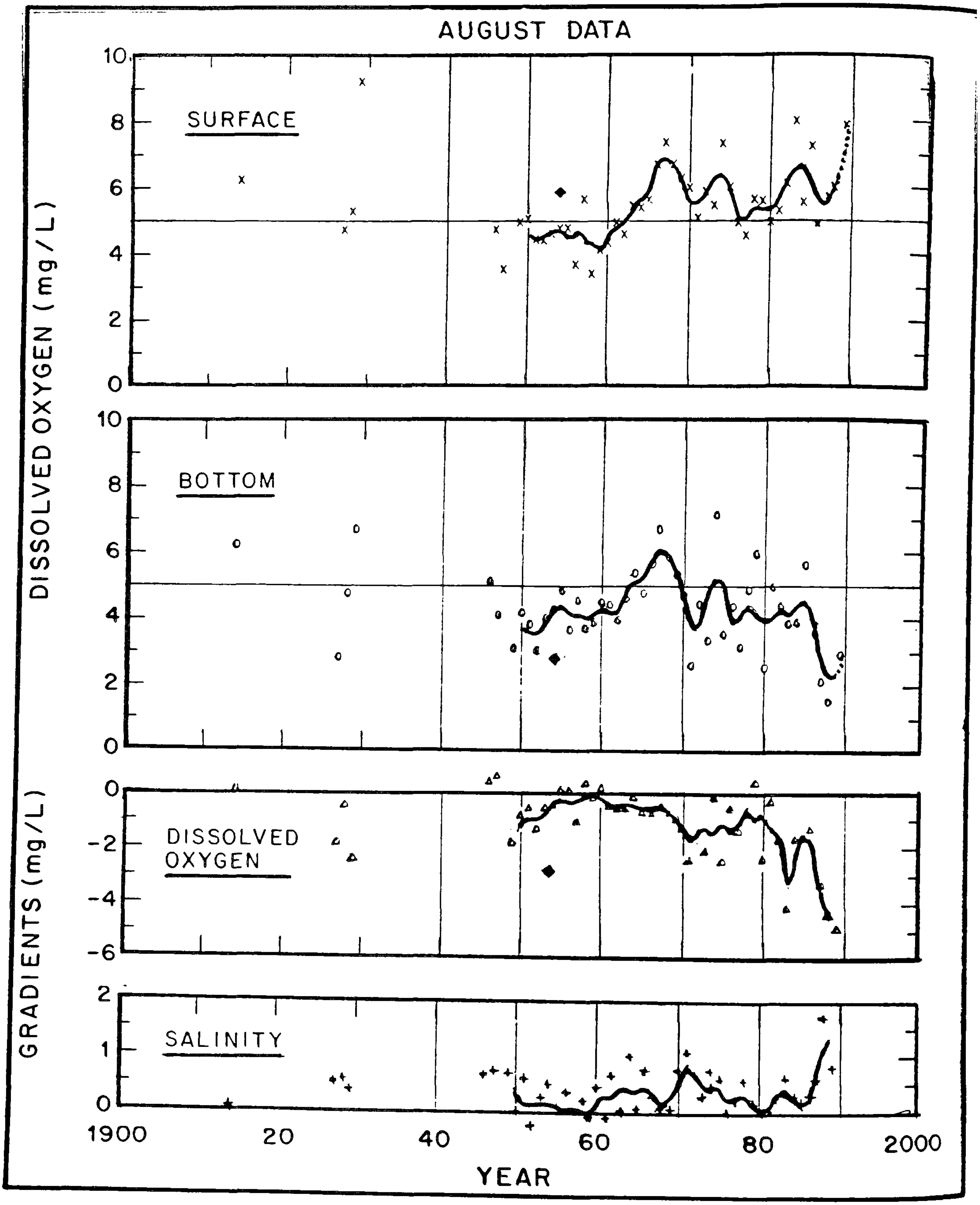

Figure 8. Hart Island, Long Island Sound.

values for the month of August, and the solid line the three-year running average of these data. This record is not as extensive as those for the North and East Rivers, but sufficient to demonstrate the trend from 1945 to the present. The maximum concentration of dissolved oxygen in the mid-sixties is similar, but the depression in the following decade is not evident. The influence of the photosynthetic production offers the effect of the negative factors. From 1910 to 1985, the dissolved oxygen varies in an apparently random manner. From 1985, the concentration in the surface layer increases while that in the lower layer decreases resulting in the maximum differential between the two layers, as shown in the lower panel. The increasing dissolved oxygen is consistent with the increase in the photosynthetic activity of the algae. Although the chlorophyll record, which is a measure of the algal concentration, is not as complete as the dissolved oxygen, there are sufficient data to indicate moderate increases of algae over this period.

An additional factor producing the relatively large difference in dissolved oxygen concentration is the associated salinity gradient. The increase in the salinity gradient is due to meteorological and hydrological factors, which also affect the hydrodynamic circulation. The general direction of the current on the north shore of Long Island Sound is westward, introducing nutrients which are discharged from the treatment plants on the Connecticut shore. Possibly more significant is the flux of nutrients from the plants on the Upper East River in New York City, as well as the effects of the heavily stressed embayments on both the north and south shores in this region. A hydrodynamic study of Long Island Sound, presently under way, will provide an important component to the water quality analysis of the Sound. The integrated hydrodynamic and water quality model should then be able to delineate the relative significance of the New York and Connecticut treatment plants, as well as the effect of the stressed embayments, with respect to both point and nonpoint sources.

There remains the question of the net direction and magnitude of the flow through the East River. Preliminary hydrodynamic analysis of this problem indicates the transport is from the Sound to the Harbor, in which case the effect of the New York City plants would be less than if the net tidal flow were toward the Sound. A study has recently been initiated to address this problem, the results of which should provide a firmer basis for the water quality management plan of Long Island Sound, as well as the New York-New Jersey Harbor.

NEW YORK BIGHT

Extensive data on water quality have been collected for the New York Bight during the seventies, particularly with respect to the anoxic conditions which occurred in the middle of the decade. Studies were conducted prior to and following this episode, but were discontinued in the earlier eighties. Limited hydrodynamic analysis of the complex circulation patterns were also made during this period. Surveys and evaluations of the Apex region of the Bight, as well as the 106-mile site, were carried on to address the issue of sludge disposal. Additional data have also been collected by a number of local and regional agencies. The complete historical record is, however, not as extensive as those for the Harbor and the Sound. The studies have focused primarily on organic enrichment, nutrient discharges, and dissolved oxygen. Information on toxic materials is relatively limited. Various analyses and summaries of these data have been conducted, but compilation of the overall data base apparently has not been performed to date; this project should be initiated immediately.

From the viewpoints of scientific understanding and engineering analysis, more questions remain than have been answered. Among these, the major issues relate to the net hydrodynamic transport and mass flux through the Sandy Hook transect, the water-bed transfer of the dissolved and particulate components of nutrients and toxicants, the metabolic characteristics of the algae and bacteria and their interaction, atmospheric deposition, and the variable circulation patterns on the seasonal, annual, and long-term time scales. The primary question of the net flux through the Sandy Hook transect is related to the direction and magnitude of the net flow in the East River. A preliminary effort, which is specifically directed to addressing this question, will incorporate as many of these remaining issues as possible. The purpose of the study is to define the relative significance of the flux through the Sandy Hook transect, by contrast to the other sources of pollutants to the New York Bight.

SUMMARY AND CONCLUSIONS

1. Significant progress has been made in improving water quality in the New York-New Jersey Harbor with respect to bacteria and dissolved oxygen. It is anticipated that the treatment upgrading of a few remaining plants should readily achieve the water quality standards for bacteria and dissolved oxygen. The relatively long history of data collection, model development, and application has provided a sound basis for planning as evidenced by the improvement in these constituents.

2. The nutrient discharges apparently have no deleterious effects in the Harbor and the North and East Rivers, but increased algal growth as well as bacteria oxidation and benthal effects are related to the decreasing dissolved oxygen in western Long Island. The scientific understanding and engineering analysis of the effects of nutrient discharges represent the state of the art. Lacking broad application, the present model contains a degree of uncertainty. Questions that further contribute to the uncertainty relate to the direction and magnitude of East River net flow, the circulation in Western Long Island Sound, the relative significance of the treatment plant effluents from New York and Connecticut, and the effect of the stressed embayments contiguous in this region. Notwithstanding, the modeling effort should provide a reasonable basis for management decisions regarding nutrient control for Long Island Sound, and subsequently, for the New York Bight.

3. Major reductions in the concentrations of some heavy metals in the Harbor waters have been recorded over the past decade, and in certain cases, such as cadmium and chromium, the present concentrations are within established standards. Much, however, remains to be done. The knowledge and understanding of the phenomena that determine the fate of toxic substances are not as complete as that existing for nutrients and, therefore, efforts toward codification of the present state of knowledge, with the associated development and improvement of the relevant models, should be initiated immediately.

4. Formulation of a water quality management plan should simultaneously take into account both nutrients and toxicants, in conjunction with the ultimate disposal of sludge and residues from proposed and existing treatment facilities, rather than unilateral consideration of each. The next logical step appears to be the reduction of mass discharges from combined sewer overflows and urban runoff, which contain both nutrients and toxicants as well as other constituents that adversely affect water quality. The large identifiable overflows are relatively amenable to modification and control, which produce improvements in water quality and reduce accumulation in the benthal layers.

5. Given the present state of knowledge and the rate at which understanding is progressing, the planning and decisionmaking process should have sufficient flexibility to incorporate future developments, presently unanticipated; thus, planning and implementation should be viewed as an incremental process, comparable to the evolving state of scientific and engineering knowledge and model development.

The engineering science of the environment is barely fifty years old -- a brief historical period by contrast to the other longer-lived endeavors of science and engineering. This field is presently characterized by the relatively specialized inputs of a variety of disciplines, rather than by a coordinated and cooperative effort of many. The activities of various governmental agencies, responsible for environmental concerns, may be characterized in a similar manner. Hopefully, the formation of a Department of the Environment at the national level may consolidate many of these activities. The foregoing assessments provide some basis for the following observations and recommendations, which also have relevance to other water quality studies throughout the country.

GENERAL ASSESSMENTS AND RECOMMENDATIONS

1. There should be a continuous and coordinated program of environmental monitoring and assessment involving scientists, engineers, administrators, and the public. The program would include data collection, laboratory and field experimentation, analysis and synthesis of these data, and modeling development and application. These activities should be incorporated in an ongoing process of environmental assessment,

not simply when a problem arises. Such a process would permit scientists and engineers to respond more rapidly when problems do arise, to assess improvements (or lack of) when remedial measures are effected, and to anticipate future issues. These scientific and engineering activities would focus on relevant environmental issues, not "pure research" questions, which are presently supported by a number of governmental agencies and private foundations. The participation personnel would be supported by and accountable to the public and the governmental agencies responsible for environmental quality.

2. These are a number of governmental agencies at local, regional, and federal levels, presently conducting or planning studies in the New York-New Jersey Harbor complex, in addition to those supported by private organizations and research institutes. This situation has led to a plethora of studies of the area, which in many cases are being carried on independently and autonomously. Admittedly, most, or at least some of these, advance the state of knowledge and contribute to the solution or control of environmental problems. It would be more efficient and productive to coordinate these projects. It is encouraging to note steps are being taken in the present project toward this goal. Further emphasis should be placed on these coordinating efforts in order to eliminate repetition, to avoid reproducing past results, and to ensure all of the important issues are addressed.

3. Present planning is focusing on specific regions -- New York Bight, Long Island Sound, New York-New Jersey Harbor, and the Hudson River estuary. While it is feasible, as an initial step, to treat these components separately, it will ultimately be required to analyze the entire system as an ecological and geophysical unit. The information evolving from the present studies will provide a basis to structure a more realistic model of the total system on a larger time and space scale. It is understood that the present plan subsequently calls for the unified approach. The preliminary formulation of this model, however, should be initiated immediately.

4. Expenditures in the order of billions of dollars will be required to realize the water quality goals. Comparable costs to answer other environmental problems, as well as the many social needs of this metropolitan area and the country, may be anticipated. The reflections of John Gardener, the Secretary of Health, Education and Welfare in the Kennedy Administration, are relevant today. From his insightful and concise comments in "No Easy Victories," published more than twenty years ago:

> We must all face the coming crunch between expectations and resources. The expectations of the American people for social benefits are virtually limitless. The proponents of every social institution or group believe passionately that support of their field must be vastly enlarged in the near future. The colleges and universities have ideas for federal support that would run to billions per year. And they ask little compared to the

> advocates of aid to elementary and secondary education. The annual costs of a guaranteed income would run to scores of billions. Estimates of the cost of adequate air- and water-pollution control and solid-waste disposal run even higher. Estimates of the cost of renovating our cities run to hundreds of billions. How do we make rational choices between goals when resources are limited -- and will always be limited relative to expectations? The question translates itself into several others: How can we gather the data, accomplish the evaluation and do the planning that will make rational choices possible?

We are taking a significant step today in answering these questions -- continuing along a path, laid out and cleared over the past half century. Anticipating limited resources to accomplish the task, we must select judiciously those alternatives that provide the maximum environmental benefit. As with resources, we have limited time and limited trained personnel, but they are sufficient to attain the goals in a staged and sequential manner. The task, however, will take longer than most of the public anticipates.

The concluding observation is again taken from John Gardener:

> One striking feature of our situation today is that we are creating new problems as we go along.... Environmental pollution is the classic example of a problem arising from our progress. Our capacity to create new problems as rapidly as we solve the old has implications for the kind of society we shall have to design. We shall need a society that is sufficiently honest and open-minded to recognize its problems, sufficiently creative to conceive new solutions, and sufficiently purposeful to put those solutions into effect. It should be, in short, a self-renewing society...and, in justice to future generations, a self-sacrificing one.

ACKNOWLEDGMENTS

The historical background of the wastewater system was abstracted from annual reports of the New York City Department of Environmental Protection, Bureau of Wastewater Treatment. The cooperation of Edward Wagner, Assistant Commissioner, and the assistance of Thomas Brosnan, Water Quality Section, are gratefully acknowledged. The collection and compilation of the data by Savas Hadjineocleous and Abigail Bergoffen, Environmental Engineering and Science Program, Manhattan College, are recognized and appreciated.

THE CONDITION OF OUR COASTAL WATERS: STATUS, TRENDS, AND CAUSES

Historical Trends in the Abundance and Distribution of Living Marine Resources

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the conference on
"Cleaning Up Our Coastal Waters: An Unfinished Agenda"
Manhattan College
12-14 March 1990

Introduction

The coastal and estuarine waters of New York Bight, Long Island Sound, and New York-New Jersey Harbor have historically supported rich, diverse populations of fish and shellfish. These resources have sustained, and continue to sustain, active commercial and recreational fisheries that are important components of the economic, social, and cultural vitality of the region. In examining the extent, cause(s), and consequences of water quality problems in the region, the New York Bight Restoration Plan, the New York-New Jersey Harbor Estuary Program, and the Long Island Sound Study are attempting to identify trends in the abundance and distribution of key fishery resource species and to relate these trends to impaired water quality or habitat changes/losses in the region. This brief presentation contributes to that analysis.

Estimating the abundance of fishery resources (stock assessment) can be done using statistics derived from commercial and/or recreational fisheries--principally landings, fishing effort, and catch per unit effort (CPUE)--or from information on biological parameters of the stock derived from fishery-independent surveys of the resources. Ideally, both types of information are used. Acceptable quality data of each type are available for some of the important marine fisheries and fishery resources of the New York Bight, and NOAA's National Marine Fisheries Service uses this information to produce stock assessments for these species. However, fishery-independent survey data and rigorous fishery effort data are generally not available for many of the more estuarine or anadromous species of fish and shellfish found in Long Island Sound and the New York-New Jersey Harbor.

The following analysis of the status of the region's marine and estuarine fishery resources relies primarily on commercial fishery landings and, less so, on commercial fishing effort. Marine recreational fishery landings and effort data are available only for the relatively recent past and are not very useful for describing historical trends in resource abundance. Trends in commercial landings do not necessarily solely reflect changes in the abundance of target species; changing levels of fishing effort and changes in the availability of resources, which might be produced by changes in key environmental parameters, also contribute to variability in fish catches.

This summary focuses on the biological condition of the region's principal fishery resources as this affects commercial and recreational fisheries. Fisheries for some species are severely or completely constrained by the presence in these species of toxic contaminants or pathogens. This unfortunate circumstance is documented elsewhere in this volume.

Commercial Fishery Landings

Commercial fishery landings in New York and New Jersey suggest that there has been a distinct decline in the abundance of fish and shellfish in the region over the past century. Total commercial landings in the two states, virtually all of which represent harvests from the Bight and contiguous waters, drop from a maximum of nearly 700 million lbs. in 1956 to approximately 160 million lbs. in 1987. Commercial fishery catch per unit effort has also dropped, mainly because effort (number and harvesting capacity of fishing vessels) has increased, particularly in the trawl and longline fisheries (NOAA, 1988; McHugh and Hasbrouck, 1989).

Much of the documentable decline in commercial fisheries in the mid-Atlantic region has been caused by overharvesting of target resource species (McHugh, 1972). This is particularly so for species that spend most of their lives in the open, coastal waters of the Bight, for which the evidence incriminating water quality deterioration as a cause for declines in resource abundance is slight. Water pollution and habitat destruction/alteration have undoubtedly contributed to the decline in abundance of a number of those species that are strongly dependent on riverine and/or estuarine environments (Summers et. al., 1987). However, even for many of these species, it is generally believed that overfishing has played as important a role in reducing standing stocks (NOAA, 1988).

On a volume basis, menhaden (Brevoortia tyrannus) historically dominated commercial fishery landings from the Bight and Long Island Sound. However, this important industrial species has been seriously reduced in abundance in the New York Bight area, particularly since the 1960s. Maximum landings were about 600 million lbs. in 1956, but by 1987 almost no menhaden were landed (Figure 1). Water pollution may have been important in this decline; young menhaden enter the estuaries of the region and move up rivers in their early development. However, it is generally accepted that overfishing, especially in Chesapeake Bay and North Carolina, is the major cause of decline in the stocks of menhaden (McHugh, 1972, 1977). Extensive catches of menhaden were once made in Long Island Sound by purse seiners operating out of ports in New York, New Jersey, Connecticut, and Rhode Island. As the stocks dwindled due to fishing pressure in the region and further south, the menhaden processing plants began to close. The last plant in New York closed in 1969. With the closing of the Sea Coast, Inc. reduction plants in northern New Jersey in 1982, the only directed fishery for menhaden remaining

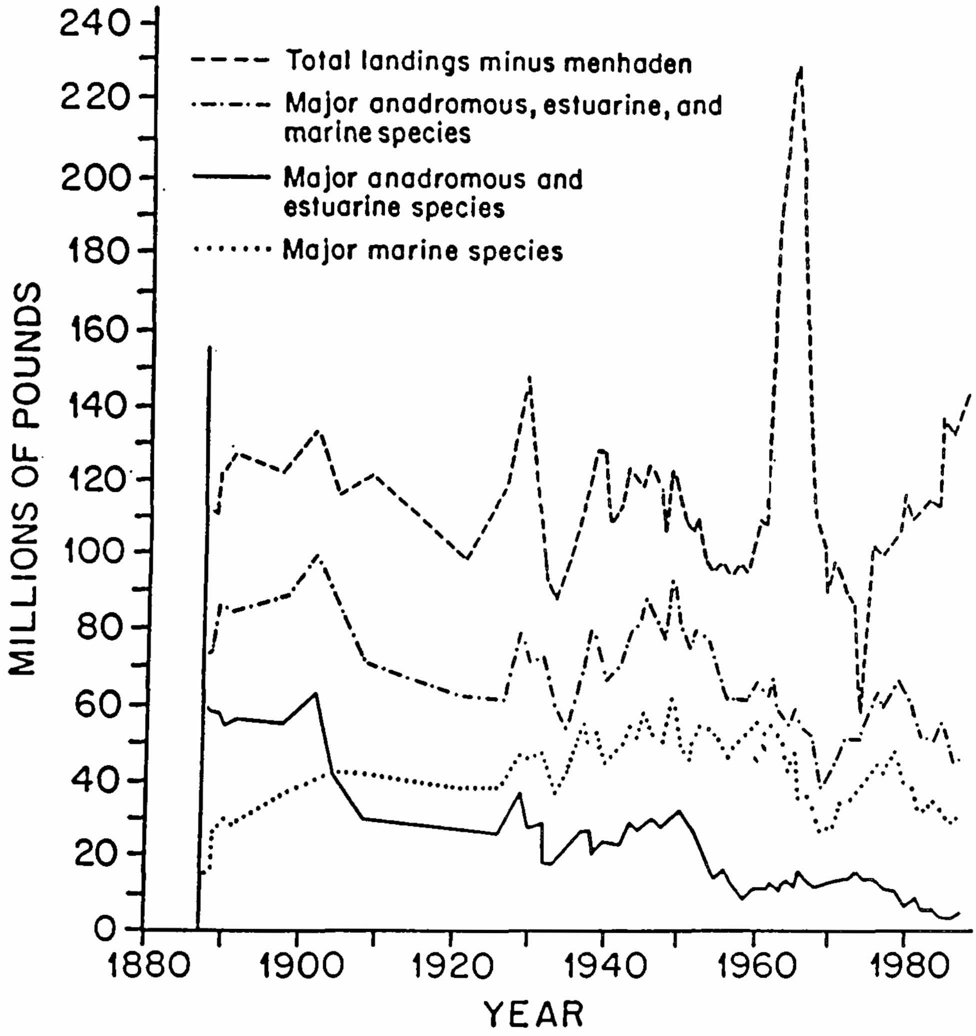

Figure 1. Commercial marine fishery landings, New York & New Jersey, 1887-1987

in Long Island Sound is a small gillnet fishery harvesting menhaden to be used as bait in lobster pots and in recreational fishing.

When menhaden landings from New York and New Jersey are substracted from the total, all-species landings, the upper curve in Figure 2 is the result. Except for the period 1962-66, when large landings of food fishes used to manufacture oil and fish meal increased total harvests substantially, annual landings of food fish and shellfish have remained fairly steady (100-120 million lbs.); the increase after 1973 has been caused largely by a major increase in fishing effort rather than an increase in resource abundance (McHugh and Hasbrouck, 1989). However, if total landings for food are divided into two categories--major anadromous or estuarine species and major marine species, indications as to the effect of water pollution on fishery resources may be made.

Combined landings of selected, major anadromous and estuarine species, notably shad (*Alosa sapidissima*), alewives (*Alosa pseudoharengus* and *A. aestivalis*), striped bass (*Morone saxatilis*), sturgeon (*Acipenser oxyrhynchus*), American oyster (*Crassostrea viriginca*), hard clam (*Mercenaria mercenaria*), and bay scallop (*Argopecten irradians*) have declined in the past century from more than 58 x 10^6 lbs. in 1887 to less than 5 x 10^6 lbs. in 1987, a decline of nearly 90%.

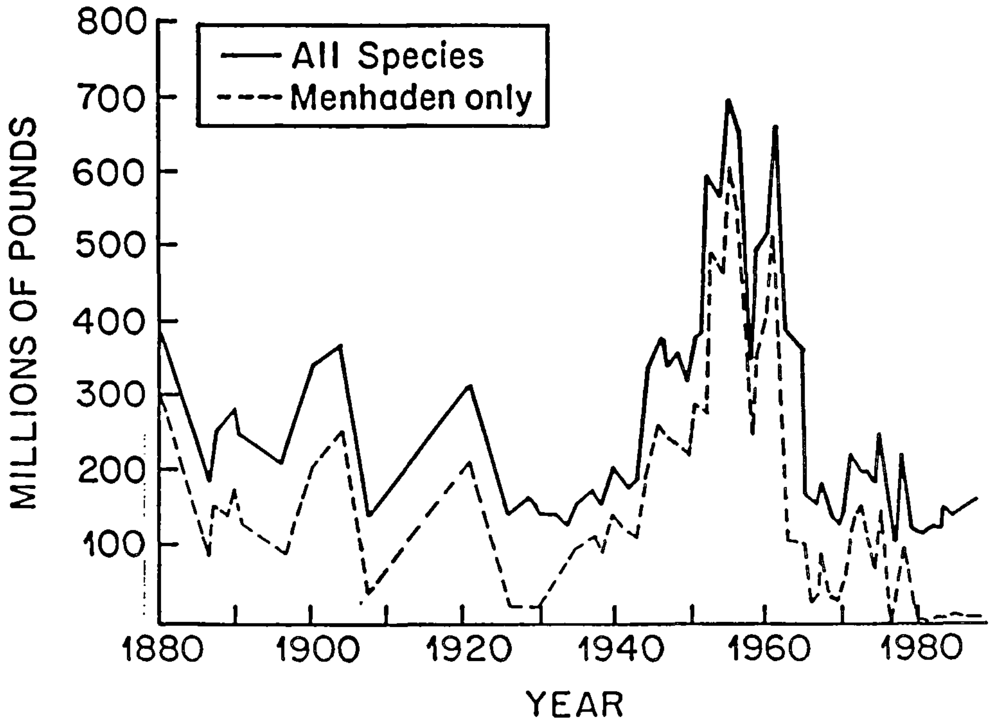

Figure 2. Landings of food finfish and shellfish, New York and New Jersey, 1887-1987

Harvests of oysters and hard clams, particularly, have declined from overfishing and also from the direct and indirect effects of pollution--the contamination of shellfish growing waters with pathogens resulting from the pollution of estuarine waters with human sewage has led to the closure of thousands ofacres of bay bottom to harvesting. Disease outbreaks traceable to consumption of contaminated shellfish produce marked reductions in the regional demand for raw shellfish (Grosslein and Azarowitz, 1982). At one time, oysters were the primary commercial shellfish harvested from Great South Bay, New York. In the 1950's, salinity increases in the Bay caused by the reopening of Moriches Inlet by a severe hurricane and a shift in phytopklankton species assemblages in the Bay to smaller-size species, a result of the introduction to the Bay of nitrogenous wastes from duck farms, combined to severely reduce the abundance of oysters. With pollution control measures gradually reducing the impact of duck wastes on the system, the hard clam assumed its current role as the primary commercial shellfish harvested from the Bay.

Shad and other anadromous species have also declined substantially in abundance. These fishes are so vulnerable to water pollution at critical stages of their lives that even though overfishing has been the major factor in their decline, loss of habitat and water pollution have also played a part (Talbot, 1954; MacKenzie, in prep.).

Although Sindermann et al. (1982) said that no signs of adverse effects of pollution on the abundance of fishes and shellfishes could be identified from commercial fishery landings data in the New York Bight, they were referring to events outside the Hudson River Estuary and the New York-New Jersey Harbor. In the River proper, in the Estuary, and in the region's inshore embayments, there is little doubt that water pollution has also been instrumental in reducing the abundance of such species as shad (Talbot, 1954), hard clam (Schubel et al. 1985), and oysters (Loosanoff, 1932).

Another factor contributing to the decline of some species is the destruction or disruption of habitat. This effect is illustrated by both Atlantic sturgeon (<u>Acipenser oxyrhynchus</u>) and Atlantic salmon (<u>Salmo salar</u>) which are now threatened in these waters due to dams in Connecticut rivers which interfere with their spawning activities, although active restoration efforts are underway with Atlantic salmon in Connecticut. The population of sturgeon in the Hudson River was also subject to excessive harvests in the latter part of the 19th-Century. The Atlantic States Marine Fisheries Commission (ASMFC) has developed a coastwide fishery management plan for shad and river herring designed to restore productive runs of these species to heavily dirupted rivers, including habitat improvement, fish passageways, and stocking programs. Dredging and filling activities in Long Island Sound have severely disrupted the habitat of other species such as soft clams (<u>Mya arenaria</u>).

Major marine species, on the other hand, represented in Figure 2 by weakfish (Cynoscion regalis), bluefish (Pomatomus saltatrix), Atlantic mackerel (Scomber scombrus), flounders (primarily winter flounder Pseudopleuronectes americanus, summer flounder Paralichthys dentatus, yellowtail flounder Limanda ferruginea, scup (Stenotomus chrysops), black sea bass (Centropristis striata), whiting or silver hake (Merluccius bilinearis), and sea scallops (Placopecten magellanicus) have not declined as much as many of the estuarine species. In 1887 about 15 million lbs. were landed in New York and New Jersey. Landings rose irregularly to a maximum of about 63 million lbs. in 1949, declined to a minimum of about 26 million lbs. in 1969, rose to a secondary maximum of about 50 million lbs. in 1979, then fell to about 32 million lbs. in 1987.

A number of regionally-important coastal marine fishery resources were purposely not included in Figures 1 and 2, including surf clam (Spisula solidissima), which did not enter the fishery in quantity until after the World War II, and ocean quahog (Arctica islandica), which was not reported in New York Bight landings untill 1976. Atlantic cod (Gadus morhua) and haddock (Melanogrammus aeglefinus) also were not included because they appeared in landings in quantity only for a few years and obviously represented a change in fishing strategy. Minor species also were not included. These omissions account for the discrepancy in Figure 2 between total landings minus menhaden and major anadromous, estuarine, and marine species.

Natural fluctuations in abundance account for some of the landings trends, as do changes in fishing effort. For instance, the maximum landings in 1949 would have been considerably lower if the New England mackerel fleet had not made an appearance off the Middle Atlantic Bight in the late 1940's (Fishery Statistics of the United States, 1949). Although the catches of major marine species in Figure 2 seem to show a slightly increasing trend, there is almost certainly a decline in actual abundance because fishing effort has increased substantially since the late 1970's (McHugh and Hasbrouck, 1989), which means that catch per unit of effort has declined. Many of the most important finfish and shellfish that have traditionally supported the commercial fisheries in the Southern New England region are currently being harvested at or above long-term sustainable levels (NMFS, 1989). This is particularly the case for species important in the trawl fishery.

Figure 3 shows total landings, fishing effort, and catch-per-unit-effort in the trawl fisheries of the northeast. Total trawl catches in the northern mid-Atlantic region declined by 28% during the period 1984-1987, while catch-per-unit-effort has declined by more than 50% from the peak in 1982. The abundance of important groundfish species has declined in the past decade while other species, such as squid, butterfish, and whiting, have

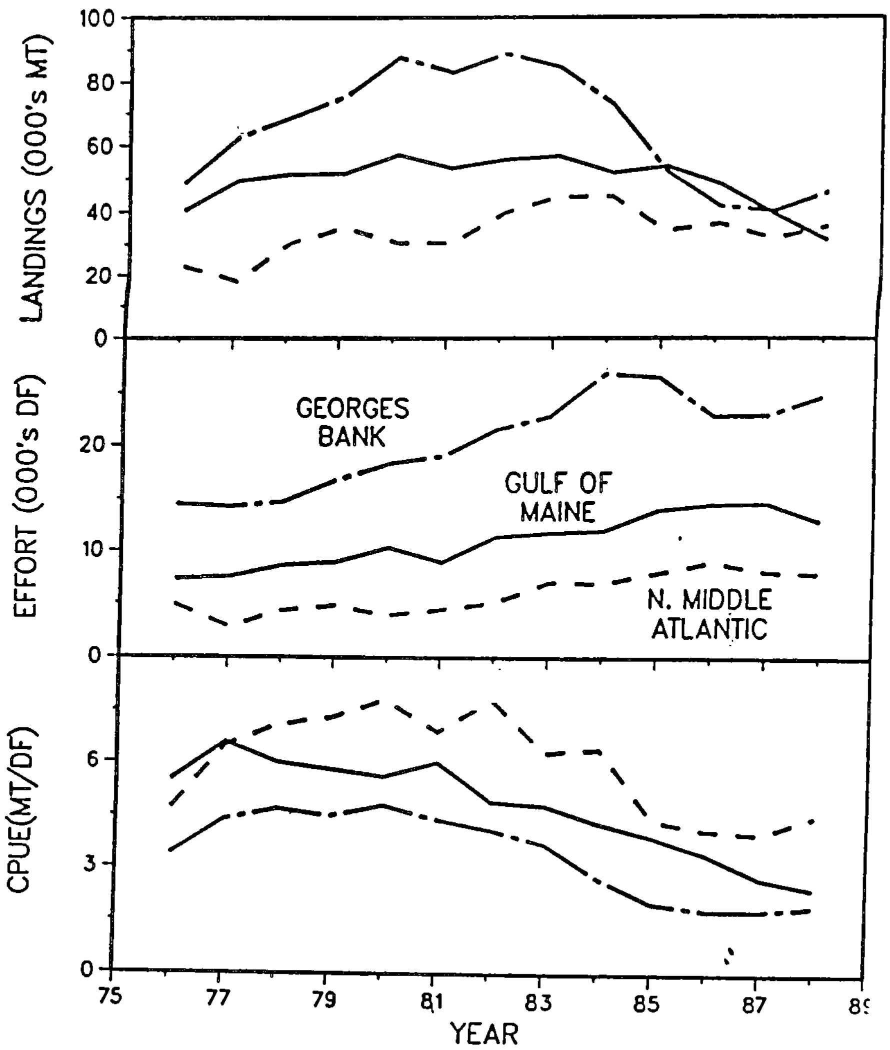

Figure 3. Total trawl catch, standardized fishing effort (days fished), and catch-per-unit-effort since 1976 for three regions of the northwest Atlantic Ocean (from NOAA, 1989).

remained relatively abundant and assumed greater importance in the fisheries of the region. There is little question that the primary cause of declining abundance of the region's historically important groundfish and flounder resources has been overfishing resulting from increases in domestic fishing effort that began in the early 1980's (NOAA, 1989). Unless fishing mortality on these species is reduced, their contribution to the fisheries of the region will continue to decrease.

Many of the fishery resources important to the New Jersey-New York-Connecticut region have clearly become less abundant over the past one hundred years, especially those that depend on rivers and estuaries. For a number of these estuarine and anadromous stocks, there is strong evidence that water pollution and other habitat disruptions have played a significant part in these declines (Franz, 1982; Mayer, 1982; Summers et al. 1987; Rose 1986; Sykes and Lehman, 1957). For some of these inshore species, however, and for many of the coastal marine species, the primary cause of stock reductions has been overharvesting.

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CONDITIONS IN LONG ISLAND SOUND

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INTRODUCTION

Renewed interest in the condition of our nation's estuaries has been fostered through the Federal EPA's National Estuary Program. The Long Island Sound Study (LISS) was initiated in 1985 as one of four estuaries to receive a special one-year federal allocation to evaluate conditions and develop management plans to correct water quality problems. The study provided a needed opportunity to look at Long Island Sound comprehensively since many state and federal jurisdictional boundaries intersect the Sound. Pollution management activities prior to LISS emphasized inland systems. While management of inland waters and point source dischargers was expected to and has improved water quality in Long Island Sound, no comprehensive evaluation of conditions or water quality problems specific to the Sound had been conducted since the 1970's. Although not yet complete, the first four estuarine studies proved to be invaluable in helping the states identify and begin to manage water quality problems not previously identified. The formal "National Estuary Program" was established by Section 320 of the Clean Water Act (CWA) of 1987 and Long Island Sound has been designated an Estuary of National Significance by its membership in the program. Information and studies conducted by dozens of investigators involved in the Long Island Sound Study form the basis of this report.

This report will address four topics identified by the convenors of the conference. They are:

* Use impairments and other adverse ecosystem impacts in the Sound.
* Ecological significance of the impacts with reference to some economic considerations.
* Trends of these conditions (better or worse) with emphasis on the present century.
* Prognosis for correcting these problems in the Sound.

Recent efforts to characterize water quality of Long Island Sound as part of the National Estuary Program have identified some key issues which will require changes in the way we manage Long Island Sound. The Long Island Sound Study has identified 1.) low dissolved oxygen, 2.) toxic contamination, 3.) living marine resources, 4.) pathogens, and 5.) floatable debris as five areas of concern. Primary among these is the issue of low dissolved oxygen, or hypoxia, that seasonally impacts substantial areas in Western Long Island Sound. Water containing less than 3 ppm is generally considered to be "hypoxic". This condition will be the focus of this report.

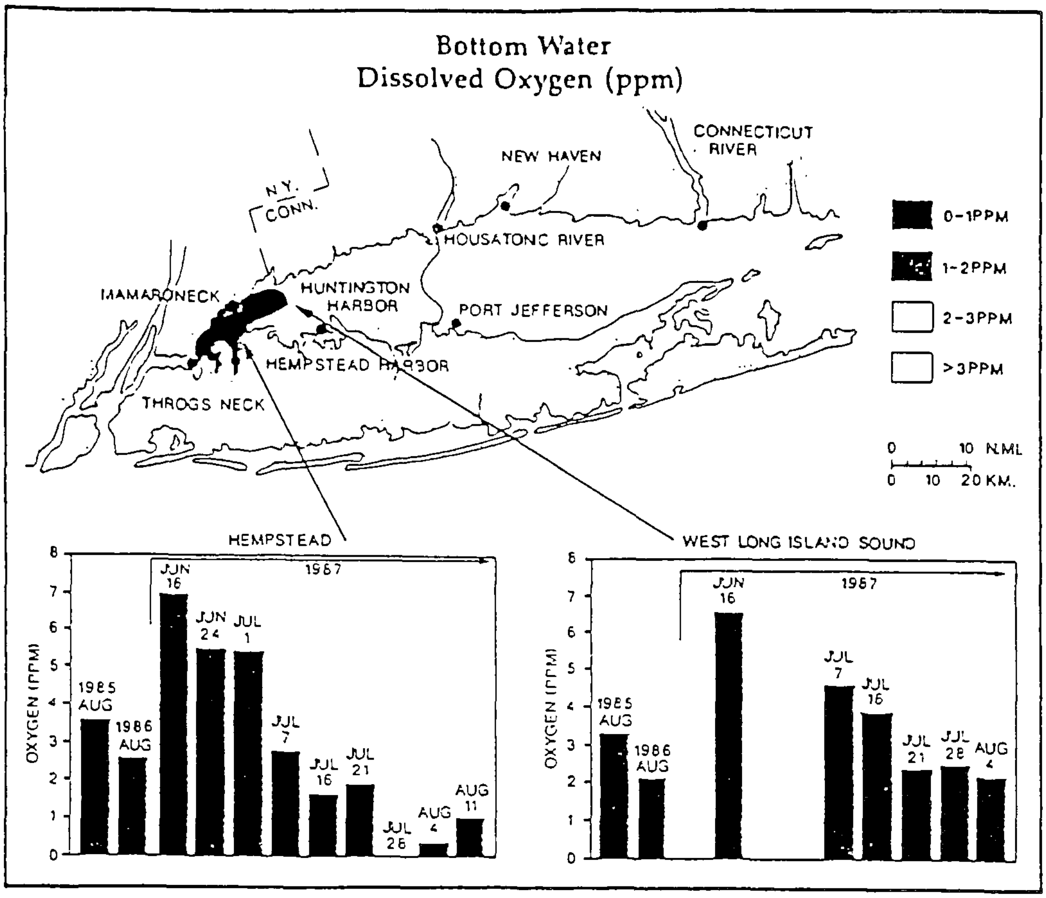
CAUSES AND IMPACTS OF HYPOXIA

LISS has sponsored field studies of Long Island Sound annually since 1986 to identify the extent of low dissolved oxygen problems. Each year there has been a hypoxic event recorded in the western Sound although the areal extent, duration and minimum dissolved oxygen levels weren't (and were not expected to be) the same each year. Generally, hypoxia has occurred sometime during the July through September period, includes an area west of the point where the Housatonic River discharges into Long Island Sound, and is most severe between Throgs Neck and the Connecticut/New York border (**Figure** 1). Depending on severity, the area impacted by dissolved oxygen levels of 3 ppm or lower ranges from 65 to 180 km^2. The water remains hypoxic from 2 to 6 weeks.

Hypoxia occurs in the bottom layer of water lying below a density gradient (pycnocline) set up by differences in temperature and salinity between the surface and bottom waters. Estuarine systems are particularly susceptible to hypoxic events because of this natural stratification which is strongest in the late summer. The pycnocline creates a barrier which prevents oxygenated surface waters from mixing with the hypoxic bottom waters. Decaying organic matter in the lower water column and in the sediments serves as a sink for available oxygen, gradually drawing the oxygen pool down to critical levels. Oxygen is not replenished until storms or falling temperatures break up the gradient and the water column becomes well mixed (**Figure** 2).

There is concern that hypoxia limits the use of otherwise viable habitats in the Sound by resident fish and shellfish. Motile species may be excluded from feeding, nursery or breeding areas for a portion of their life. The result can be reduced growth, lowered survival, increased predation, or increased competition for food as organisms are crowded into the remaining available habitat. Sedentary shellfish or slower moving species may suffer direct mortality when trapped in a hypoxic area or be sublethally impacted in ways similar to those listed for motile organisms when stressed by low oxygen levels. While these impacts have not been quantified, migration from hypoxic areas has been documented during fish surveys. An estimated 65 to 180 km^2 is unavailable to many species during these events; therefore, some loss in productivity is likely. Algal blooms and fish kills also occur periodically, particularly in coastal coves and embayments, which may reduce recreational use of the Sound for both ecological and aesthetic reasons.

Long Island Sound supports a vigorous commercial and recreational fishery (Smith et al., 1989) Market value of the commercial catch from Long Island Sound runs about $40 million per year and sportfishing adds between $70 and $130 million to the regional economy. Important commercial species include



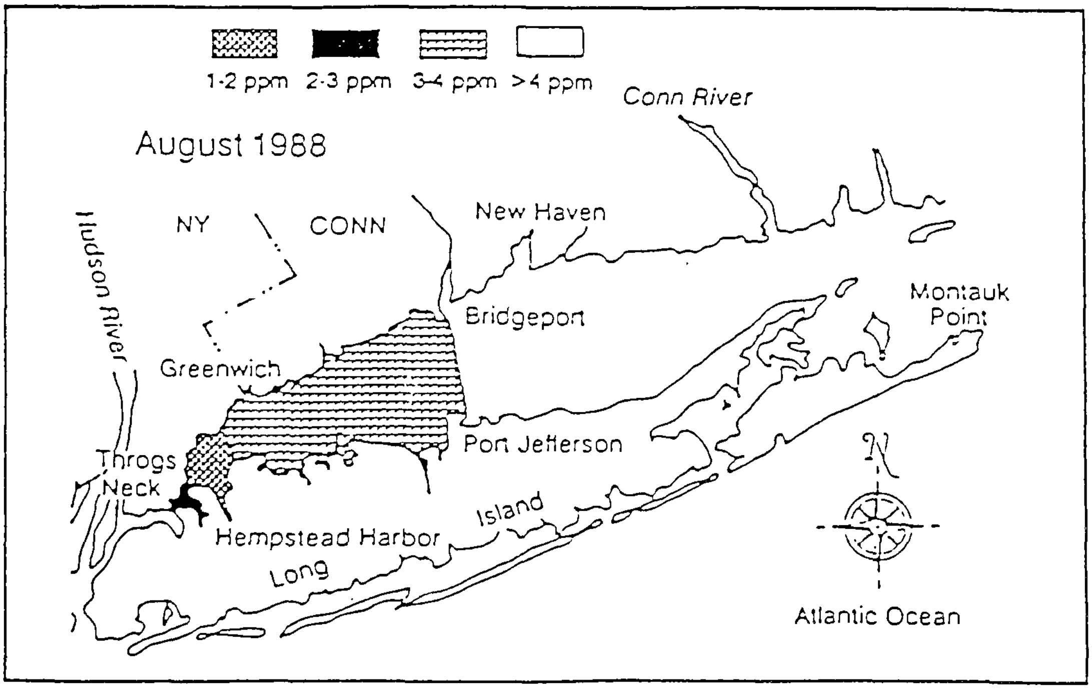


Figure 1. Dissolved oxygen levels in bottom waters of Long Island Sound during the late summer hypoxic period in 1987 and 1988. (Source LISS, 1987; 1988a)

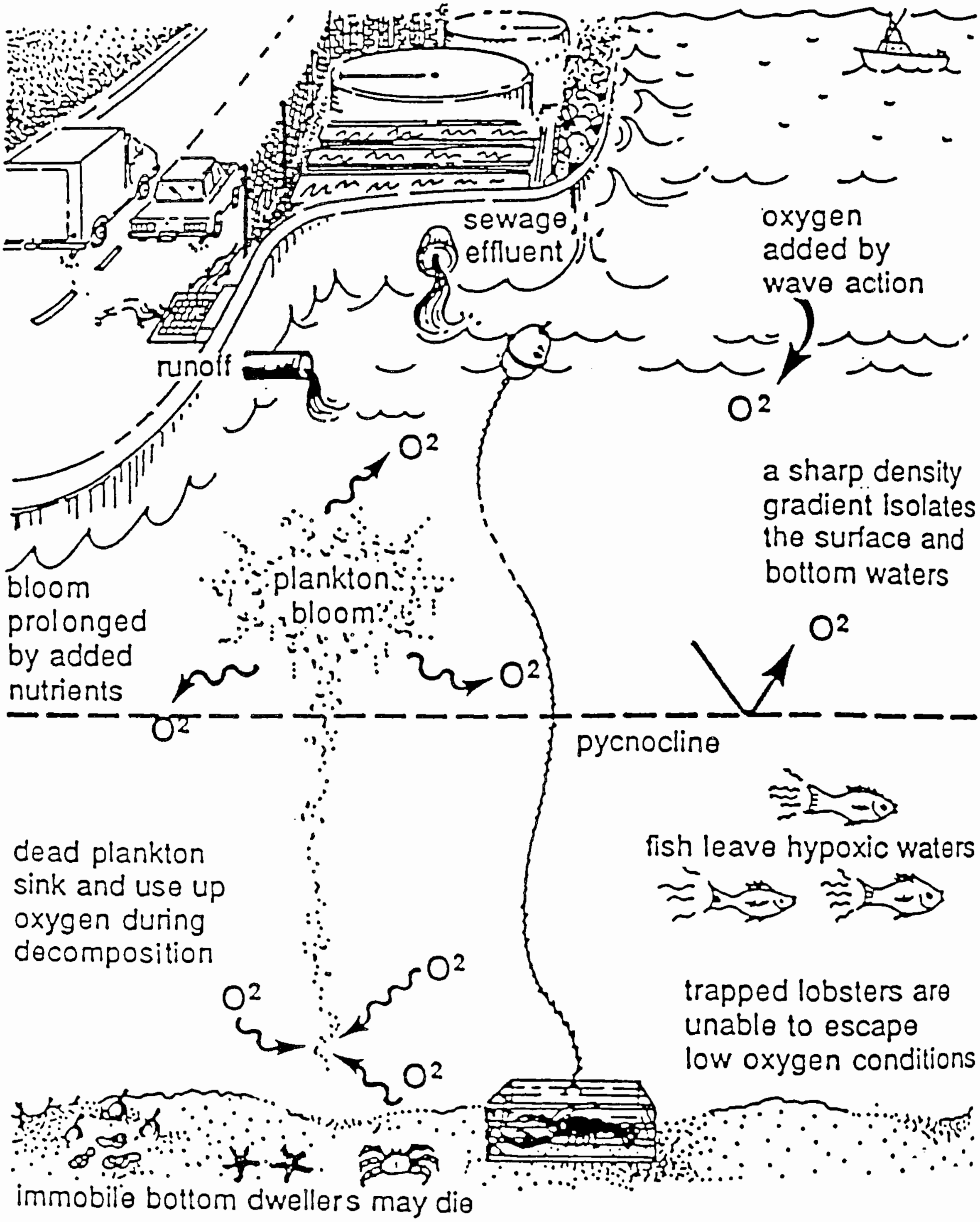


Figure 2. Vertical profile of hypoxia in the water column of Long Island Sound. (Source: LISS, 1988b)

lobster, oyster, winter flounder and scup. While commercial landings data are subject to many variables, including catch effort, accuracy of landing reports and natural variations in stocks, a compilation of 25 years of commercial landings data show peak landings during the last five years of the 1961 1985 period for three of the four species (**Figure** 3).

The most compelling information that hypoxia impacts some of these valuable resources has come from Connecticut DEP's Division of Marine Fisheries. Since 1984, Marine Fisheries has been studying the relative abundance and distribution of marine finfish and lobsters throughout the Sound east of Greenwich. Beginning in 1986, collections have been made in an area off Hempstead Harbor to determine fish distribution in the area most susceptible to hypoxia. Generally, Hempstead abundance indices were less than half those observed in non-hypoxic areas of the central Sound and species abundance was near zero in July and August (Howell, 1990). While arguments can be made that the species which utilize western Long Island Sound are adapted to this forced migration and interference with their life history is minimal, such arguments can only be supported if hypoxia in the western Sound is shown to be largely a natural phenomenon. The reduction in species presence and abundance in the hypoxic zone is well-established (**Figure** 4), but marine systems are complex and absolute proof of this relationship and its quantitative impact on productivity awaits additional research.

TRENDS IN HYPOXIA

Long Island Sound, despite its rich cultural history, has not been extensively nor continuously studied or monitored to establish trends of hypoxia. Earlier surveys summarized by NOAA suggest that minimum dissolved oxygen levels have fallen over the last four decades (**Figure** 5). Key among these is the extensive work of Gordon Riley and his associates at Yale University. His surveys in 1954 and 1955 extensively measured oxygen levels in both surface and bottom waters throughout much of the area currently impacted by hypoxia. During his surveys, no measurements of dissolved oxygen below 3 ppm were observed at any time in the bottom waters. Surveys conducted in the early 1970's began to report oxygen levels below 3 ppm in the western part of the Sound during the late summer period (Collins and Heimerdinger, 1986; Reid, Frame and Draxler, 1979; Hardy and Weyl, 1971). While the historical record is by no means complete, based on the available information, a trend toward more extensive hypoxia and lower minimum dissolved oxygen levels seems apparent. The monitoring sponsored by the Long Island Sound Study has identified recurrent seasonal hypoxia in the western Sound since 1986, as discussed above. Minimum dissolved oxygen reported in the Long Island Sound Study work was zero during 1987 (LISS, 1987; **Figure** 1). Similar observations, particularly east of the Throgs Neck Bridge, were not reported in the earlier surveys.

Studies conducted for the Long Island Sound Study have identified nutrient enrichment as the probable cause of hypoxia. Population growth and related increases in the volume of sewage treatment plant effluent have led to loadings of nutrients beyond natural levels and beyond the assimilative capacity of Long Island Sound. The added nutrients stimulate algal growth, creating a demand on oxygen when the algae dies and decays. It is estimated that Long Island Sound

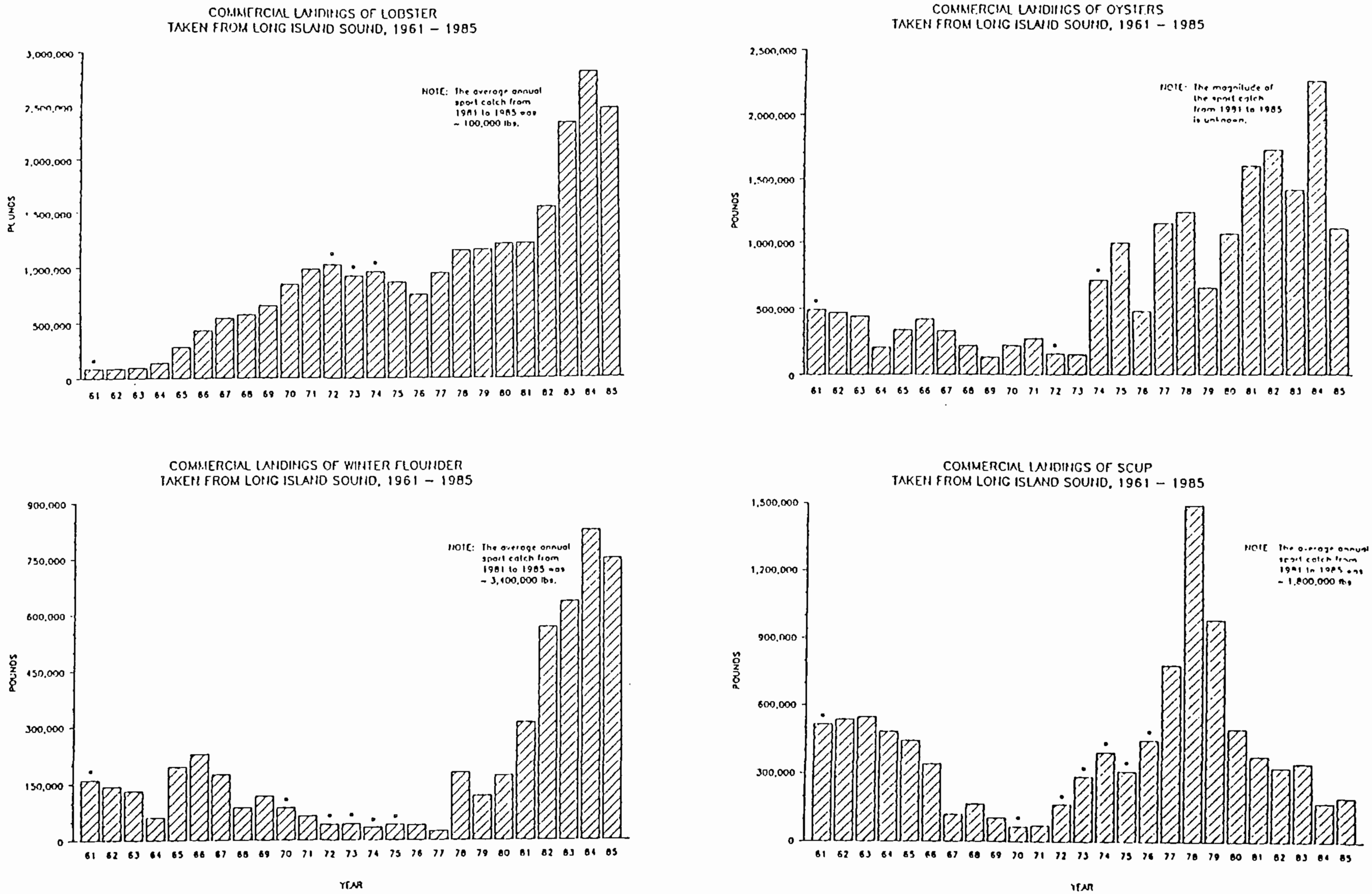
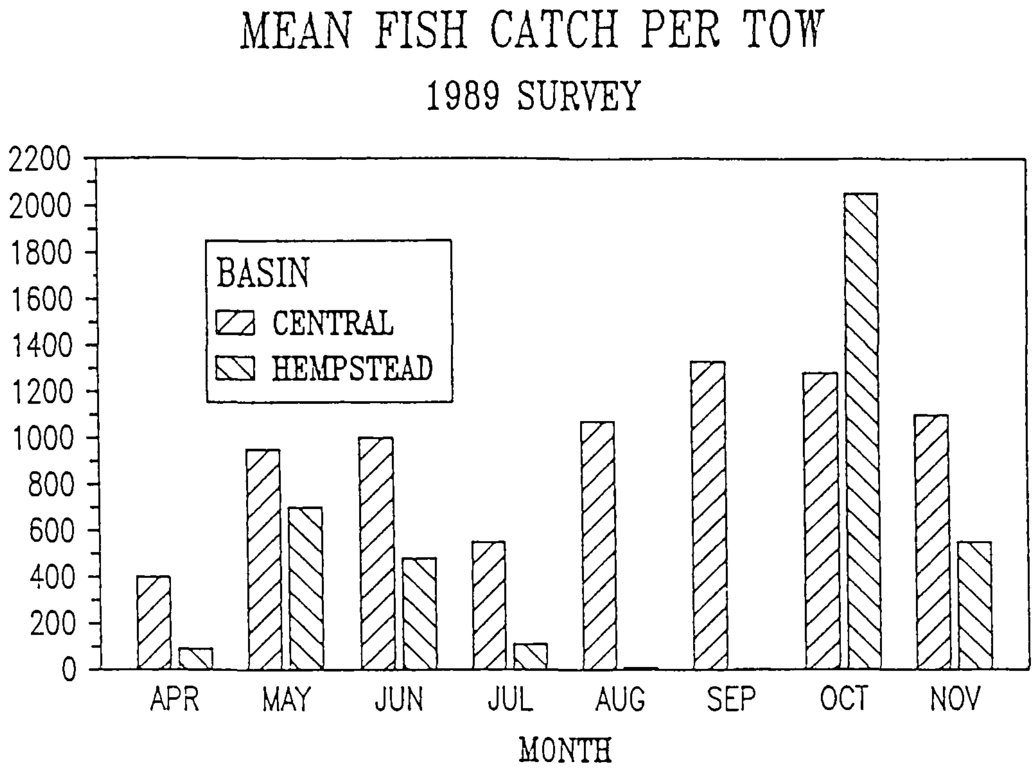


Figure 3. Commercial landings of lobster, oyster, winter flounder and scup taken form Long Island Sound, 1961-1985. (Source: Smith et al., 1989)



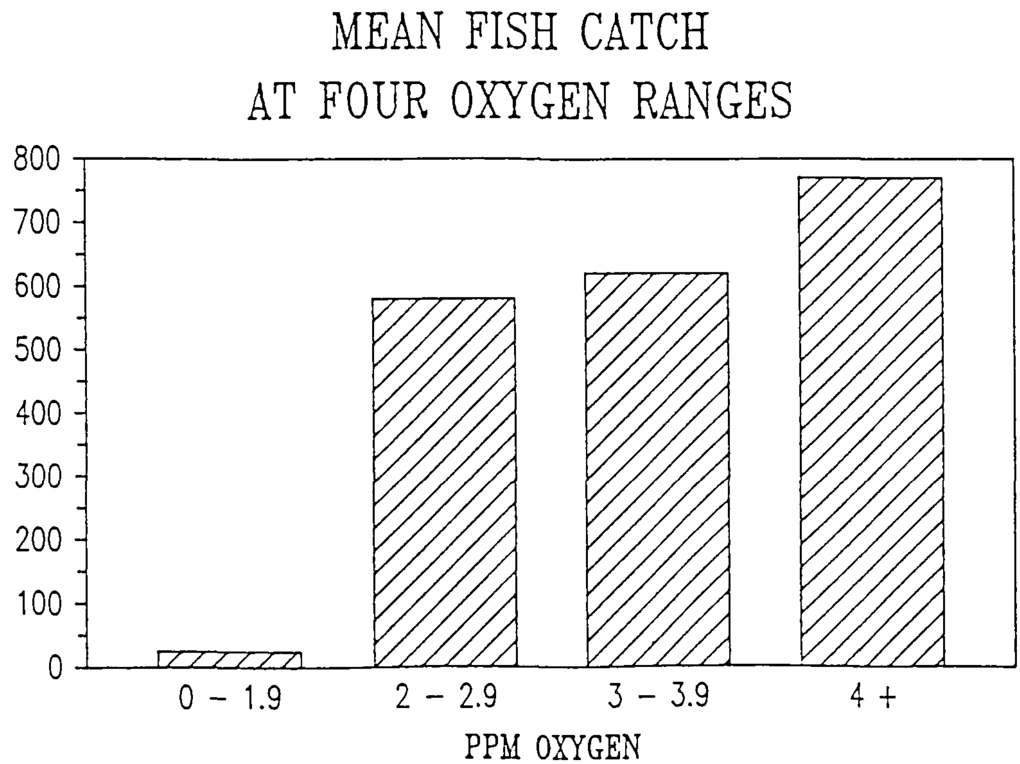
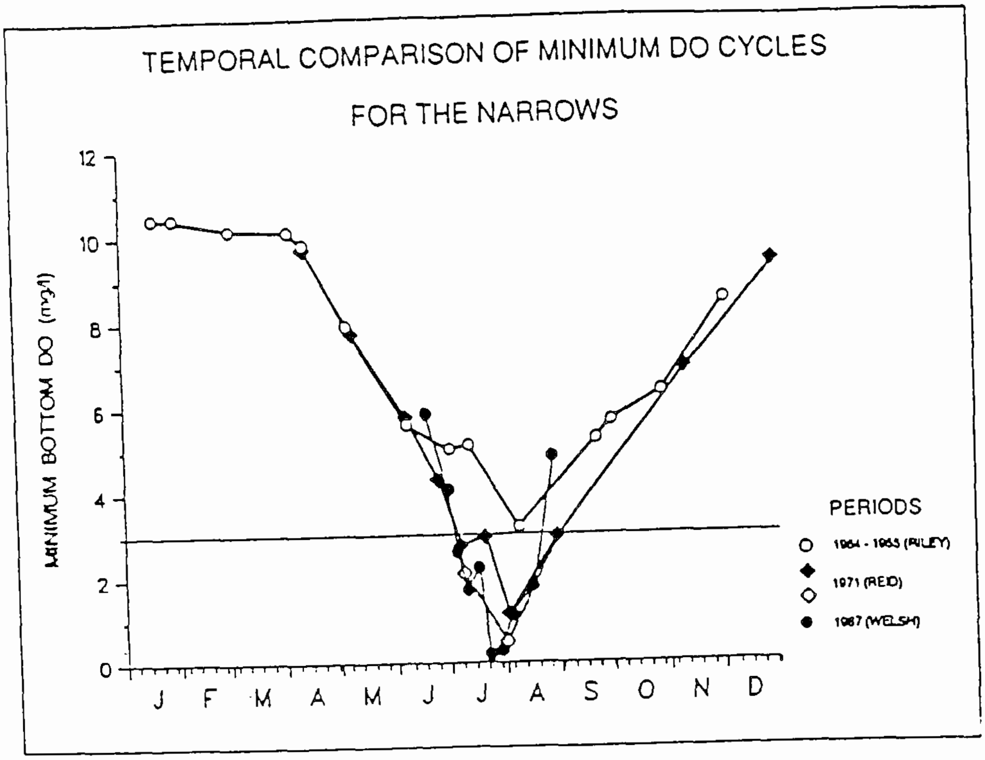


Figure 4. Total fish catch, all species combined, in the Central Basin vs the Hempstead Harbor area (top graph) and relationship between fish catch and dissolved oxygen levels (bottom graph). (Source: P. Howell, CT DEP, Div. of Marine Fisheries)



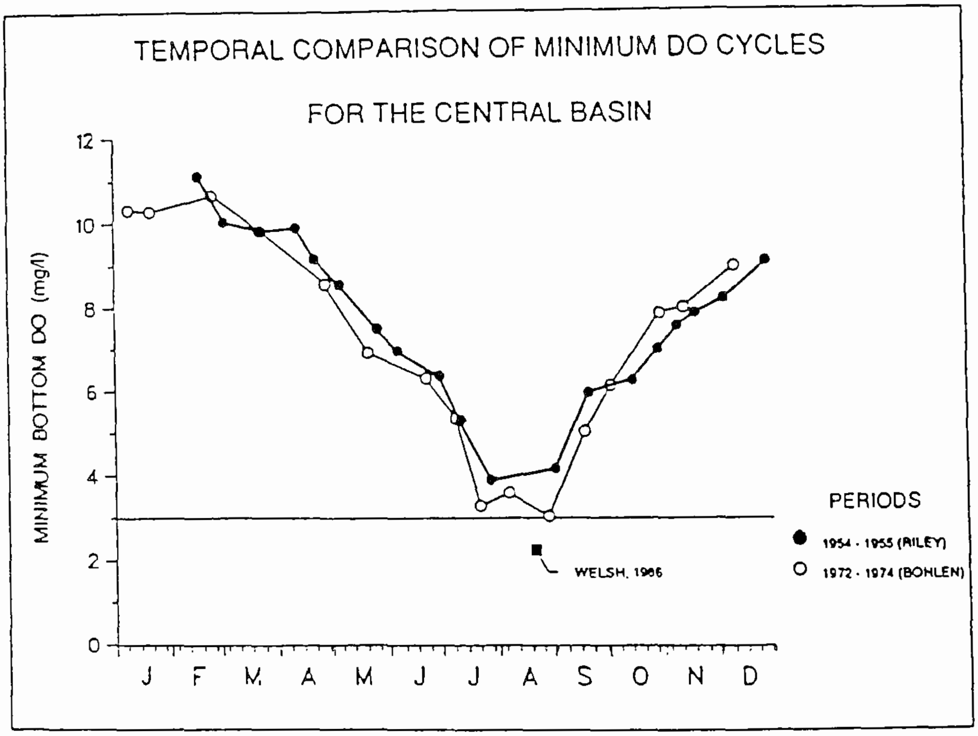


Figure 5. Historical comparison of minimum dissolved oxygen levels in the Western Narrows and Central Basin of Long Island Sound. (Source: Parker, C.A., NOAA)

receives about 60,000 tons (5.4×10^7 kg) of nitrogen each year. Much of this load is carried by the Connecticut River, driven by the 4.39×10^{12} gallons (1.66×10^{13} liters) per year discharged by the river. That represents about 58% of the water being discharged to the Sound from all sources (**Figure 6**). It does not take a very high concentration of nitrogen in this major water source to create a large load to the system each year. In that context, the roughly one-third of the total nitrogen load delivered to the Sound each year by the Connecticut River is not unexpected.

Other sources of nitrogen, particularly anthropogenic sources, may be of greater concern because they represent a non-natural load located in close proximity to the hypoxic area. Sewage treatment plants, for example, also contribute about a third of the total nitrogen (in the coastal counties which border Long Island Sound)(**Figure 7**). They are concentrated in the western part of the Sound's drainage basin (**Figure 8**) and provide a high potential for management. While the effect of the major treatment plants along the East River on Long Island Sound is unclear at this time, a strong relationship to hypoxia is likely, and treatment plants east of New York City in the western Sound will undoubtedly require management.

The temporal trend in nitrogen discharged by sewage treatment plants has not been well-documented because of incomplete monitoring in the study area. However, a relationship between discharge volume and nutrient loads exists and a reasonable parallel between discharge volume and nutrient load can be presumed. Since 1974, for example, sewage treatment plants in western coastal municipalities have increased their discharge volume 32 %, from 722 mgd to 1061 mgd (**Figure 9**) While sewage treatment plant upgradings have led to an effluent quality far superior to past decades in terms of quantity of oxygen-demanding substance concentration, standard secondary plants remove only a small portion of the nutrients associated with sanitary wastes. A standard secondary sewage treatment plant removes only about 10 to 30% of the total nitrogen in raw sewage, for example.

While treatment plant upgradings to secondary have reduced the immediate drain on oxygen associated with minimally treated effluents, release of nutrients can still result in a "delayed" response. The nutrients discharged by sewage treatment plants stimulate algal growth which sets up its own oxygen demand when the algae dies. This effect is suggested by the historical dissolved oxygen data in the East River and Western Narrows by Parker, O'Reilly and Gerzoff (1986). The data seem to show a trend toward higher dissolved oxygen levels in the East River where upgrading to secondary level of treatment at the major sewage treatment plans located there decreased the immediate oxygen demand of minimally treated sewage. In the Western Narrows, however, dissolved oxygen levels appear to be declining, possibly a delayed response to nutrients still being released into the East River and by western Long Island Sound treatment plants. As the nutrient rich water travels into the Western Narrows, algal growth is stimulated along its route, deposited in the Western Narrows as it dies, and an oxygen demand is created in that area. As the Long Island Sound Study model is refined and verified, these relationships and the role of the East River sewage treatment plants should become more clear.

Non point sources of nitrogen are also of concern in Long Island Sound. For example, non-point stormwater runoff in the entire basins of the major

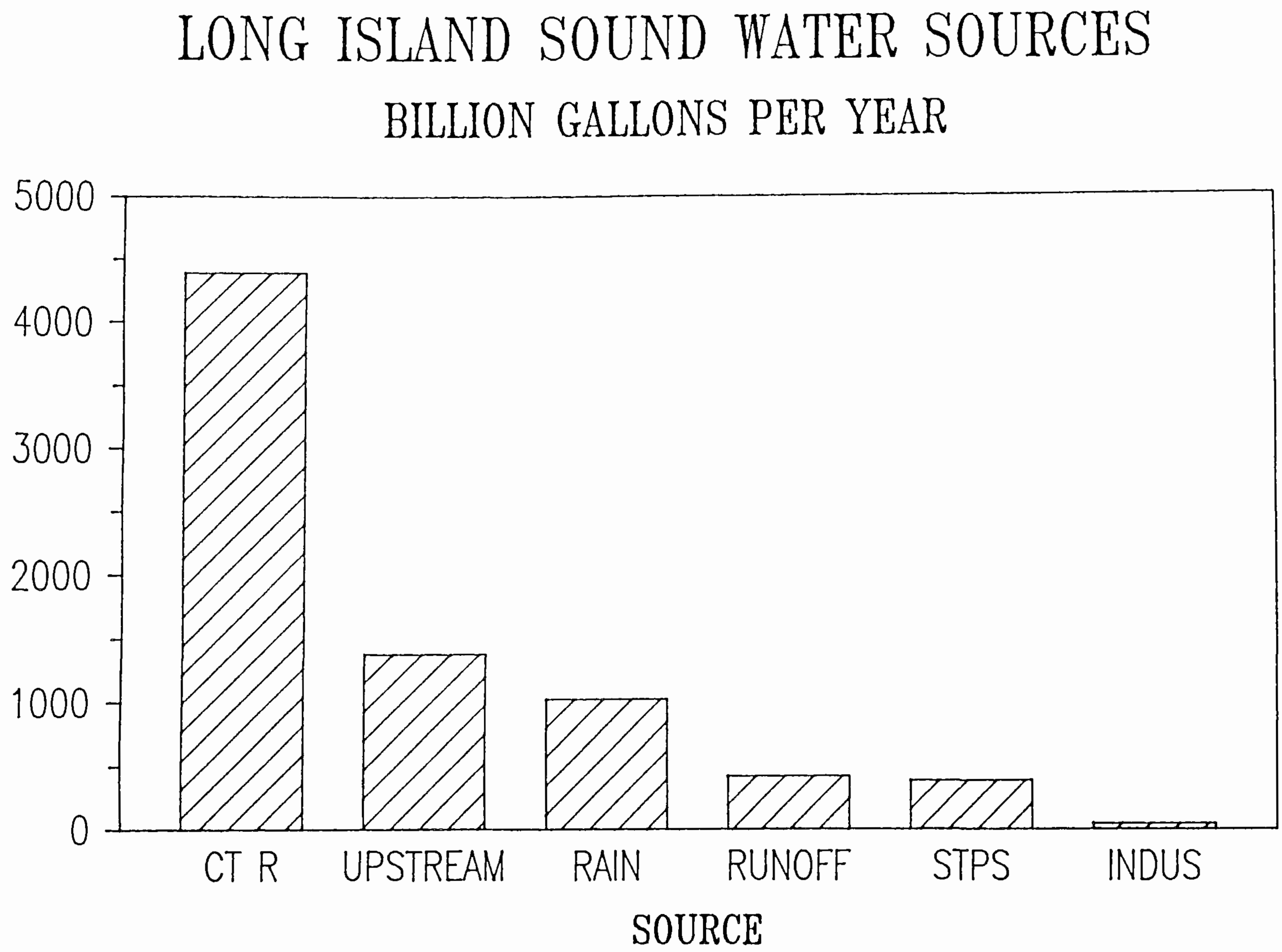


Figure 6. Sources of water (billion gallons per year) discharged to Long Island Sound. "Upstream" is the volume transported into the coastal counties via the major tributaries excluding the Connecticut River, "Rain" is the volume falling directly on the Sound, and other categories are for those source types in the coastal counties bordering Long Island Sound only.

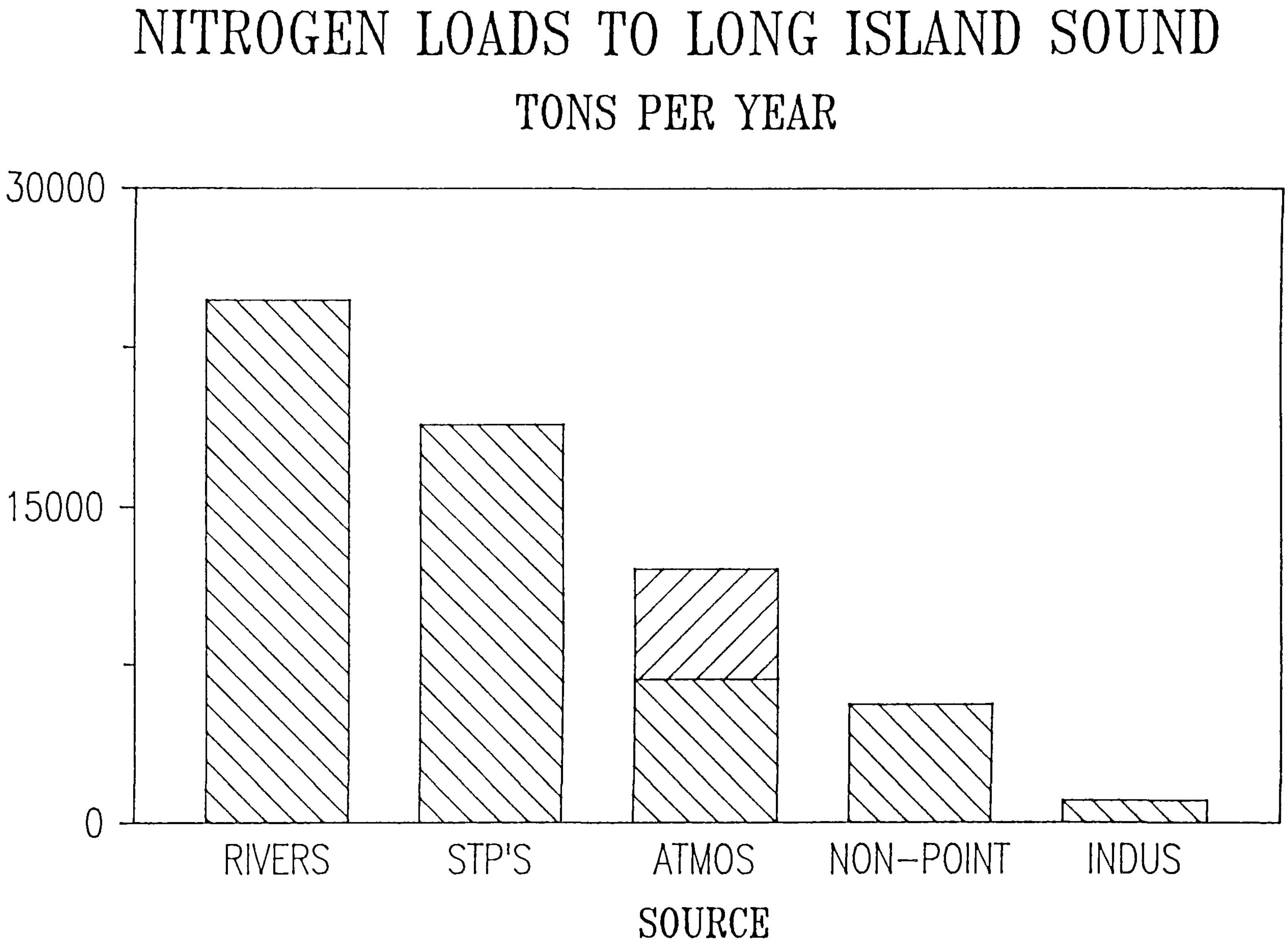


Figure 7. Distribution of nitrogen loads (tons/year) delivered to Long Island Sound by source type. The "ATMOS" bar represents a range of estimates.

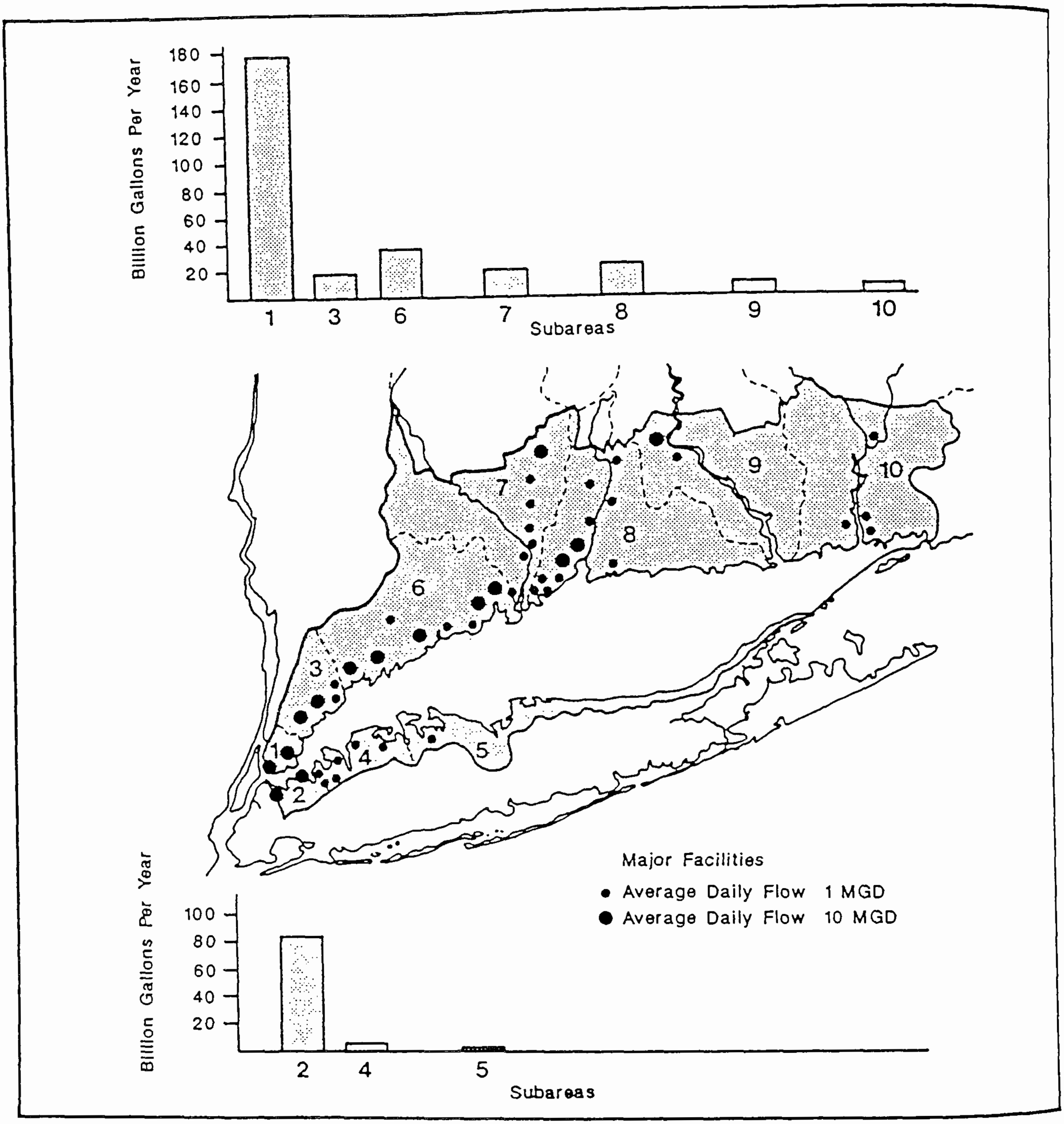


Figure 8. Location of sewage treatment plants in the coastal counties surrounding Long Island Sound. (Source: Farrow et al., 1986)

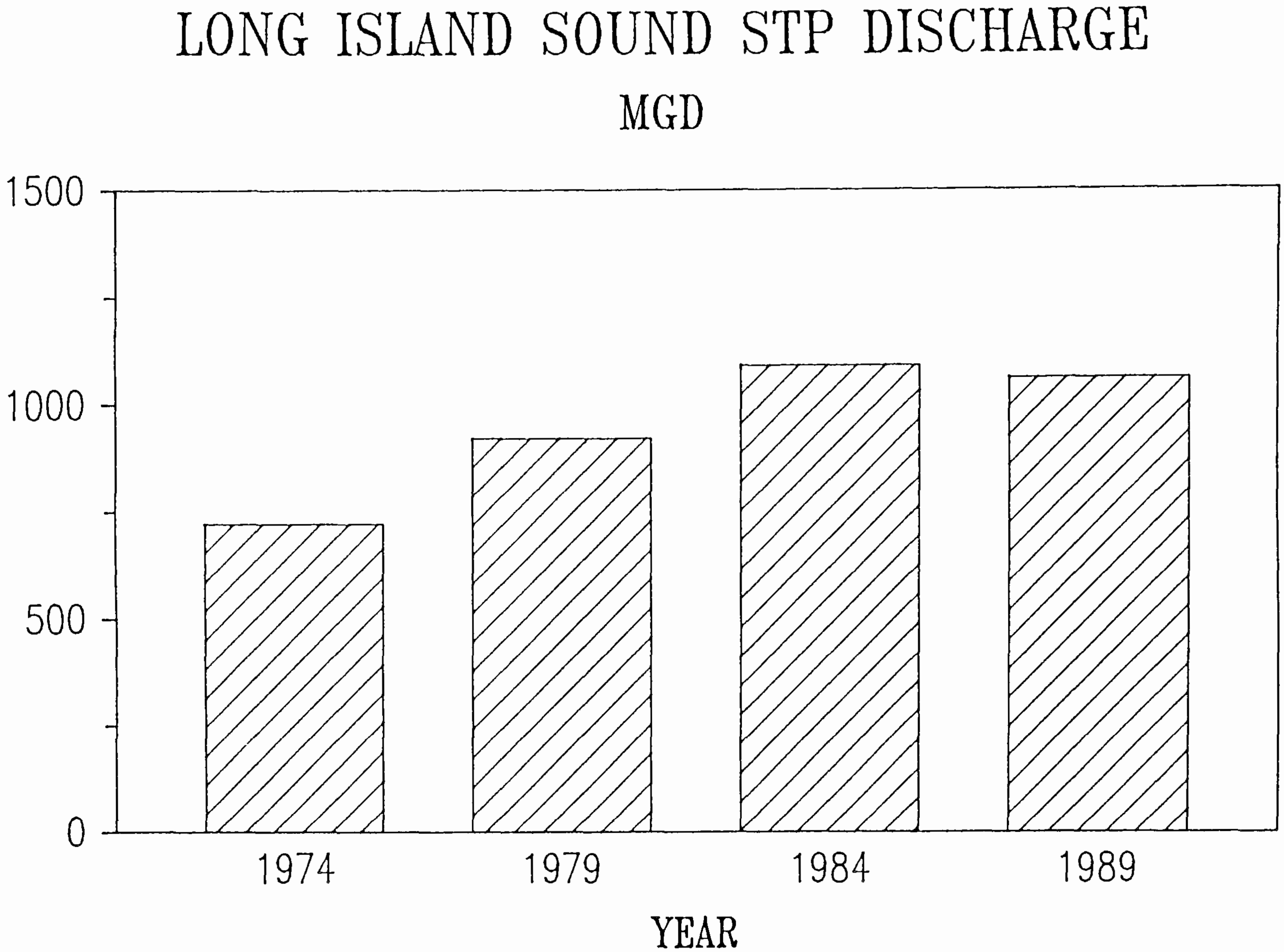


Figure 9. Discharge volumes of sewage treatment plants in New Haven and Fairfield Counties, CT, Westchester and Nassau Counties, NY, and along the East River in New York City which discharge to Long Island Sound or its tributaries. (Source: Interstate Sanitation Commission, 1974; 1979; 1984; 1989)

Connecticut tributaries contributed about 25,000 tons (1.1 x 10^8 kg) of nitrogen during the October 1987 through September 1988 period (U.S.G.S. Water Year 1988) to the system and rainfall, directly on the Sound, contributes another 4,000 to 12,000 tons/yr (1.7 x 10^7 to 5.3 x 10^7 kg/yr). Estimates for these categories are not well-documented, however, particularly for atmospheric deposition. Recent monitoring suggests the atmospheric constribution directly on the Sound may be toward the lower end of the range. Similarly, the non point load calculations for the Water Year 1988 represent a below average discharge period: a wetter year would contribute higher loads of nitrogen and the percent relationship between point (not greatly affected by rainfall) and nonpoint would consequently change, tipping the distribution of nitrogen sources more heavily toward the non point category.

If the non-point component of the "upstream" source is estimated, of the total load of nitrogen to the Sound, non point sources may be responsible for 50% of the total nitrogen load. The "natural" component of the nitrogen load to Long Island Sound from stormwater runoff is estimated to be about half of the nonpoint load. This means that the stormwater runoff contribution of nitrogen might be reduced by 50% if the Sound's drainage basin could be returned to a natural condition, an unlikely proposition. Also, much of the nonpoint load is contributed by the Connecticut River which, because of its location, may not be as important a source as the Housatonic River which contributes a much smaller load of nitrogen (**Figure 10**). Nevertheless, the Housatonic River shows at least a 40% enrichment of nonpoint load (**Figure 10**), is close to the hypoxic area, and is therefore a prime candidate for non point management. Estimates for a natural load from atmospheric sources have not been made. Note that stormwater runoff includes the contribution from atmospheric fallout over land that is not absorbed into the system before it reaches Long Island Sound.

PROGNOSIS FOR CORRECTING HYPOXIA

Hypoxia has been regularly observed in the bottom waters of western Long Island Sound and, left unchecked, it is expected that the expanse and minimum levels of dissolved oxygen would worsen with time. The present evaluation of the condition indicates that a reduction in the nitrogen load to Long Island Sound will help alleviate hypoxia. It is not known what level of reduction is needed right now or what the minimum level of dissolved oxygen is that can be achieved with best management efforts. There is only a preliminary indication of what a minimum dissolved oxygen level, protective of the most sensitive species in Long Island Sound, might be. It is clear, however, that sewage treatment plant effluent in the area west of New Haven (excludes the large load from the Connecticut River) contributes roughly 30,000 tons/yr (1.3 x 10^8 kg/yr) of nitrogen being discharged to Long Island Sound by both natural and cultural sources. Assuming that a portion of the East River load moves eastward into Long Island Sound, sewage effluent will be a key in any management scenario. From a management perspective, point sources are much easier to control. Technologies for nutrient removal at sewage treatment plants exist and, given the importance of sewage as a nutrient source in the Long Island Sound basin, prospects for management and control are good.

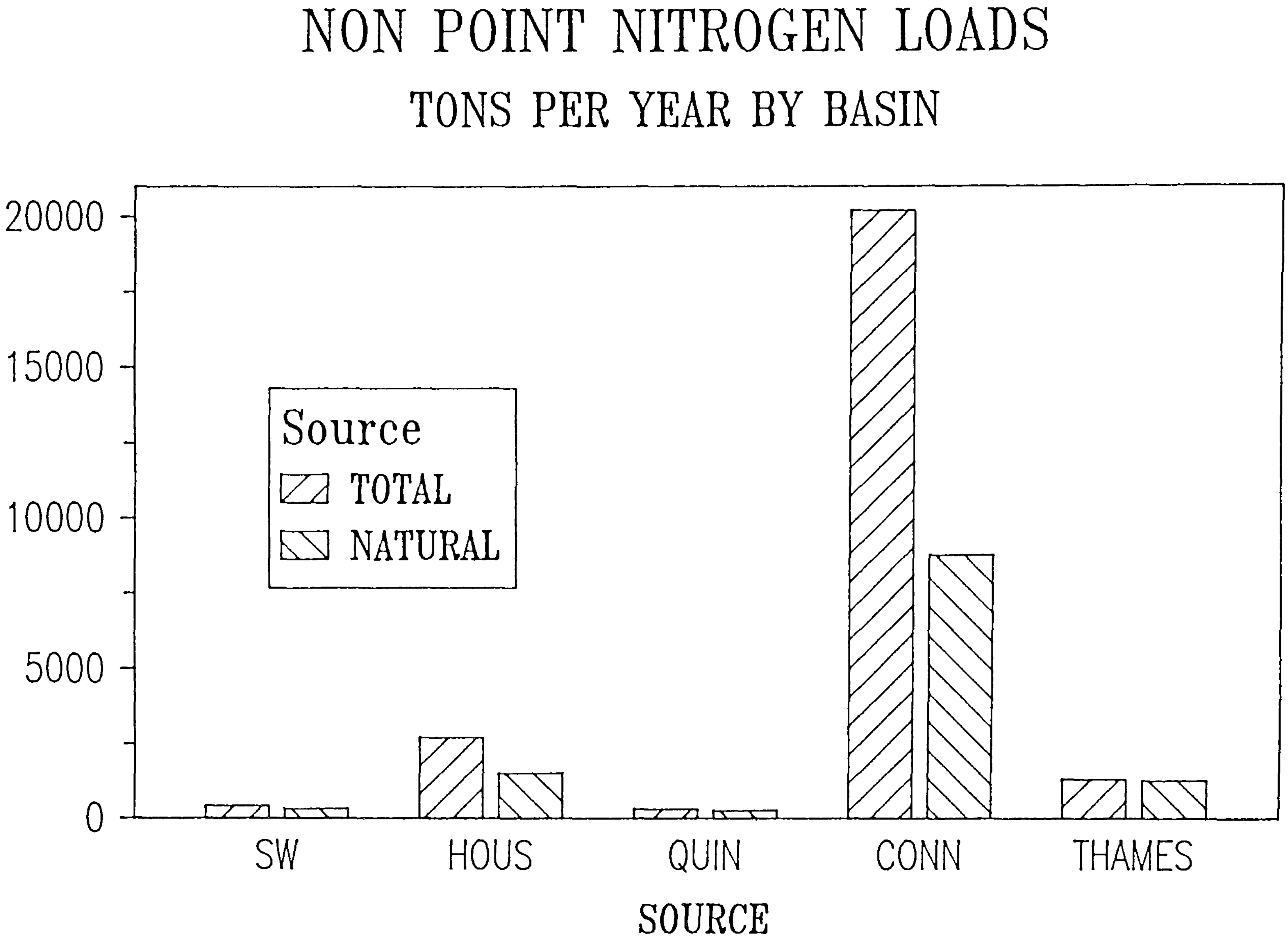


Figure 10. Calculated (Water Year 1988) vs. "natural" non point load estimates for major tributary basins discharging to Long Island Sound. SW = Southwest Coastal Basin, HOUS = Housatonic River Basin, QUIN = Quinnipiac River Basin, CT R = Connecticut River Basin, and THAMES = Thames River Basin.

It is unlikely that "natural" conditions in Long Island Sound can be restored, however, because of the high density of development and the difficult nature of non point source controls. Non point sources basinwide contribute at least one third of the nitrogen load and even if best management practices are widely applied within the basin, we should expect only a modest reduction in nitrogen from non-point sources. Fortunately, much of the load is discharged by the Connecticut River, distant from the western Sound, which may not be as critical to manage. Final hydrodynamic modeling underway at this time will help answer that question. Estimates of atmospheric contributions of nitrogen to Long Island Sound run as high as 20%. Management actions to control atmospheric loads would require a national effort, and would undoubtedly, be costly. Clearly, our best prospects for nutrient control lie with better management of point sources.

Finally, the prognosis for improvements in Long Island Sound is only as good as our ability to implement management programs recommended by, and beyond the Long Island Sound Study Comprehensive Conservation and Management Plan. A "Study" of Long Island Sound, or any system for that matter, can never be of finite duration if it is to be of value. A management plan, no matter how "comprehensive" can never be timeless. There will always be changes as our understanding of Long Island Sound evolves and new issues that will need addressing which cannot even be predicted at this time. Quite often, when a study is over, the structure that went into the development of the study and its plans dissolves. To ensure success, the pathway to implementation must be in place and structurally sound.

While the Long Island Sound Study will probably be remembered for its pioneering work in identifying and describing the dynamics of hypoxia in Long Island Sound, this is not a new issue. In the last "Long Island Sound Study" conducted by the New England River Basins Commission (NERBC, 1975a), it was stated:

> Long Island Sound has long been the repository for many pollutants. It is still not possible to make quantitative predictions of the cumulative effects of pollution such as the nutrients and toxic substances which enter Long Island Sound. This is complicated particularly by our lack of understanding of the three-dimensional circulation pattern in the Sound and its variations with time.
>
> Some scientists have voiced serious concern over the eutrophication problem caused by man-added nutrients in parts of Long Island Sound. The short-term effects of excessive enrichment are generally rapid growth or blooms of algae, resulting in large daily fluctuations in oxygen concentrations, lowered dissolved oxygen due to algae die-off and biodegradation, and possible benthic animal and fish kills because of oxygen stress.

One of the "high priority" recommendations of the study (NERBC, 1975b) was to conduct a "Study of nutrient enrichment in the western Sound". Attention to this recommendation during the ten-year interim before the initiation of the present Long Island Sound Study would have been extremely beneficial in attacking the problem of hypoxia. Comments by NERCBC on the need to understand the three-dimensional circulation of the Sound and the role of New York City/East River treatment plants are especially haunting. The Long Island Sound Study has placed a lot of effort into describing the East River dynamics. Completion of three-dimensional hydrodynamic model will finally answer the question of the East River's role in another year.

SUMMARY

The Long Island Sound Study has identified hypoxia as its top priority management issue to be addressed by the conference. A substantial portion of western Long Island Sound bottom water has been found to be impacted by hypoxia during the late summer each year since the study began monitoring in 1986. Fisheries surveys show that many of the important commercial and recreational species avoid the hypoxic area and some impact on productivity of both motile and sedentary species is likely. While the historical database is weak, available information suggests an increase in hypoxic area and minimum dissolved oxygen levels since the 1950's when no measurements of dissolved oxygen below 3 ppm were recorded. Without proper management of the condition, it is expected that water quality would continue to decline.

There is a clear relationship between levels of nutrients, particularly nitrogen, and hypoxia. Excessive nutrients stimulate algal growth which eventually dies and creates an oxygen demand as it sinks into the bottom layer of water and the sediments. Population growth in the Long Island Sound basin has resulted in increases in sewage treatment plant discharge volume and nonpoint contributions from land use changes. Both of these sources contribute large loads of nutrients and are targeted for management. It is expected that control of nutrients from sewage treatment plants and non point runoff will reduce the extent and severity of the hypoxic condition. Whether control of nutrient loads will return Long Island Sound to a "natural" condition, however, is uncertain at this time.

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CONDITIONS IN THE NEW YORK/NEW JERSEY HARBOR ESTUARY

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INTRODUCTION

The New York/New Jersey Harbor Estuary (NY/NJ Harbor Estuary) is a network of connecting tidal waterways located within eastern New York and northern New Jersey. Though the entire estuary includes all waterways landward of the Sandy Hook/Rockaway Transect to their head of tide, the National Estuary Program is focussing its efforts on a *core area* which includes the waterways shown in Figure 1.

The NY/NJ Harbor Estuary receives the freshwater drainage from an area encompassing 42,190 square kilometers (16,290 square miles) (Rod et. al, 1989). The freshwater sources are defined by Mueller et al. (1982) as depicted in Figure 2. Freshwater from the tributaries is by far the largest contributor (78%), however, freshwater from wastewater sources (13%) is major factor influencing water quality within the estuary. The large wastewater input reflects the huge population surrounding the southern portion of the estuary.

The estuary has served as a major thoroughfare for commercial navigation, been a receptacle for the disposal of huge quantities of sewage, and has supported functional commercial fisheries and a variety of recreational activities, such as bathing, boating and fishing. The ecosystem has, at times, been in serious conflict with the uses of both the estuary and the land within its drainage basin.

This paper provides an overview of the status of conditions in the estuary. A review of historical trends is presented with regard to water quality, habitat abundance, and fisheries. In addition, impairments to present uses are documented.

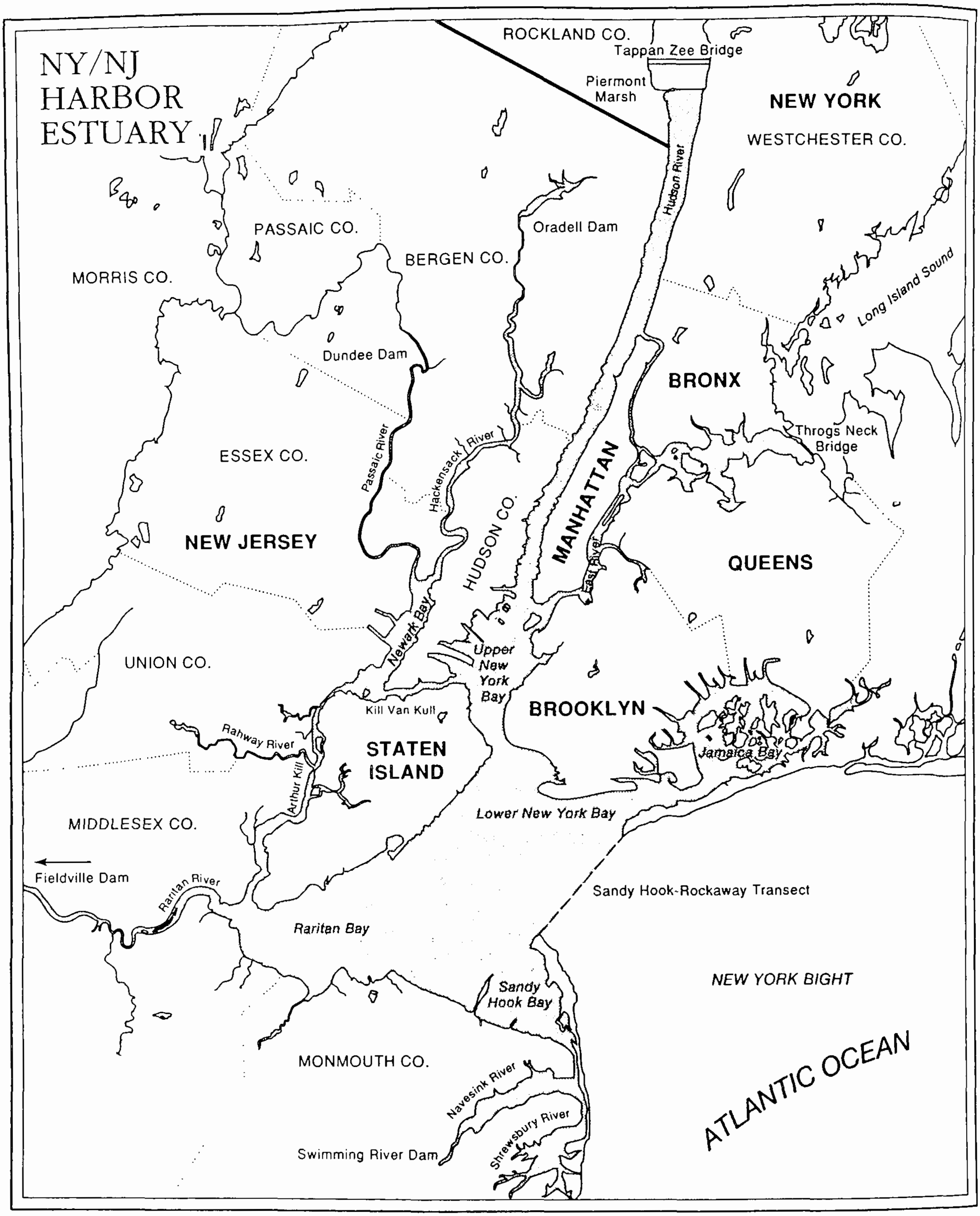
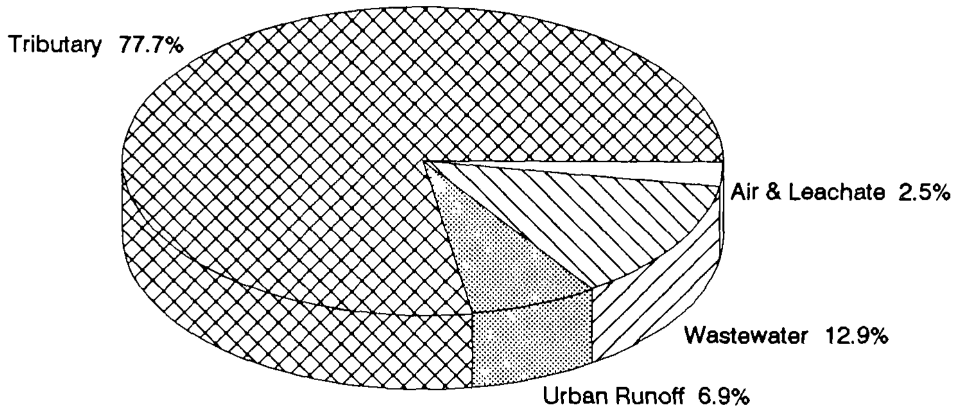


Figure 1. Map of the lower portion of the NY/NJ Harbor Estuary. The shaded areas represent the core area of the Harbor Estuary Program.



Source: Mueller et al. (1982)

Figure 2. Freshwater sources to the NY/NJ Harbor Estuary.

HISTORICAL TRENDS

Land Use and Population

Historic land use trends in the estuarine drainage basin are shown in Figure 3. Rod et. al (1990) indicates that *developed land* in 1980 is defined as areas having population densities greater than 2500 individuals per square mile. The *undeveloped land* category includes rural and suburban areas along with forested regions. The two principal historic trends are the dramatic decrease in croplands and the increase in urbanized areas.

Population trends since 1880 are depicted in Figure 4. Population in the drainage basin has increased from approximately 4 million persons in 1880 to about 17 million in 1980. Nearly 88% of the population resides in urban areas. Combining these statistics with Figure 3, we find that for the NY/NJ Harbor Estuary drainage basin, 88% of its human inhabitants reside within 13% of the land area. Most of these people live in the New York City metropolitan area.

Water Quality

Sewerage

Perhaps the greatest impact to water quality in the estuary has been from the discharge of sewage from a large and expanding population. Nuisances caused by sewage pollution are nothing new. Large cities, like New York City and Newark, NJ, have experienced sewage-related problems for nearly three centuries. Loop (1964) reports that waste disposal in New Amsterdam in the 17th Century was crude and simple. Sewage was collected in pails and dumped into the rivers. This practice continued until approximately 1850. Sewage and other refuse disposal became such an offensive problem that the Governor ordered a common sewer to be built in 1680 in what is now lower Manhattan. During the early 1800's some street sewers were constructed, however, in 1867, the Metropolitan Board of Health found that sewers were obstructed, manure heaps were piling up, and privies were overflowing. The street sewers that weren't clogged, discharged their contents into boat slips which were described in 1868 as "poisoning the water and contaminating the air" (Loop, 1964). Besides the normal runoff from rains, which caused serious flooding problems to city dwellers, the opening of the Croton aqueduct system in the early 1800's brought added volumes of water to an already overtaxed sewerage system.

Newark faced similar problems to New York City. Galishoff (1988) indicates that in 1857, sewage from cesspools and privies not absorbed by the soil, drained into open ditches. Conditions were thought to be of public health concern along with being unsightly and foul smelling. In 1857, the city authorized the construction of sewers. As with New York City, these early sewers were designed for surface drainage, not graded properly and were not suitable maintained. After 1890, a major capital improvement

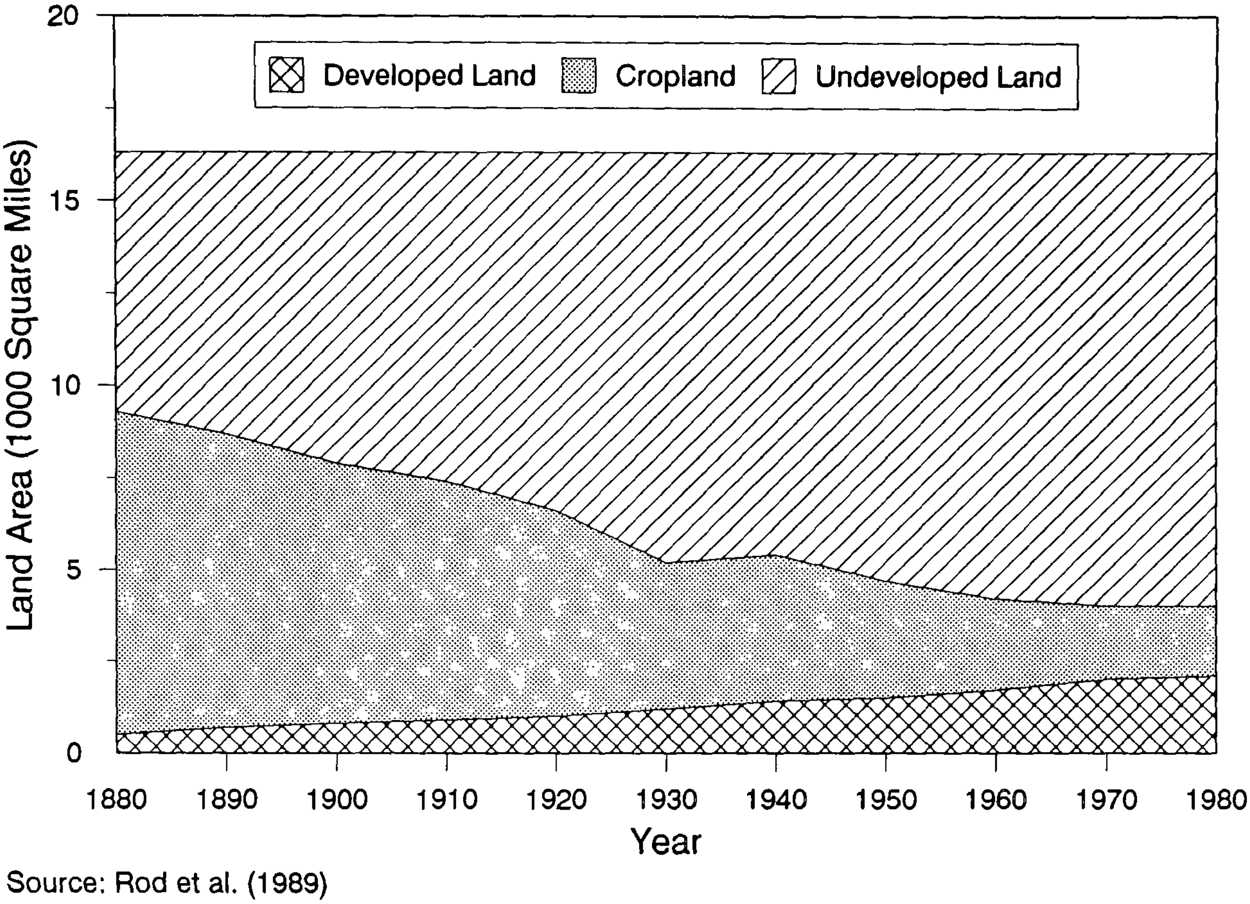
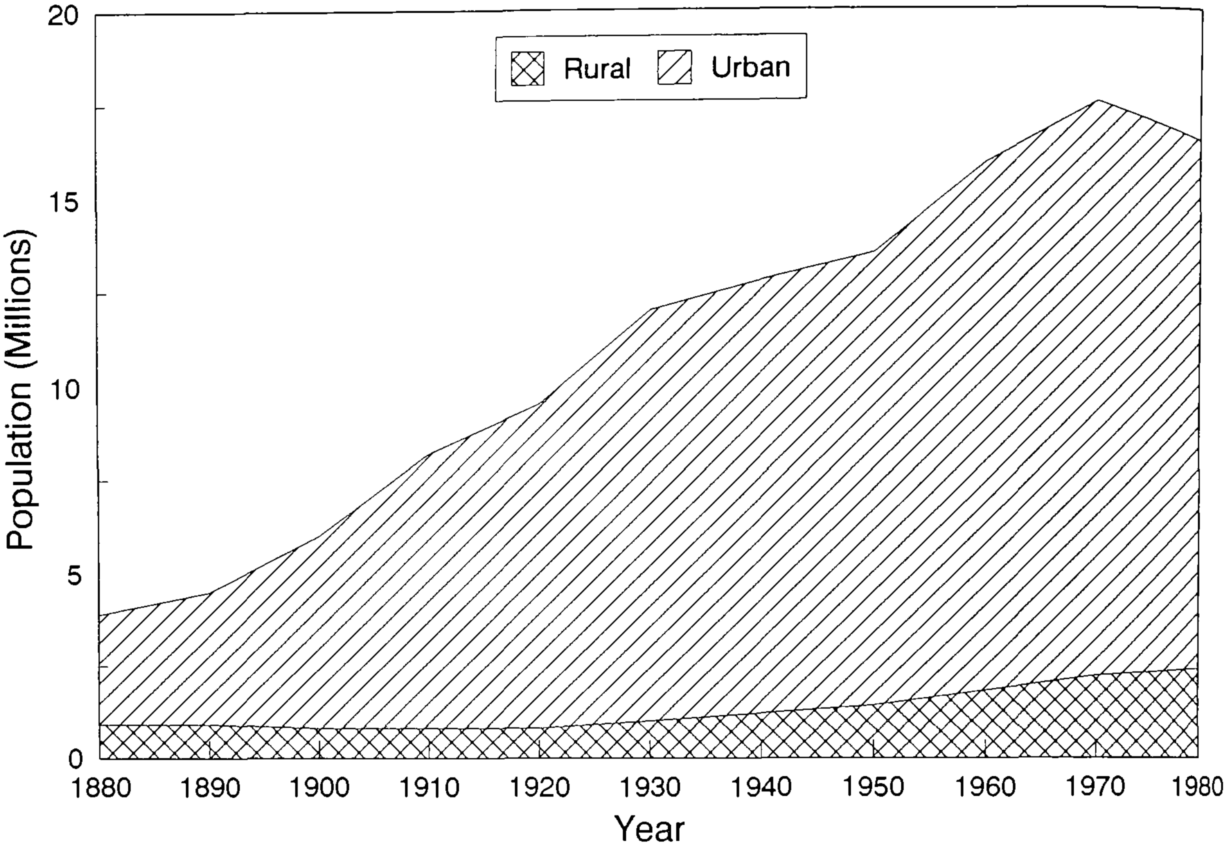


Figure 3. Land use trends in the estuary's drainage basin.



Source: Rod et al. (1989)

Figure 4. Population trends in the estuary's drainage basin.

program was undertaken in Newark to built more efficient sewers. By 1919, every part of the city had sewers, however, it was the responsibility of the private citizens to pay for their connection to the main sewer lines. As reported by Gaslishoff (1988), the poor were unable to pay for the improvements and consequently sanitary conditions were not achieved in many parts of Newark.

In 1906, the City of New York was directed by the State Legislature to create the Metropolitan Sewerage Commission of New York which would study the conditions of sewerage and sewage disposal in the metropolitan region and formulate a general plan or policy for protecting and improving the sanitary conditions of New York Harbor. The Commission conducted many scientific investigations, including the first field investigations of the concentrations of dissolved oxygen in harbor waters. The Commission did a comprehensive and extensive examination of harbor conditions and concluded, in part, with the following observations (Metropolitan Sewerage Commission, 1910):

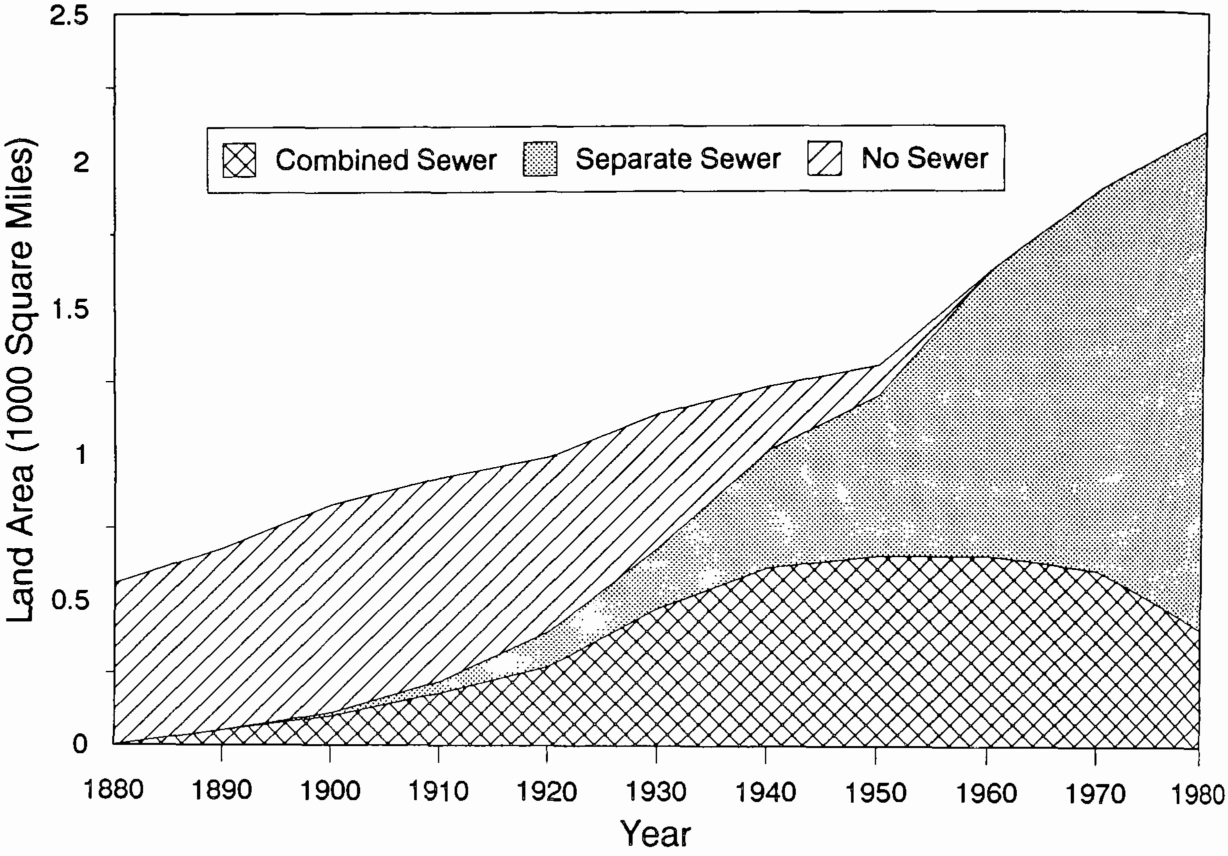
- "Bathing in New York Harbor above the Narrows is dangerous to health, and the oyster industry, already driven to the outer limits of the district, must soon be entirely given up."
- "The Passaic river, the Rahway river, the Bronx river, Gowanus and Newtown creeks, and the Harlem river have become little else than open sewers. Innumerable local nuisances exist along the waterfronts of New York and New Jersey where the sewage of the cities located about the harbor is discharged..."
- "Not only does the discharge of sewage now produce objectionable conditions near the points of outfall, but the water which flows in the main channels of the harbor above the Narrows and in the East and Hudson rivers is more polluted than considerations of public health and welfare should allow."

The Commission recommended that New York City's sewerage system be dramatically upgraded, and that effluent be diverted away from the near-shore slips and piers to a central diffuser in the Lower Bay. While reconstruction of the sewerage system eventually took place (including the construction of modern sewage treatment plants), the Commission's recommendation regarding a central outfall was never adopted.

Figure 5 summarizes the historic trends in urban sewerage. It wasn't until about 1960 that all urban areas within the drainage basin were sewered. Large cities, like New York City, constructed combined systems, handling both stormwater runoff and sewage. Since these systems allow raw sewage to bypass treatment plants during storm events, they have been in disfavor over the past 20 years and their areal extent has actually declined.

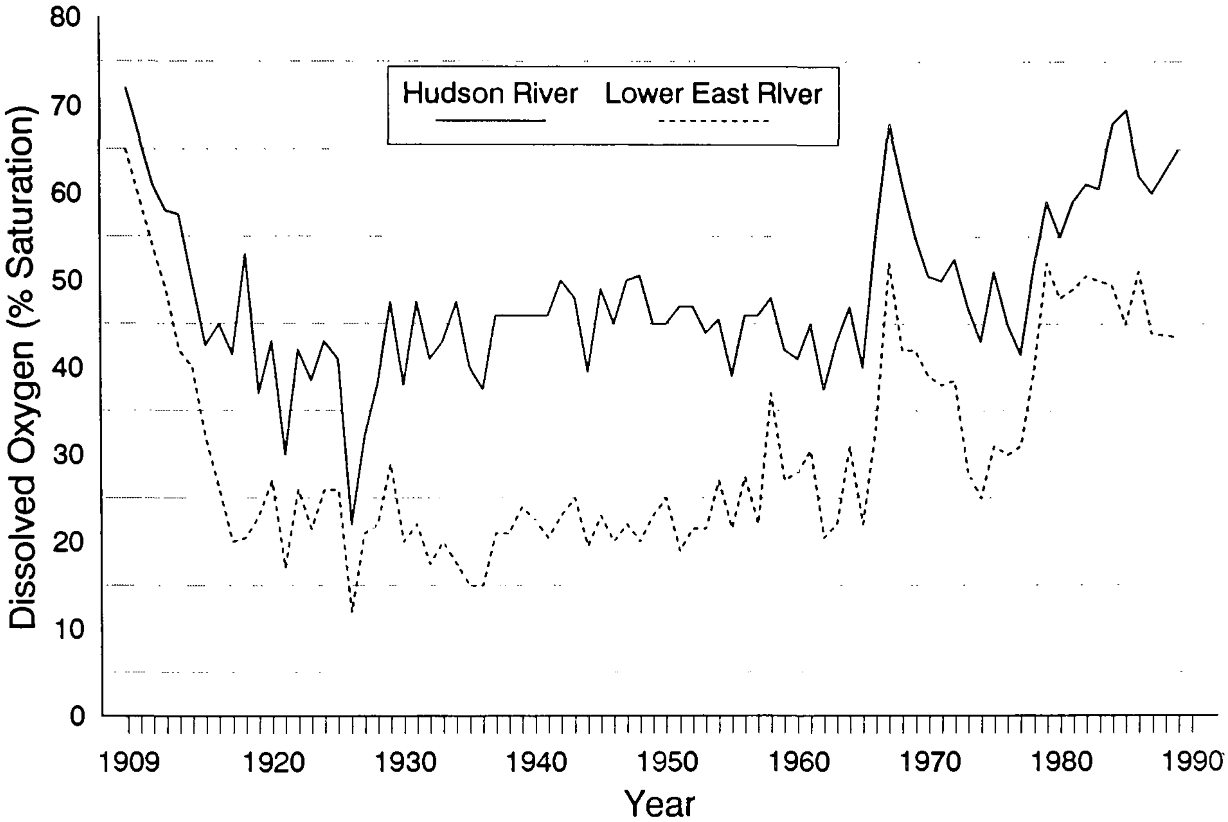
Dissolved Oxygen

Dissolved oxygen has been measured in the harbor since 1909. Figure 6 shows



Source: Rod et al. (1989)

Figure 5. Sewerage trends in the urban areas of the estuary's drainage basin.



Source: New York City Department of
Environmental Protection (1987 & 1990)

Figure 6. Tends in dissolved oxygen concentrations for the Hudson River and Lower East River.

long-term dissolved oxygen trends for the lower East River and the Hudson River adjacent to Manhattan. The East River concentrations are typically lower than the Hudson's because of the greater quantities of sewage that have historically been discharged there. The trends, however, are similar for both waterways. A decline in concentrations is evident from 1909 to approximately 1930. From about 1935 to the present, a general increase can be observed. This increasing trend follows the construction of modern sewage treatment works in the metropolitan area which began in the 1930's.

Figure 7 shows the relationship between dissolved oxygen concentrations and Biochemical Oxygen Demand (BOD) loadings from New York City. The loadings from 1909 to 1965 were calculated by first multiplying average water consumption rates taken from Citizens Union Foundation (1987) by an average BOD concentration for raw sewage of 150 mg/l. This estimate was considered reasonable after discussions with HydroQual, Inc. (1990) and New York City Department of Environmental Protection (1990). Radiloff (1972) provided historic estimates of BOD removal by New York City treatment plants. His estimates were subtracted from the calculated BOD loadings to obtain the loadings shown in Figure 7. For 1965-1989, estimates of BOD loadings from HydroQual, Inc. (1990) were used.

A strong relationship exists between BOD loading and dissolved oxygen concentrations for the East River. The data point for 1909 seems to represent the weakest relationship. This is consistent when one considers the amount of sewage that reached the river and how it was discharged. In 1909, much of Queens was not sewered (Loop, 1964). Consequently much the BOD loading never reached the East River, but was likely discharged into cesspools and privies, or to small streams and tributaries. In addition, much of the sewage which reached the river was discharged into basins, such as Newtown Creek and Gowanus Bay, and into the boat slips along the edge of the river. The measured dissolved oxygen levels reflect conditions in the main channel areas. Therefore, the 1909 calculated BOD load is thought to be a much higher amount than what actually reached the river. This coupled with the near-shore discharge of sewage seems to explain the apparent discrepancy in this part of the graph.

Metal Loadings

Rod et al. (1989) reconstructed historical loadings of a variety of trace metals to the estuary. Figure 7 shows estimated loadings of lead and copper. These trends which are also similar to other metals such as mercury and cadmium, show generally increasing loadings from 1880 through 1980. This follows the expansion of industry throughout the basin. Declines in loadings generally follow a decline in industrialization, changes in product uses, and environmental controls. Environmental control (i.e. the ban on lead in gasoline) is clearly evident in the decline in lead loadings between 1970 and 1980.

Habitat

Near-shore and wetlands habitats in the lower estuary have been greatly modified

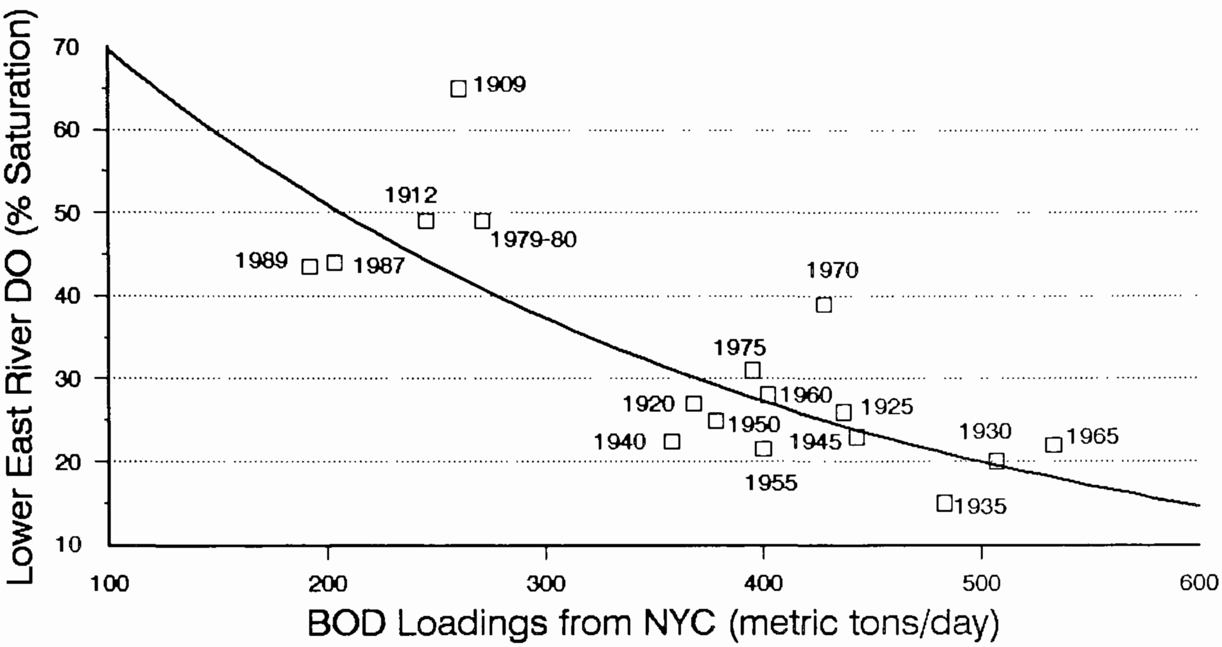


Figure 7. Relationship between BOD loadings and dissolved oxygen concentrations in the Lower East River. Data sources included New York City Department of Environmental Protection (1987 & 1990), Citizens Union Foundation (1987), HydroQual, Inc. (1990), and Radiloff (1972).

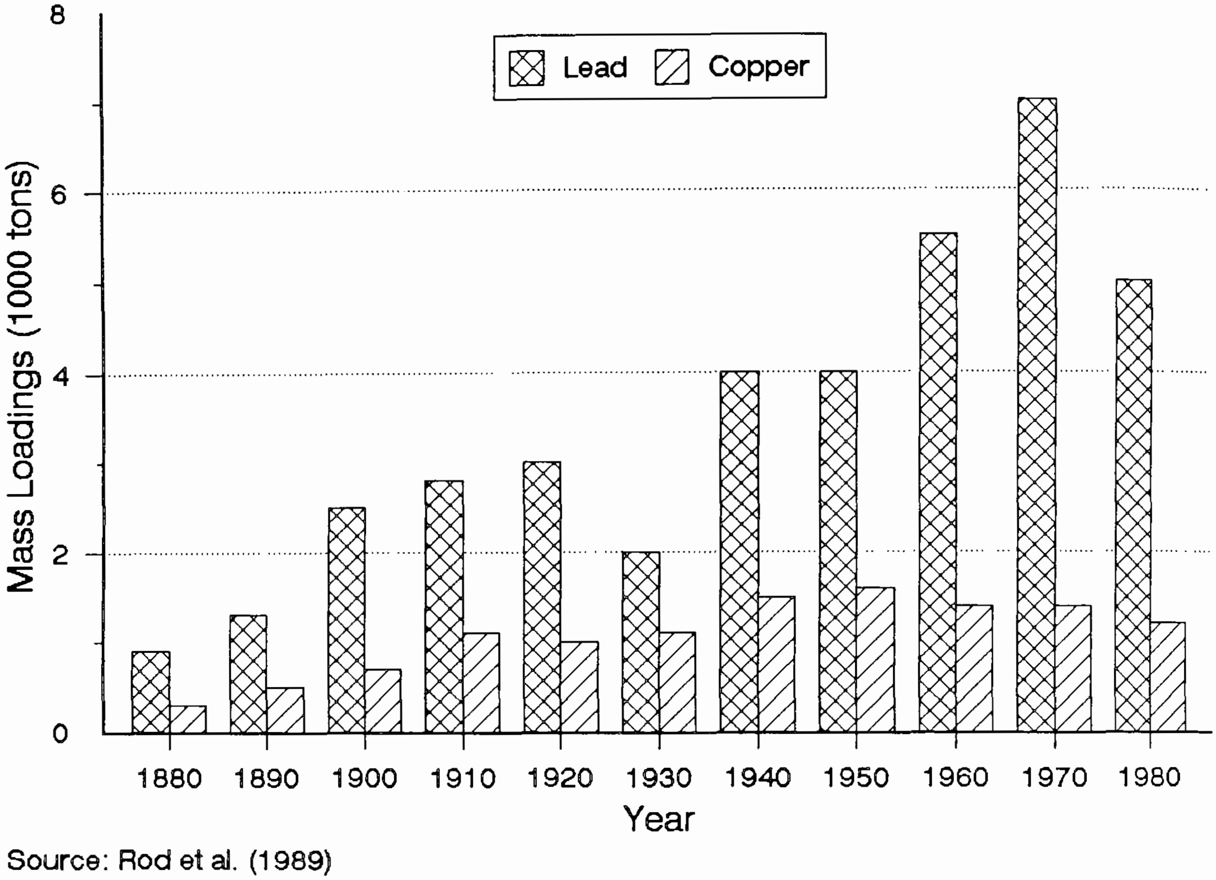


Figure 8. Reconstructed metal loadings to the estuary for lead and copper.

through filling to create new lands, dredging to provide deeper draft navigation channels and berthing areas, and dredged material disposal, particularly into wetlands. Figure 9 shows how the size of Newark Bay has been altered since 1855. Between 1886 and 1976, the bay has been reduced in size through shoreline modifications by over 33%. At the same time, the bay has increased in average depth from 2.0 m to 3.1 m due to channel excavations (Suszkowski, 1978). This general pattern of development is consistent with other areas of the estuary, however, filling along Manhattan started many years earlier. Major shoreline modifications have not occurred within the NY/NJ Harbor Estuary since the early 1970's, due to: (1) the application of new environmental laws to more stringently regulate these encroachments; (2) a changing and less favorable economic and social climate for massive projects; and (3) the fact that many *developable* near-shore areas have already been modified.

Fisheries

McHugh et al. (this volume) report that many estuarine fish species in the northeast have experienced significant declines during the 20th Century. The most probable hypotheses for the declines include overharvesting (principally by commercial fishing), toxic effects due to poor water quality, and habitat loss caused by anthropogenic modifications.

Summers et al. (1986) examined relationships between historical declines in fish abundance in the estuary and pollution variables (dissolved oxygen and BOD loading). They found positive correlations between abundance for four out of 24 stocks and dissolved oxygen concentrations. (See Table 1) In addition, they found a correlation between the oyster decline and increased BOD loadings to the estuary. In 1988, Limburg & Schmidt (in press) conducted a study of fish spawning in several tributaries to the Hudson River. The tributaries studied receive the runoff from 42% of the Hudson River's drainage basin. They found a strong statistical relationship between densities of fish eggs and larvae and urbanization in the drainage area. Basically, less fish were found in the urbanized stream basins. Both Summers et al. (1986) and Limburg & Schmidt (in press) have demonstrated that human activities are statistically correlated with fish abundance in the estuary. They provide added impetus to continue further investigations into the cause and effect relationships between human activity and fish abundance.

USE IMPAIRMENTS

Both human use and ecological impairments to the estuary are summarized in Table 2 using the same general format employed by the Waste Management Institute (1989) in their review of use impairments to the New York Bight. The causative factors and the extent of the impairments are listed along with an assessment of the economic impact and ecological significance. The assessments of economic and ecological impacts reflect the judgments (and prejudices) of the author and should be viewed as discussion points in connection with an overall evaluation of the significance of use impairments to societal and ecological values. Where a large degree of uncertainty is exists in evaluating significance, question marks (?) appear next to the assessment.

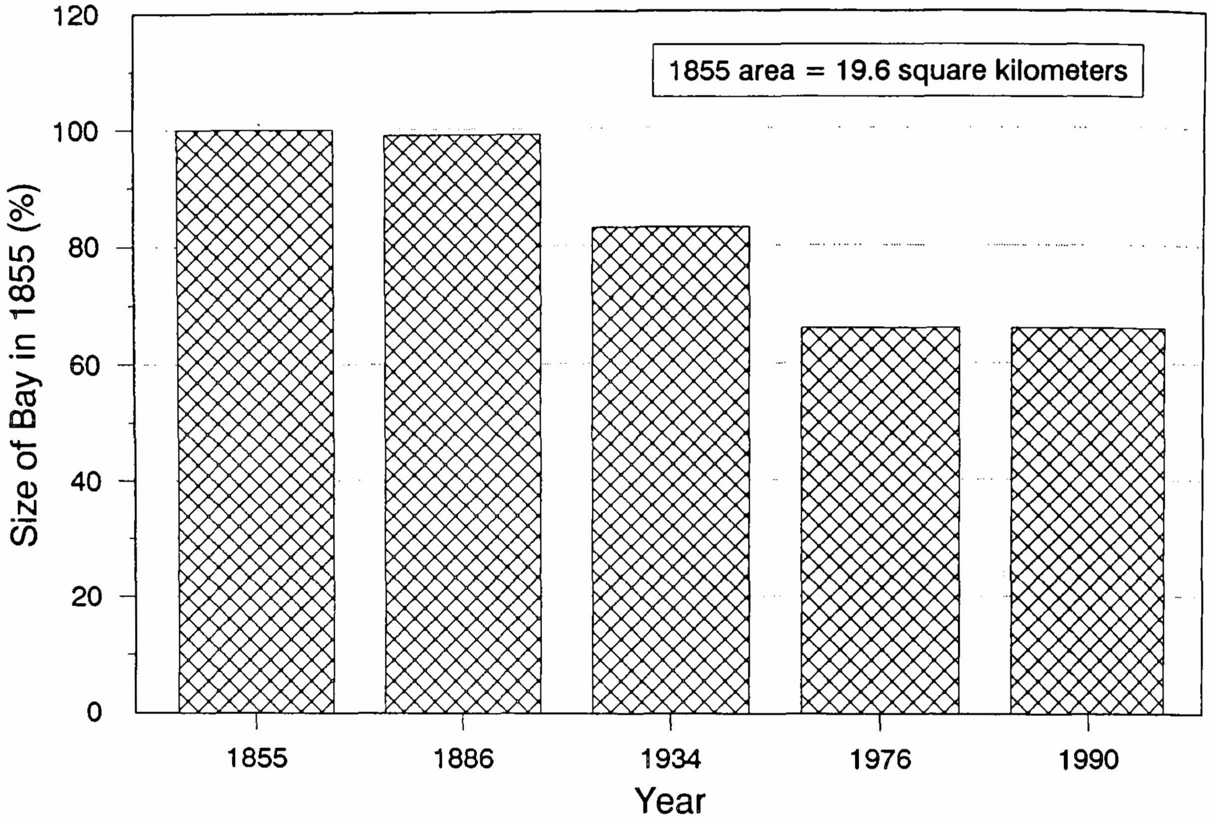


Figure 9. Historic changes in the size of Newark Bay, New Jersey.

	Dissolved Oxygen	BOD Loading
American shad	X	
bluefish	X	
oyster		X
lobster	X	
soft clam	X	

TABLE 1. CORRELATIONS REPORTED BY SUMMERS ET AL. (1986) BETWEEN FISH AND SHELLFISH ABUNDANCE AND POLLUTION VARIABLES.

TABLE 2. USE IMPAIRMENTS AND ECOLOGICAL IMPACTS IN THE NY/NJ HARBOR ESTUARY

	Factors Causing Impairment	Extent of Impairment	Economic Impact	Ecological Significance
BEACH CLOSURES	o Pathogens	Persistent closures in Keansburg, NJ & Staten Island	Local	Little
	o Floatables	Periodic closures in NYC & NJ	Regional	Little
	o Spills	Closures due to sewage spill in 1988	Regional	Little
UNSAFE SEAFOODS	o Toxicants	More than 18 major species affected	Regional	See Fisheries Section
	o Pathogens	Severe shellfish harvest restrictions in NY & NJ	Regional	Little
NAVIGATION	o Floatables	Periodic damage to vessels	Regional	Little
	o Toxicants	Dredging delays making Port less competitive	Regional/National?	Moderate
	o Floatable, sewage	Aesthetic impacts to recreational boating	Local/regional?	Little

TABLE 2. (cont.)

	Factor Causing Impact	Extent of Impact	Economic Impact	Ecological Significance
Commercial & Recreational Fisheries	o Toxicants	Disease: most adult tomcod develop liver cancer	Local?	Unknown
		Abundance & Distribution: oyster decline; declines in resource species linked to water quality	Regional?	Large?
	o Habitat Loss	Large loss of wetlands; loss of nearshore habitat througout Harbor	Regional?	Large?
	o Overharvesting	Stock declines?	Regional	Moderate/Large?
	o Hypoxia	Link between abundance and DO	Regional?	Moderate/Large?
Other Ecological Impairments	o Spills	Loss of wetlands, birds, and invertebrates - e.g. Arthur Kill	?	Moderate/Large?
	o Nutrient & Organic Enrichment	Overfertilization; changes in lower web; impacts to Bight	?	Moderate/Large?

Beach Closures

Within the NY/NJ Harbor Estuary, there are several areas that have and continue to be used as bathing beaches. In New Jersey, there are 9 public beaches located along Raritan and Sandy Hook Bays. The New Jersey Department of Environmental Protection monitors the quality of the bathing waters with the cooperation of county health officials. Beaches are closed if fecal coliform concentrations are greater than 200 fecal coliforms/100 ml in 2 successive measurements prior to weekends during the summer. In addition, if officials believe that the public's health may be endangered from the presence of floatables or algal blooms, they may close beaches a well. In 1989, beaches were closed 34 times; all due to pathogens (New Jersey Department of Environmental Protection, 1990a). One beach, Keansburg - Beachway, accounted for 28 of the 34 closures. No beaches were closed during the summer of 1989 due to floatables.

In New York City, bathing beaches are located along the Lower Bay at Coney Island and Staten Island, and in the Upper East River at Orchard Beach and the Bronx. The New York City Department of Health monitors water quality at these beaches during the summer months. Based upon their findings with to respect to total coliform counts, beaches are recommended for bathing or restricted in subsequent years. The criterion for closure is a consistent measurement of 2400 total coliforms/100ml at any given beach. In 1989, 2 beaches on Staten Island were restricted because of pathogen contamination (Ashendorf, 1990). In addition, one of the Staten Island beaches was closed in 1989 due to floatables, and others were closed in 1988 due to a spill of raw sewage.

The economic significance of beach closures is thought to have regional implications, but little ecological consequences. However, in the case of beaches which are closed on a routine basis (such as Keansburg), it is thought that these beaches have had diminished appeal for bathing for some time and consequently their periodic closure does not result in serious disruptions to beachgoers. Therefore, closure of these beaches was regarded as having a local economic impact.

Unsafe Seafoods

The consumption and sale of seafood products are regulated by both state governments in New York and New Jersey. With regard to toxics, more than 18 major species of fish and shellfish are currently being restricted for sale or consumption. Table 3 presents a summary of the various state restrictions by geographic reach of the estuary. In New Jersey, striped bass caught anywhere in the estuary cannot be sold commercially, while American eel has a ban on sale for catches within the Hudson River. Both of these species, along with an additional 3 (large bluefish, white perch, and white catfish) having consumption advisories, are restricted principally because of high concentrations of PCB in their flesh. Within Newark Bay, the Arthur Kill, the Kill Van Kull, and the lower Passaic River, a ban on sale along with a complete consumption prohibition on all fish and shellfish species is in effect due to the presence of dioxin.

TABLE 3. FISHERY RESTRICTIONS DUE TO TOXICS

	New Jersey Ban on Sale	New Jersey Consumption Prohibited	New Jersey Consumption Restricted	New York Ban on Sale	New York Consumption Prohibited	New York Consumption Restricted
(1) Entire Estuary (except East River & Harlem River)	striped bass	-	American eel large bluefish white perch white catfish striped bass	American eel striped bass white perch carp goldfish brown bullhead pumpkinseed white catfish black crappie	American eel white perch carp goldfish brown bullhead largemouth bass pumpkinseed white catfish striped bass walleye	black crappie rainbow smelt Atlantic needlefish northen pike tiger muskellunge bluefish blue crab
(2) Hudson River	American eel striped bass	-	same as (1)	same as (1)	same as (1)	same as (1)
(3) Newark Bay (incl. KVK, AK, & Passaic River)	striped bass blue crab American eel	striped bass blue crab	same as (1)	N/A	N/A	N/A
(4) Tidal Passaic River	all fish, shellfish, & crustaceans	all fish, shellfish, & crustaceans	N/A	N/A	N/A	N/A
(5) Harlem River & East River	N/A	N/A	N/A	same as (1)	American eel	-

Sources: New York State Dept. of Environmental Conservation (1990a & 1990b); New Jersey Dept. of Env. Protection (1990b)

In New York, nine species of fish and shellfish are banned from commercial sale, while an additional seven have either a consumption prohibition or restriction on intake. Twelve of these are resident finfish of the tidal freshwater portion of the estuary. PCB is the principal contaminant causing these restrictions.

The harvesting of clams from the estuary is severely restricted due to the presence of pathogens. Table 4 summarizes the restrictions for each state. Though the terminology is different, the effect is the same. All areas of the estuary are closed to shellfish harvesting, except the Lower Bay. There, special permits or designated areas can be used to harvest the shellfish and transplant them to safe locations. In New Jersey, clams have been transplanted in Barnegat Bay, while clams harvested in New York State waters have been relayed to areas in Long Island.

Unsafe seafoods are thought to have regional economic consequences, even beyond the species that are restricted. The public's fear of consuming unsafe seafood may affect the entire seafood industry within both states. The significance of pathogens in shellfish is thought to have little ecological significance.

Commercial & Recreational Fisheries

As stated above, fisheries in the estuary have experienced historic declines. The causative agents are unclear, however, possible culprits are overharvesting, toxicants, habitat loss and hypoxia. Several important commercial fisheries have been curtailed or completely eliminated including the striped bass, oyster, and clamming industries. The striped bass fishery is closed due to PCB. The oyster was decimated years ago, probably due to some form of pollution (Haskin, 1990), and the clamming industry has been curtailed due to bacterial contamination. At present, the commercial shad fishery is in danger of becoming economically unprofitable. While harvests in recent years have been good, shad fisherman have had the *misfortune* of catching large quantities of striped bass in their nets. Under normal circumstances the fisherman would be delighted since striped bass always was a prize catch. However, because the commercial striped bass fishery is closed because of PCB contamination, the bass must be returned to the river. The abundance of striped bass in the shad nets are requiring an enormous effort on the part of the fishermen to remove them. Consequently, the economics of continuing to fish for shad is becoming marginal.

Toxics discharged to the estuary may be contributing to fish disease. Cormier et al. (1989) have reported that the estuary is unique with respect to other U.S. estuaries in that 24% to 100% of the tomcod in the estuary develop liver cancer. The work by Cormier et al. (1989) suggests that estuary water contains a causative agent for tumorigenesis. The ecological significance of this and other possible diseases (e.g. shell disease in crustaceans) is currently unknown.

Since a variety of fish and shellfish species have undergone declines during the past century, this impact is considered to be of large ecological significance. Since none of

TABLE 4. SHELLFISHING RESTRICTIONS DUE TO PATHOGENS

	New York	New Jersey
Lower Bay & Raritan Bay	Non-Certified (but can get special permit to harvest transplants)	(1) Condemned areas (2) Special area to haravest transplants
Rest of Harbor	Non-certified	Condemned

Source: New York State Dept. of Env. Conservation (1990c)
New Jersey Dept. of Env. Protection (1989)

the potential causative agents have been definitively linked to the declines, the assessments contained in Table 3 all contain question marks.

Navigation

Commercial navigation has been impacted over the years due directly to floatables and indirectly to toxicants. Floating debris from dilapidated piers and derelict vessels have been a serious nuisance, requiring large efforts on the part of the U.S. Army Corps of Engineers (Corps) to conduct daily collections of debris. In addition, The Corps has also undertaken a massive cleanup project to remove the sources of drift along the shorelines of New York Harbor.

Dredging and dredged material disposal activities have been under scrutiny for several years because of the presence of toxic compounds in the dredged sediments and their potential harmful effects upon open water disposal in the New York Bight. While dredging operations have continued in the Port, there has been considerable uncertainty in the ability of the Corps and port users to obtain timely dredging and disposal permits. This uncertainty is causing the shipping community to continually reassess its use of the Port of New York & New Jersey. While the Port is constantly in a struggle for a competitive edge with other ports, the uncertainties in obtaining permits is affecting whatever edge the Port may have. Consequently, the impact of toxics may be having both a regional and national economic impact.

Other Ecological Impairments

The recent oil spills in the Arthur Kill have indicated that the estuary can suffer ecological damage due to spills. In particular, several species of herons which in recent years have established nesting colonies, are potentially at risk. An evaluation of the long term effects of the recent spills awaits further study and evaluation.

The massive discharges of nutrients and organic matter have certainly affected the carbon cycle in the lower estuary. The implications of alterations to the carbon cycle are not well understood. Is sewage-related organic matter being incorporated into food web? Is sewage being converted into fish production? Has sewage pollution changed the composition of the lower food web and caused changes to the higher trophic levels? These are interesting questions whose answers require a much more extensive knowledge of the estuary and its functions than we now have. They should not be overlooked in long term planning efforts.

SUMMARY: THEN AND NOW

Table 5 contains qualitative judgments regarding whether conditions in the estuary are better or worse than those in 1900 and 1970, respectively. The rationale for choosing these two time periods is to: (1) reflect the long-term trends that are evident throughout this century; and (2) to document any trends that are evident since the enactment of

	Since 1900	Since 1970
Toxics	Worse	Better
Organic Enrichment	Different	Better
Habitat Loss	Much better	Marginally Better
Floatables	Much better	Better
Living Resources	Worse	?
Pathogens	Better	Better

TABLE 5. COMPARISON OF CONDITIONS IN THE ESTUARY IN 1900 AND 1980 TO 1990.

major environmental legislation, primarily the Clean Water Act in 1972.

Toxics

Regarding toxics, conditions are clearly worse than in 1900. With continued industrialization, more inorganic and organic compounds have been discharged to the estuary. Since 1970, lesser quantities of toxic metals and organics are being discharged to the estuary principally because of reduced industrialization and environmental controls. Conditions are considered to be better today than in 1970 because of reduced loadings, however, this does not imply that the residual amounts of contaminants that are found in estuarine sediments and within the drainage basin are any less a cause for concern than in 1970. In fact, there may be more *stored* contaminants today than in 1970.

Organic Enrichment

In 1900, there were similar total BOD loadings to the present. However, the quality of the sewage effluents and the distribution of the discharges were clearly different. For instance, there was no treatment of wastewater at the turn of the century. In addition, the discharges of sewage were in near-shore locations. At present, virtually all sewage is treated and the effluent pipes are located at the pierhead line. There are, however, CSO discharges which occur at the bulkhead line. In 1970, more than 25% of the sewage entering the lower estuary was untreated. The overall sewerage system in the metropolitan area is certainly superior to that of 1900, but the quantities of sewage have dramatically increased due to an expanding population. Sewage treatment has resulted in dissolved oxygen improvements since 1935. At present, there is considerably less BOD loading to the estuary than in 1970.

Habitat Loss

Large acreages of near-shore and wetland habitats were eliminated by a variety of development projects from the 1800's to approximately 1970. Since 1970, little loss of habitat has occurred.

Floatables

The discharge of refuse, street sweepings, and raw sewage into estuarine waters was a common practice at the turn of century. Sanitation practices have drastically improved since then. With increasing concern about floatables in relation to beach closures and navigation impairments, increasing controls in handling refuse (e.g. at Fresh Kills landfill), the better enforcement of illegal dumping, and the harbor drift collection of the Corps of Engineers have brought about improvements since 1970.

Living Resources

There have been declines in a variety of estuarine fisheries since 1900. The apparent causes seem to be overharvesting, pollution, and habitat loss. The natural fluctuations inherent in fish stocks and the lack of quantitative abundance information for most fish species make it impossible to judge the overall condition of living resources today in relation to 1970. However, for at least one species, Heimbuch et al. (in press) report that striped bass have shown a 7.9% annual increase in stock size since 1974 in the Hudson River.

Pathogens

The New York City Department of Environmental Protection (1987) has documented decreasing concentrations of coliform bacteria in harbor waters during the last decade. This appears to be correlated with upgrading of sewage treatment and increased chlorination. If the coliforms are indicative of other pathogens, then certainly conditions have improved since 1970. Though bacteria measurements were made in the harbor as early as 1909, the differing methodologies make long-term comparisons impossible. What is significant, however, is the awareness of the public health implications of improper sewage disposal, and the steps taken by health officials to reduce the exposure of the public to pathogens in harbor waters. At the turn of the century, floating bathing establishments surrounded Manhattan. The Metropolitan Sewerage Commission (1910) pointed out that it was not unusual for sewage-related materials to drift into these bathing areas. Over the years numerous steps have been taken to restrict bathing, discourage the use of sewage-covered driftwood as fuel in homes, and restrict the consumption of contaminated shellfish.

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USE IMPAIRMENTS AND ECOSYSTEM IMPACTS OF THE NEW YORK BIGHT

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INTRODUCTION

East of New Jersey and south of Long Island, the continental shelf spreads into the rolling sand plain of the New York Bight. The floor of the Bight slopes -- about 30 meters in a hundred kilometers -- toward the edge of the shelf from an apex at the mouth of the Hudson River (Figure 1). A wide, shallow valley, cut by the Hudson River during the last ice age, crosses the shelf and terminates in the Hudson Canyon. Bight waters which cover this section of the continental shelf are subjected to external forces and processes that in many ways control the consequences of anthropogenic interactions with this marine ecosystem. Driving forces such as the northwestern Atlantic circulation, meteoro-logical and climatological conditions, and the influence of the Hudson-Raritan Estuary and back bays of New York and New Jersey are among the most dominant.

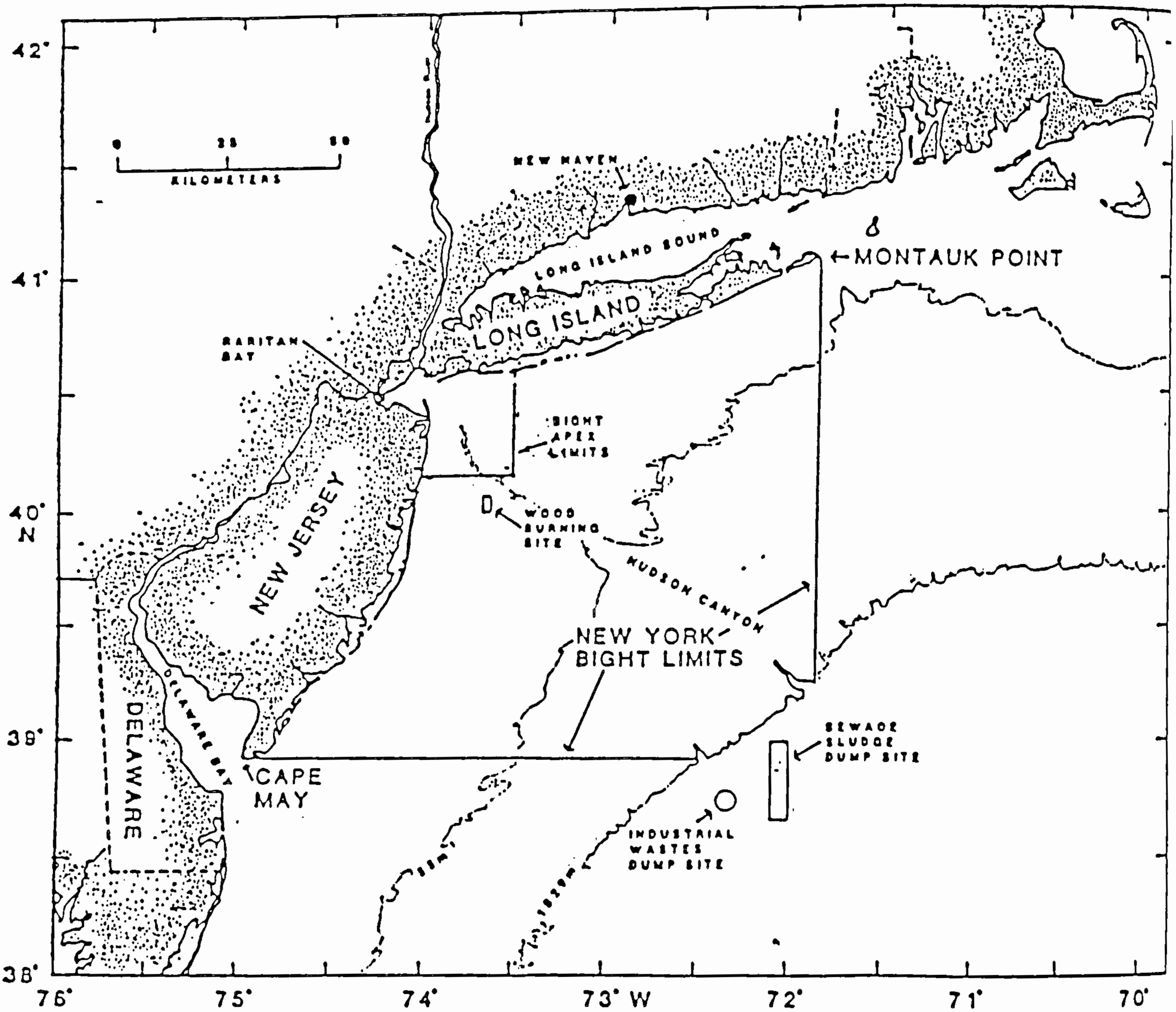

Figure 1. New York Bight and approaches.

The Bight is perhaps one of the most used and abused coastal areas in the world as a consequence of urbanization and the disposal of the waste of some 20 million people who reside by its shores and surrounding bays and estuaries. A variety of sources, including those associated with sewage wastes, industrial wastes, contaminated dredged material, urban runoff, and atmospheric fallout contaminate these coastal waters. These sources discharge wastes indirectly to the Bight via the inflowing Hudson-Raritan Estuary and coastal inlets, as well as directly from coastal runoff and sewage outfalls. Much of the area's municipal wastes have been taken by barge out into the Bight for nearly a century. Legal dumping of garbage and trash ceased in 1934 but, as late as 1987, some 8.4 million wet tons of sewage sludge and 6 million cubic yards of contaminated dredged material were dumped into the ocean waters 10 to 180 km offshore[1] (Figure 2).

Still the Bight provides important resources for its millions of users. There are offshore fisheries in these waters, and wildlife inhabit the less populated shores. The Gateway National Recreation Area borders the Bight and provides marine recreational opportunities in a relatively natural environment. The Bight is a major sea lane for marine commerce, and its resources include sand and gravel and perhaps other untapped resources.

In order to conserve and hopefully rehabilitate the Bight, it is important to understand ecological processes in the Bight and the impact of anthropogenic activities on the marine ecosystem. To acquire and allocate resources for rehabilitation, it is useful to understand impacts in terms of economic costs and benefits. Many of the stresses of excess population and industrialization as measured by pollutant loadings and ecosystem impacts can be specified in terms of use impairments use impairments that have measurable social and economic relevance.

Five broad categories of impairment attributed to pollution in the Bight that are causing significant losses of ecological, economic, or social values are: beach closures, unsafe seafoods, hazards to commercial and recreational navigation, losses of commercial and recreational fisheries, and possible impacts on some marine animals. These impairments are generally caused by floatable wastes, nutrient loading, toxicants, pathogens, and loss of habitat. Measures of such impairments are not standard, nor in many cases, totally quantifiable. We have examined specific subsets of these impairments (Table 1) in terms of their spatialand temporal changes, when available, and as a first approximation determined the economic and social significance of these changes.

In some cases, there may be overlap when an impairment is caused by more than one agent. For some of the impairments, the causal agent may have an indirect effect on the resource. For example, human health may be threatened by toxicants via eating contaminated fish. The direct effect of the toxicant may jeopardize the health of the fish (lower reproductive capacity), while the indirect effect is on public health.

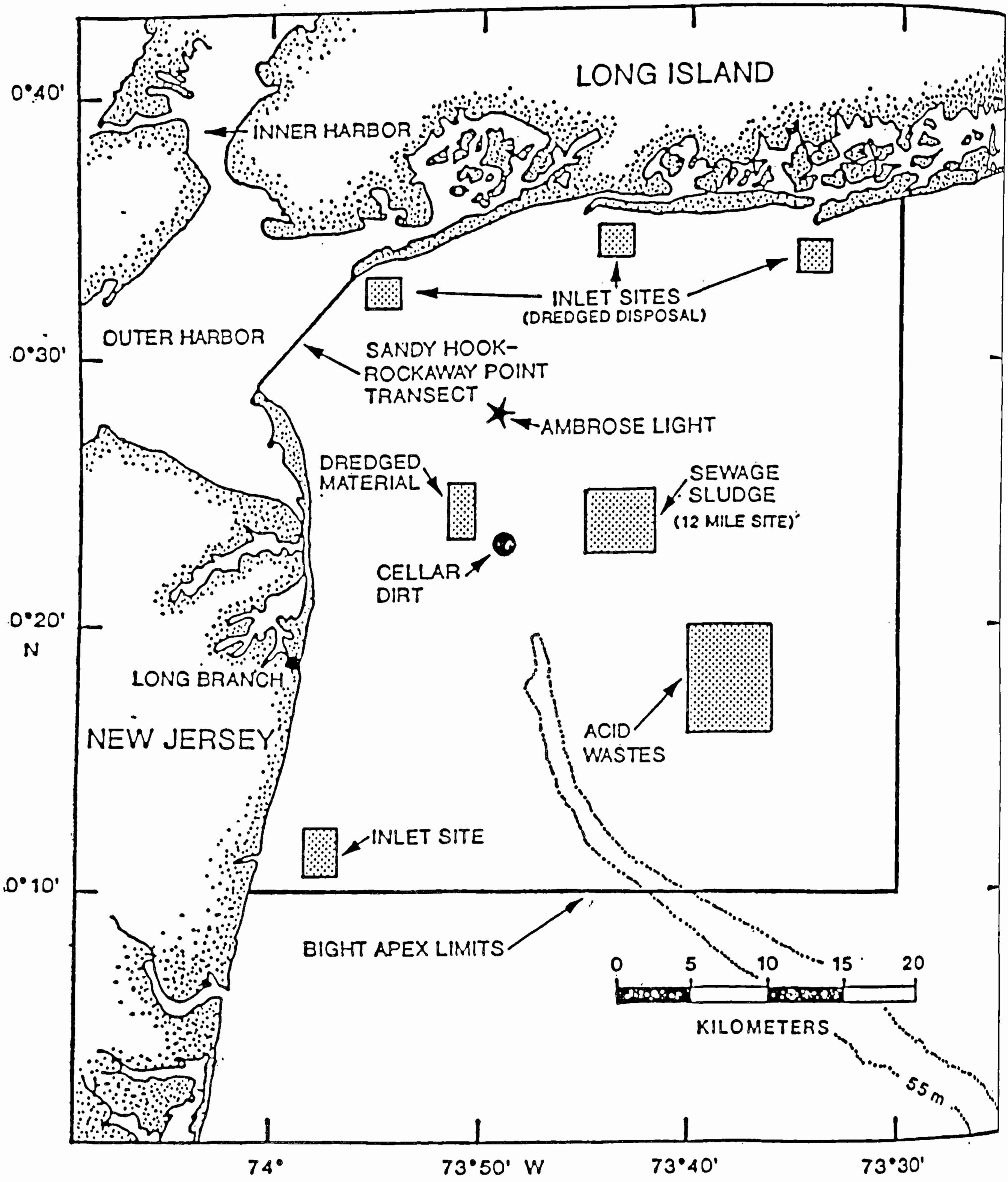

Figure 2. New York Bight apex and disposal sites.

TABLE 1. USE IMPAIRMENTS AND ADVERSE ECOSYSTEM IMPACTS

Use Impairment	Measures ofImpairment
Beach Closures	Pathogen Contamination Washup of Floatable Waste Algae Washups
Unsafe Seafoods	Toxicants in Marine Foods Pathogen Contamination
Commercial Navigation and Recreational Boating	Floatable Hazards and Noxious Water Quality Features
Ecosystem Health and Productivity Impacts	
Commercial and Recreational Fisheries	
	Disease Distribution and Abundance Fish Kills
Birds, Mammals, and Turtles	Habitat Loss Human use Conflicts Toxicants Floatable Wastes

METHODS

Beach Closures

The economic consequences of beach impairments from algae, pathogens, and floatables are based on beach use which can be measured in user days; however, there is no single or comprehensive source from which these data can be derived.[2] The extent to which beach use has decreased at New York beaches as a result of pollution can be approximated by comparing beach attendance in 1976 (60 million user days) with either the baseline attendance figure (105 million) or attendance in peak years (150 million). Alternatively, for an extremely conservative assessment of the reductions in beach usage, one could assume that the 1976 level was the baseline, and measure a 25% to 50% reduction in use from that level. This reduction is based on reports of the effects of 1988 waste washups on beach attendance. Using these assumptions, the reduction in beach use would be between 30 and 90 million user days in New York State. Comparable figures for New Jersey would be 6.7 to 37 million user days (based on an observed decline in beach attendance of 7.9% to 34% at beaches along the New Jersey shore in 1987-1988).

A beach pollution event has three major economic impacts. First, there is a reduced level of expenditures[3] on beach activity, which has negative effects in many sectors of the economy. Second, there are impacts on employment. Third, the people who use the beaches suffer a lower quality of life because of diminished recreational opportunities. The measures of the first two impacts are apparent to the non-economist. The third, measured by consumers' surplus, is not considered in this analysis.

Beach closures due to pathogens, while not appearing to have economic consequences as large as those due to floatables, do have significant economic impacts. Beach attendance was again used to measure the impacts. Specifically, the average yearly attendance at New York State Park beaches in the 1970s (excepting 1976, a year of pronounced floatable washups) was computed and compared to average attendance in the 1980s (excepting 1987 and 1988, characterized by high incidence of floatable washups). The averaging process evened out the effects of weather on beach attendance, and it was assumed that the remainder of the difference was due to pathogens (or possibly other forms of chronic pollution).

The assignment of economic values is similar to those described above for floatables. Since comparable figures were not available for New Jersey, these values were assumed to be proportionate to the New York values. Estimates were based on the ratio of floatable impacts to pathogen impacts being the same for New York and New Jersey.

Unsafe Seafoods

In addition to the effect on human health in those small segments of the population who are subsistence fishermen and who disregard health advisories against consuming contaminated seafood, there are losses in economic benefits associated with reduced activity in the recreational and commercial fisheries. Recreational fishing, after beach use, involves the most people using the New York Bight. Roughly 2.5 million anglers (National Oceanic and Atmospheric Administration 1980; Kahn, 1986, unpublished), for New York and New Jersey combined, derive enjoyment from recreational fishing and inject roughly $2 million yearly of direct expenditures into the region's economy (Kahn, 1986, unpublished).

There was a significant reaction by recreational fishermen to the recent medically related waste washups. The washups may have exacerbated existing negative reactions as the washups came shortly after the considerable media coverage of the following events: closure of the New York striped bass fishery, the issuance of a New Jersey bluefish health advisory, and the unexplained deaths and washups of dolphins and whales. This intense media coverage created the impression that the fish are simply too contaminated to eat. Much of our information is based on informal survey data following the 1988 fishing season.

The economic multipliers or ripple effects for both the recreational and commercial fishery are estimated to be between 2 and 3. The impact of toxicants on commercial fishing markets was based on the catch of a prohibited species and the downward shift in demand that could have had effects on price and quantity of landings.

It is difficult to measure employment impacts in the commercial fishing industry that result from a reduction in demand since there are many part-time fishermen in the industry. Shocks of this nature usually affect the part-time fishermen first. It is also difficult to measure impacts on employment in the shellfishing industry as a result of closure of shellfish beds. Closures have been a problem for decades, so there are not the sudden and unexpected impacts that have characterized recreational fishing and beach use.

Still other important economic impacts are associated with the closure of shellfish beds and with pathogen contamination in general. Approximately 32% of the shellfish beds that once existed in the Bight and Hudson-Raritan Estuary are closed. The first costs are those associated with the lost potential production which could take place if the beds were open. Second are the costs associated with the human ingestion of pathogens, either from consumption of shellfish from beds that are contaminated but not yet closed, or from the consumption from illegal beds. The third group of costs are those associated with enforcing closures. Finally, there are the lost economic benefits from declining demand for shellfish because people are afraid of ingesting pathogens. Our estimates were based primarily on lost potential production.

Commercial/Recreational Navigation

Our measures of costs of floatable hazards to commercial and recreational boating were limited to the costs of damage due to collision with floating objects and costs to remove floating hazards from waterways. They do not measure the economic damages generated from reduced aesthetic quality of the recreational boating experience.

Commercial/Recreational Fisheries

Changes in both abundance and distribution of fish may have important impacts on the economy. The commercial catch has declined over time as has catch per unit effort. It is assumed that the recreational catch per unit effort has declined as well. One must use caution when discussing catch per unit effort in recreational fishing because the effort is the source of enjoyment. However, studies by Buerger and Kahn (1989) show that catch rates are an important determinant of the demand for recreational fishing.

If the demand declines as a result of the reduction in catch rates, then both the value to the anglers and the number of trips (and expenditures) will decline. Buerger and Kahn (1989) showed that the decline in striped bass populations resulted in a loss of economic benefits of $2 to $8 million alone. Changes in distribution of fish will also increase the cost to anglers, lowering their number of trips and reducing their catch rates, which will further reduce their trips.

It was not possible to approximate the economic losses associated with changes in abundance and distribution in recreational fishing due to pollution. It is difficult to determine how much of the decline in abundance and distribution was due to overfishing and how much was due to pollution. It is probably safe to assume that the effect of pollution was greater for estuarine and anadromous species than for offshore marine species. It could also be argued that the estuarine and anadromous species were subject to more fishing pressure than offshore species, particularly with respect to the recreational catch. Since the data do not exist to estimate this relationship properly, we have assumed that for every 1% increase in recreational fishing activity, direct expenditures would increase by $20 million, total expenditures by $40 million to $50 million, net economic benefits by $10 million, and employment by roughly 900 jobs. It is possible that the recreational fishing benefits of reducing pollution and increasing fish abundance could be negated if the response of commercial fishing to the increased stock is an increase in fishing effort which would result in lower stocks.

The above analysis for recreational fishing can be extended to commercial fishing. Fish kills and fish disease are likely to have small negative impacts on the economic benefits derived from commercial fishing, with the exception of shellfish. Given that the total value of landings for shellfish in New Jersey and New York is approximately $70 million, it appears that the annual damages for a shellfish kill of large magnitude could approximate this amount.

Stock reductions from overfishing are likely to have a significant impact on the fishery, but the stock reduction from pollution could not be inferred from existing data. However, for each one percent increase in commercial fishing activity, direct expenditures would increase by $1.2 million dollars, total expenditures by $2.4 million to $3.6 million and net economic benefits by $1.2 million. Employment impacts are difficult to determine due to the presence of part-timers in the industry.

As with recreational fishing benefits, the commercial fishing benefits of reducing pollution will be dissipated if the response to less pollution is more intense fishing, which ultimately reduces stocks and catch. It is essential that fishery management policy be coordinated with environmental policy to avoid this.

Birds, Mammals, and Turtles

Marine mammals and turtles are not commercially and recreationally exploited. However, marine birds, such as ducks and geese, are hunted in some cases. Economic impacts of impaired uses were therefore difficult to quantify. Some estimates might have been made by examining sales receipts from whale watching excursions, visitations to wildlife refuges, and memberships in wildlife clubs. Although assigning a value to these resources is difficult, birds, turtles, and mammals are nonetheless aesthetically and ecologically important.

Three levels of impairments need to be examined. At the lowest level are impairments that reduce the regional population of a species. The second level is the endangerment (or extinction) of a species in the region. At the third level, regional endangerment (or extinction) leads to global endangerment (or extinction in the wild). For most species in the New York Bight area, the first and second levels are the most relevant.

Since the reduction in habitat for certain endangered birds and sea turtles may have a critical effect on their reproduction (birds) or development (turtles), continued loss of habitat in addition to anthropogenic mortality in the New York Bight region may threaten their existence. Fisher and Krutilla (1985) docu-mented the economic importance of preventing species extinction. They also demonstrated that when faced with an irreversible en-vironmental change such as the loss of critical habitat or ex-tinction of a species, one should avoid these irreversible con-sequences even if the immediate costs of doing so seem to exceed the benefits.

The reduction in abundance of these animals leads to social losses in a variety of ways. First, the sighting of these animals leads to increased enjoyment during a variety of other activities. For example, the highlight of a recreational fishing trip might not be the fish the angler catches, but the sighting of a whale, eagle, or osprey. Large nesting populations of birds add enjoyment to beach trips. Second, the existence of healthy numbers of these species is taken by many people as an important indicator of the quality of the environment and the quality of life. When individual or large numbers of organisms die from oil spills, entanglement or other anthropogenic causes, people hold themselves responsible as members of a society that allowed the tragedy to take place.

The importance of marine mammals in this regard cannot be understated. Many members of society feel a warmth towards marine mammals that does not extend to other members of the animal kingdom. This may be because of the superior intelligence of these animals, their size, grace or other factors. The source of this enchantment is not as important as its existence, and there is ample evidence to suggest that it exists. Such evidence includes the widespread contributions to the "Save the Whales" campaign, the passage of the Marine Mammal Protection Act, the attention given to the washup of dead porpoises in the Mid Atlantic Bight area, and the $5.8 million international effort (Rose, 1989) to save three California Gray whales trapped in Arctic ice. It is beyond the scope of this report, however, to conduct these analyses.

While it is difficult to quantify the losses from pollution-induced reductions in populations of birds, marine mammals, and sea turtles, the losses do exist and are important. In any overall comparisons of the costs and benefits of reducing pollution in the New York Bight, these values should not be ignored.

USE IMPAIRMENTS

Beach Closures - Pathogenic Contamination

Particular pathogenic bacteria and viruses excreted by man can cause gastrointestinal tract diseases: typhoid, paratyphoid, dysentery, diarrhea, cholera, polio, and hepatitis. Beach closures in the Bight are not based on the presence of the actual pathogens, a determination that is costly and slow. Closures are based instead on the presence of total and fecal coliform bacteria -- presumptive evidence that pathogens are present. Since Escherichia coli is an intestinal bacterium, its presence in a water sample suggests fecal contamination.

The criteria for beach closures based on coliform concentrations are different for the states of New York and New Jersey. The differences in the standards for the two states may account for some of the discrepancy in numbers of beach closings in New Jersey (more restrictive in recent years) versus those in New York. Despite these differences it is likely that fewer ocean beaches closed in New York because there are fewer sources of fecal coliform in inshore waters -- fewer storm sewers and only two sewage treatment plant outfalls along the coast.

Areal Extent

In New Jersey, between 1985-1988, there were 86 ocean beach closures. In the 1980s there were approximately 100 beach closures in each state due to pathogens. Closures occurred in all the coastal counties, although the greatest impacts cover the 45 km of beaches from Sandy Hook to Manasquan (Table 2).

The periods of closures have generally been on the order of days with several instances of closures in excess of a month. Information for beach closings in New York due to high coliform counts was lacking for years prior to 1987. In 1987, no ocean beaches in New York were closed due to pathogens, but one ocean beach (Quoque) was closed in 1988.

Causes of Impairment

Certain pathogenic bacteria and viruses excreted by man may be contained in the greater than two billion gallons of wastewater (secondary treatment), 400 million gallons of wastewater (primary treatment) and 18 million gallons of untreated effluent that are delivered to New York harbor daily (HydroQual, 1989). Storm water via CSO's also delivers raw effluent to the Harbor. A portion of this water mixes with the water at various New York and New Jersey beaches.

TABLE 2. SUMMARY OF 1985-1988 NEW JERSEY BEACH CLOSINGS DUE TO PATHOGEN-INDICATED CONTAMINATION

New Jersey County Beaches	Period Beaches Closed 1985	1986	1987	1988
Atlantic County:				
- Atlantic City Beach	?*	None	6	None
Burlington County	None	None	None	None
Cape May County:	6/85-8/85 location unknown			
No. Wildwood..................)		1	1	
Wildwood......................)	7 days	-		
Wildwood Crest................)		^@		
Lower Township		1		
Cape May City			1	-
Ocean City			-	5
Monmouth County:				
Army Recreational Beach........)				
Sandy Hook.....................)				
Asbury Park....................)	?*			17
Ocean Grove....................)				15
Bradley Beach				9
Avon				9
Belmar				2
Monmouth Beach		?		
Long Branch		7/21 to	?	
Loch Arbour		end of season	1	
Ocean County:				
Ortley North Beach	2			
Ortley South Beach	2	None		
Barnegat high tidal A&B	5			
Seaside Heights			4	1
Island Beach State Park	None	None	2	None
Total No. Days	~75	~35	~15	58

*Fecal coliform levels exceeded 50/100mL water sample, but beach closure cannot be directly determined. Beaches have been closed without preliminary or confirmatory samples when water quality problems were assumed.

Problems Associated with the Impairment

Certain pathogens may cause gastrointestinal tract diseases and testing for the presence of actual pathogens is costly and slow. However, based on the few incidents of disease outbreaks reported, the public has been well protected over the years, a measure of the effectiveness of the standard. Although chlorination and other treatments may kill off most of the fecal coliforms, other problem organisms such as viruses may survive the treatments. Fecal coliform standards alone may give a false sense of public health status.

Economic and Social Impacts

The most significant social impacts of beach closures due to pathogens are the lost opportunities to recreate. The major economic loss for New Jersey in 1988, estimated at $390 million, was from decreased revenues resulting from actual beach closures, although the general public's perception that beaches are unhealthy resulted in decreased beach use. In New York the economic loss was approximately $200 million (Table 3). New Jersey's user days also decreased by eight million during 1987 as a result of coliform-caused closures.

For New York, there were no beach closures due to coliforms, although the general perception that beaches and water quality were poor apparently culminated in decreased beach use. New York's user days in 1987 decreased by 20 million.

Beach Closures - Washup of Floatable Waste

Floatable wastes are waterborne materials and debris that are buoyant. These include debris (wood and beach litter such as cans, bottles, styrofoam cups, sheet plastic, balloons, straws, and paper products); sewage-related wastes (condoms, sanitary napkins, tampon applicators, diaper liners, grease balls, tar balls, and fecal material); fishing gear (nets, floats, traps, lines); and medically related wastes (hypodermic needles, syringes, bandages, red bags, enema bottles).

Areal Extent

In the period 1980-1988, there were on the order of 100 beach closures around the New York Bight due to floatable wastes. Until 1989, the criteria for closing beaches because of floatable wastes were not consistent from beach to beach. Water quality (as measured by the coliform indicator) has generally not been a factor in closing beaches during a floatable washup. Rather, closures have depended on subjective criteria such as the look or smell of the material or on expectations of public perception -- to avoid a possible public outcry.

TABLE 3. USE IMPAIRMENTS - BEACH CLOSURES

Use Impairments	Factors Causing Impairment	Ecological Significance of Impairment	Spatial and Temporal Extent of Impairment	Economic Impact
Beach Closures				
• Pathogens	Pathogens	little	approx. 100 beach closures in 1980s in each state	$590 million
• Floatables	Floatables	little	up to 100 km closed at one time over short periods of time in each state	$1.0-5.4 billion
• Algae	Nutrients	little	limited	small

Most closures occurred for hours -- rarely more than a day. More consistent beach closure guidelines by local and state agencies are now in use (Marine Sciences Research Center, 1984).

In New Jersey, the area closed on numerous occasions during May 1987 due to floatables included 40 km of beaches; in August 1987, the area closed comprised 80 km of beaches (Figure 3). Few beaches were closed because of floatable wastes in 1988. In New York in 1976, sewage-related floatable wastes were responsible for closing 93 km of beaches. There were 2.4 km of beaches closed in 1987; and in July, 1988, 93 km of beaches were closed due to medically related and other floatable wastes (Figure 4).

Temporal Changes

From the late 1800s through the 1930s, garbage, paper, bottles, metal, and dead animals were discarded into New York Bight and New York harbor waters. During the 1940s-1950s, the floatables problem was probably held somewhat in check with the end of refuse dumping at sea and introduction of sewage treatment plants. During the 1960s and 1970s, styrofoam cups, disposable plastic diapers, plastic tampon applicators and PET (polyethylene teraphthalate bottles increased the floatables load, and in 1987 and 1988, some medically related wastes were found with the typical floatables.

Causes of Impairment

The majority of floatable wastes are located along the periphery of the Hudson-Raritan Estuary, and much of these wastes are flushed out into the Bight during the spring freshet (Swanson and Zimmer, 1990). The intensity of the freshet dictates the size and distribution of the summertime floatable load. The peak of floatable waste input from the freshet is at or near the start of the beach season.

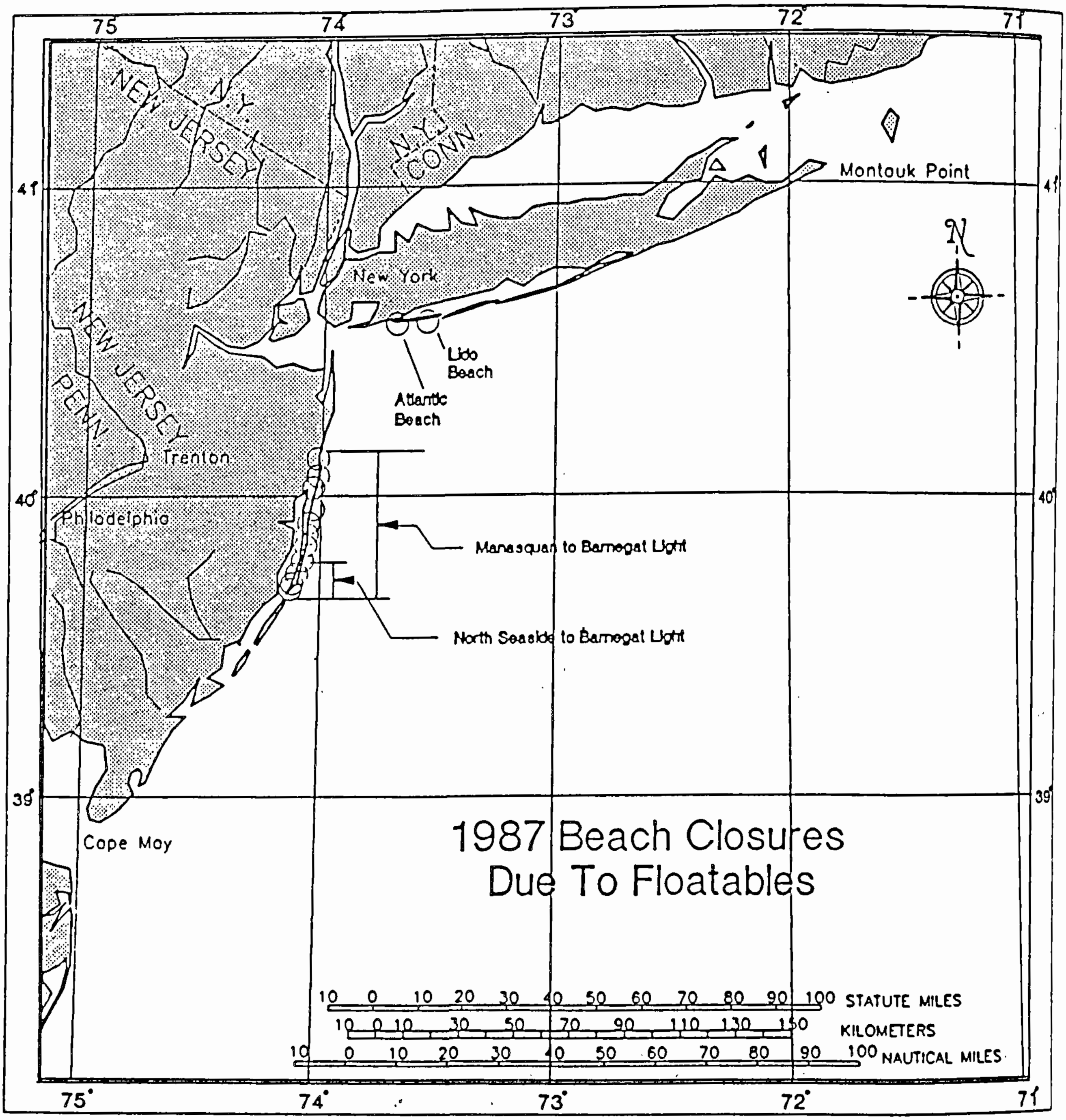

Figure 3. 1987 beach closures due to floatables.

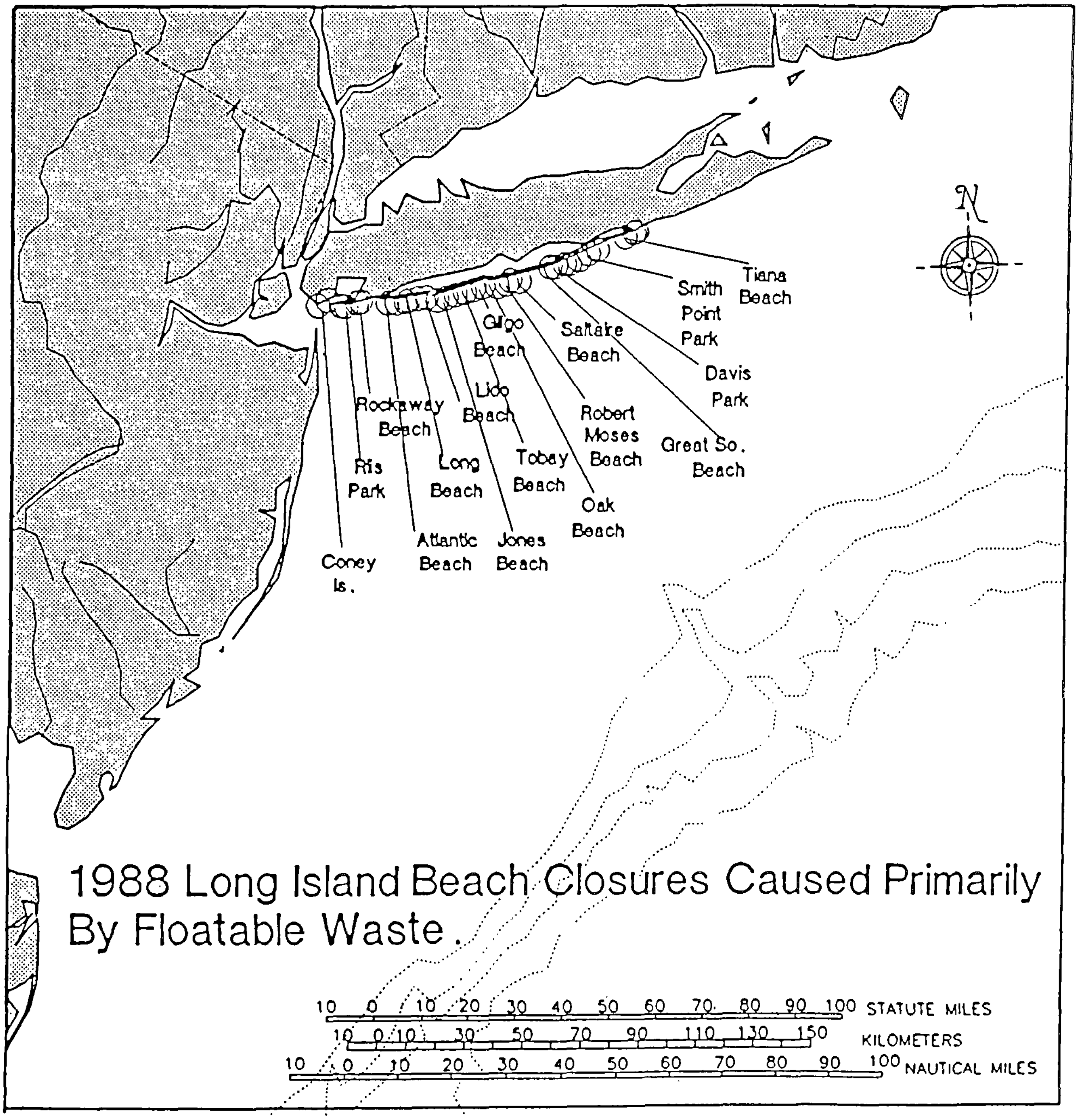

Figure 4. 1988 Long Island beach closures caused primarily by floatable waste.

During the summer, rainfall causes bypassing of sewage treatment plants, delivering floatable wastes to the receiving waters from combined sewer overflows. Garbage and trash reach marine waters through poor solid waste handling in the metropolitan area and from storm sewers, particularly along the New Jersey coast. Illegal disposal is probably a minor source. Sea breezes may wash ashore debris accumulated along oceanic fronts and convergences and in Langmuir circulation cells. Long Island is particularly vulnerable to washups of floatable wastes because of the prevailing summer winds in the area (Swanson et al., 1978, Swanson and Zimmer, 1990).

Problems Associated with the Impairment

Floatable materials on beaches and in our coastal waters are mainly an aesthetic problem for the public. There is a perception that contact with floatable material poses a major public health threat; however, there is no evidence to support that supposition. Public safety (injury from cuts, bruises, punctures) may be a more significant threat. The fear of exposure to AIDS made the medical wastes found in the floatable material a major concern in the 1987 and 1988 washups. These fears are unfounded (Green, in press, 1990).

There are also detrimental impacts on marine birds, turtles, fishes, and other marine animals from floatable wastes which may result in death: entanglement in plastic objects and in fishing line and ingestion of plastic objects that are mistaken by animals for prey food. Some of the impacted marine animals have been designated as endangered or threatened species, underscoring the ecological significance of this impairment.

Economic and Social Impacts

For New York the loss in total expenditures is estimated to be between $750 million and $1.8 billion for 1988. The New Jersey loss in total expenditures is estimated to be between $600 million and $3.6 billion. Our estimates for losses in beach user days in 1988 range from 6.7 30 million in New Jersey and 30 91 million in New York as compared to estimates of baseline attendance.

In an independent analysis, R. L. Associates (1988) report a reduction in user days of 1.9 million in 1988 relative to 1987 along the New Jersey coast. They also report a reduction of $700 million in expenditures in 1988 relative to 1987.

In a study for the Long Island Tourist and Convention Commission, Fey (1990, in press) estimated that the net loss of expenditures on Long Island in 1988 was $700 million. In this estimation, the Commission considered that the loss in beach related expenditures of $1.4 billion was partially returned to other parts of the economy and that the Island had been experiencing a 5.6% growth rate in the tourist industry since 1978. The actual loss in expenditures in 1988 relative to 1987 was $900 million.

In an effort to reduce the impact of floatables, the USEPA in cooperation with the U.S. Army Corps of Engineers, the U.S. Coast Guard, the states of New York and New Jersey, and New York City implemented a short-term floatables action plan. The plan supplements the U.S. Army Corps of Engineers program of skimming

New York Harbor debris that might pose a hazard to navigation. The effort, implemented in 1989 at an additional cost of $1 million, consists of reducing the mesh size of the existing nets in order to pick up much of the floating debris.

Beach Closures - Algae

Algal blooms -- green tides and red tides, have occurred throughout the Bight, particularly off New Jersey's coast but rarely have caused ocean beaches to close. Blooms may be enhanced by the introduction of certain nutrients that enter the Bight in the effluent from sewage treatment plants (point sources along the New Jersey coast); from the Hudson-Raritan Estuary; and direct runoff from the land (non-point sources), especially from agricultural runoff. Nutrients are also transported onto the continental shelf from slope waters and to some degree from atmospheric fallout.

Problems Associated with the Impairment

Algal blooms are aesthetically displeasing and disconcerting because they often look and smell like sewage. There are no known health risks associated with blooms occurring in the Bight, although in 1972 blooms of *Prorocentrum micans* were associated with complaints by swimmers of respiratory discomfort (Olsen, 1989). Beach closings in New Jersey (near Atlantic City) in 1984 and 1985 resulted from blooms of the non-toxic dinoflagellate *Gyrodinium aureolum*, but these beaches closed as a precautionary measure.

Economic and Social Impacts

Economic impacts affect many communities that are economically dependent on beach-goers. The dollar amount is unknown, but assumed to be relatively small.

Ecological Significance

Very dense algal blooms are known to cause a reduction of dissolved oxygen (DO) in the water column. Low DO in certain areas --usually enclosed or restricted areas having limited flushing with oxygenated waters -- has resulted in kills of marine animals, particularly benthic fauna. In the Bight proper, there are very few areas subject to these conditions; therefore, the ecological impacts resulting from algal blooms are negligible. Recent reports of kills in the Bight have been of very few fish and of a very localized and sporadic nature, mainly in several spots along the New Jersey coast. An exception was the anomalous 1976 widespread bloom of *Ceratium tripos*, which contributed to a major faunal kill extending over some 8600 km^2 (Swanson and Sindermann, eds., 1979). In most of the localized kills, DO had not been measured; therefore low DO has not unambiguously been determined to be the cause of the recent fish kills in the Bight. However, these episodes along with direct measurements of general hypoxic conditions and phytoplankton bloom events along much of New Jersey's nearshore may be indicative of chronic, increasing coastal eutrophication. The dolphin strandings which occurred off the New Jersey shore in 1987 have recently been indirectly tied, through the food chain, to a bloom of Ptychodiscus brevis, a species not found in the New York Bight.

Unsafe Seafoods - Toxicants

The types of toxicants in edible marine species of the Bight include the organic compounds: polychlorinated biphenyls (PCBs), DDT, and polyaromatic hydrocarbons (PAHs); and the metals: mercury, cadmium, lead, and silver.

Areal Extent

In general, toxicants mainly affect inshore species because their concentrations are greater near the sources along the coast and in estuaries.

PCBs In general, concentrations of PCBs are below the Food and Drug Administration (FDA) action limits (2.0 mg/kg) (Mearns, et al.,1988), except in large, fatty species of fishes. PCB concentrations are generally higher in fishes than in shellfish.

DDT The average concentrations all fall well below the 5.0 mg/kg FDA limit (National Oceanic and Atmospheric Administration, 1986).

Other Toxicants Data are very limited, but generally these toxicants fall below FDA action levels (National Oceanic and Atmospheric Administration, 1986).

Temporal Changes

Comparisons over time are difficult to make because measurements of contaminants historically have been made from different tissues within the same species and among different species. However, for PCBs there is a decreasing trend exemplified by the PCB content in menhaden populations along the New Jersey coast between 1969 and 1975 (Mearns et al.,1988). DDT levels have decreased eighty to one hundred-fold nationwide since the mid-1960s. For dieldrin, there is some evidence of a nationwide decrease in shellfish contamination, but the national trend in marine fishes is not apparent (Mearns et al., 1988).

Social and Economic Impacts

The most immediate impact to the public is issuance of health advisories limiting or prohibiting ingestion of fish or actual fishing for certain species. In both New York and New Jersey, advisories warn the public to limit consumption of striped bass (Morone saxatilis), bluefish (Pomatomus saltatrix) and American eel (Anguilla rostrata) (Belton, 1985; Halgren, personal communication).

In the longer term, risk analysis studies indicate there may be an increased incidence of cancer from ingestion of contaminated seafood. Although the indication of increased cancer risks is speculative, a recent study (National Oceanic and Atmospheric Administration, 1986) determined that only that part of the population that consumes large quantities of contaminated fish may be at an unacceptable risk. However, the lifetime cancer risks of anyone who eats carcinogen-contaminated fish are increased in proportion to the amount of the carcinogen consumed.

The major economic impact is from a decrease in seafood consumption due to fears that the food may be harmful. Based on anecdotal information, some of the public still avoided seafood as of January 1989 as a result of the floatable medically related waste washups of the summer of 1988. (Dilernia and Malchoff, 1990, in press) found a decline in consumption of 25-50% relative to 1987 based on a survey of fishermen on party boats from New York City and Long Island . These vessels ply the nearshore waters where the impact of the floatables problem was most evident.

The offshore charter boat fleet was not so much impacted by the floatable problem as by adverse stock abundance and distribution. In 1988 this was apparently related to unusual water temperatures, not pollution. While the local commercial sales of fisheries products was down, the price the fisherman received at the dock did not seem to be affected. Fishermen were able to sell their catch to foreign markets. Ofiara and Brown (1990, in press) found a 20-50% decline in the number of fishing trips in a survey conducted in New Jersey of party boats and charter boats. New York and New Jersey recreational fishing experienced a loss in total expenditures of $1.25 billion (Table 4). New York and New Jersey commercial fisheries suffered a loss in total expenditures of $60 million.

Pathogens in Shellfish

Filter-feeding bivalves can collect and concentrate bacteria and viruses of anthropogenic origin. Therefore, health risks to consumers are increased by the practice of eating raw or partially cooked shellfish.

TABLE 4. USE IMPAIRMENTS - BEACH CLOSURES

Use Impairments	Factors Causing Impairment	Ecological Significance of Impairment	Spatial and Temporal Extent of Impairment	Economic Impact
° Toxicants	Toxicants	little	Inshore	$1.3 billion
° Pathogens	Pathogens	little	825 km^2	$73-109 million

Areal and Temporal Extent

Typhoid fever outbreaks associated with shellfish were common until the mid-1920s (Lumsden, 1925). An infectious hepatitis epidemic was linked to contaminated Raritan Bay hard clams in 1960-61 (Ringe et al., 1962; Mason and McClean 1982). In 1986 about 25% of the nearly 4,047 km^2 of shellfishing grounds in the New York Bight and bordering shallow bays and lagoons were closed to shellfishing (Figure 5). The Hudson-Raritan Estuary has been closed for over 60 years. The total closed area in the Bight apex is approximately 825 km^2.

Causes of Impairment

As is the case with beach closures due to pathogens, coliform bacteria are the indicator organisms used to assess the water quality of shellfish beds. New York's and New Jersey's monitoring standards are much more stringent for closing shellfish beds than for closing beaches. The sources of the coliform, however, are the same -- sewage effluent (treated and untreated), ocean dumping of sewage sludge and contaminated dredged material, effluent from the Hudson-Raritan Estuary, storm water runoff, combined sewer overflow, and sewage discharge from boats.

Economic and Social Impacts

The estimated potential production in dollars, if closed shellfish beds were open, is $36 million annually. This estimate is based on the assumption that all beds have equal productivity and that an increase in production does not reduce the price of shellfish.

Costs associated with human ingestion of pathogens and the costs associated with enforcing closures are not known, but probably are significant. Also unknown is the cost in lost economic benefits from declining demand for shellfish because people are afraid of ingesting pathogens. The total annual economic impact from this impairment is estimated at $73-109 million.

Ecological Impact

The ecological consequences of pathogens in shellfish are believed to be insignificant. In fact, closures of beds to shellfishing probably result in overall increased shellfish populations, since the closed beds serve as seed populations. Shellfish populations appear to thrive in nutrient-enriched waters, despite toxicant content, and in some instances are safe for ingestion using today's relaying and depuration techniques.

Commercial and Recreational Navigation - Floatables and Noxious Conditions

Areal Extent

Floating debris, particularly driftwood, poses some hazards to boating in the Bight, but the number of boats damaged is not known. The greatest impact to navigation is in or just outside the Hudson Raritan Estuary, for which the greatest amount of data exists. The drift collection program of the U.S. Army

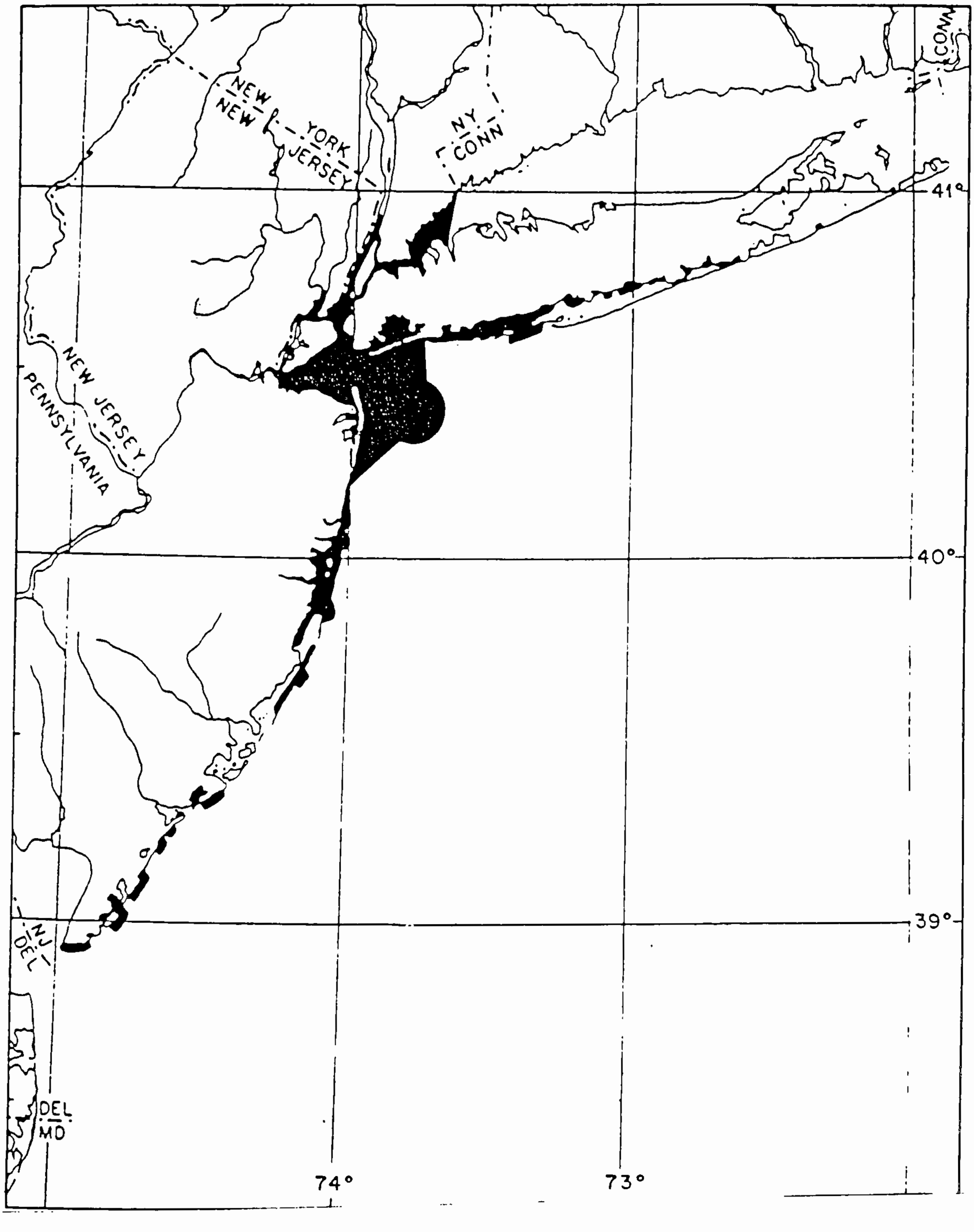

Figure 5. Shellfish closure areas of the New York Bight region in 1986

Corps of Engineers is carried out in the harbor proper; however, the Bight is directly affected by the program since whatever driftwood is eliminated from the harbor lessens the amount entering the Bight. As one moves progressively farther away from the Harbor along the coast of New Jersey and Long Island's southern coast, the reports of drift-related accidents decreases dramatically.

Causes of Impairment

Much of the driftwood is carried downstream in the Hudson during high river stages. A significant contribution is also made from abandoned and disintegrating piers, boats, sheds, and other structures around the harbor, as well as intentional and unintentional dumping of dunnage, crates, and other unwanted materials from vessels and docks into the harbor. In 1987, 17,500 m^3 of drift was collected compared to the average annual 14,077 $\pm$452 m^3 for the period 1967-86.

Economic and Social Impacts

Floating debris and slicks of pollutants are aesthetically displeasing to recreational boaters in the Bight. Noxious slicks of pollutants usually result in some inconvenience but rarely in expense to boaters having to clean their boats. Large economic losses, however, are frequently incurred when plastic is sucked into the engine via the water intake pump. There can be even greater economic losses when a boat strikes a partially sunken drifting object large enough to damage the hull, propeller, or shaft. However, the amount of losses incurred by recreational boaters from these types of impacts is not known. According to insurance companies, many boating accidents that are actually due to poor navigation, are reported on insurance claims as the result of hitting drifting objects. Total estimated economic expenditures, including the program to collect and burn drift in the harbor, may amount to $500 million annually (Table 5).

TABLE 5. USE IMPAIRMENTS - COMMERCIAL/RECREATIONAL NAVIGATION

Use Impairments	Factors Causing Impairment	Ecological Significance of Impairment	Spatial and Temporal Extent of Impairment	Economic Impact
° Floatables	Floatables	Little	No data for Bight; data for harbor only	$500 million annually
° Noxious Conditions	Floatables, sewage	Little	------------	$25 million

ECOSYSTEM HEALTH AND PRODUCTIVITY

Commercial and Recreational Fisheries - Disease

The diseases that impact fisheries species in the Bight are mainly fin rot in fishes (Sindermann, 1988) and shell disease in crabs and lobsters. The prevalence of fin rot in the Bight has declined significantly between 1974 and 1983 (Table 6) for reasons that are not clear.

Areal and Temporal Extent of Impairment

Fin rot An outbreak of fin rot disease affecting several species was reported in the Bight in 1967. During 1967 there was an 8% prevalence in bluefish (*Pomatomus sultatrix*) and 4% in winter flounder (Pseudopleuronectes *americanus*), with a much larger prevalence (25%-70%) in adjacent rivers and bays. From 1973-74, 14.1% of winter flounder from the Bight apex were diseased, compared to 1.9% from control areas. From 1974-75, 3.9% of winter flounder from the Bight apex were affected by fin rot, while only 0.7% of winter founder from outside the apex were affected. In 1983 the prevalence had decreased to about 1% in the Bight apex.

Shell disease Epizootic incidents of 10-90% prevalence occur among stressed populations of crabs and lobsters; natural prevalence may be as low as 2%. In 1988, 30% of red crabs from the Hudson Canyon (Figure 6) and several

TABLE 6. ECOSYSTEM HEALTH AND PRODUCTIVITY IMPACTS
COMMERCIAL/RECREATIONAL FISHERIES

Use Impairments	Factors Causing Impairment	Ecological Significance of Impairment	Spatial and Tempora Extent of Impairment	Economic Impact
° Disease	Toxicants	unknown	Bight apex (prevalence of finrot decreased from 13% to 1% in winter flounder from 1974-83.	nms
° Abundance and distribution	toxicants, overharvest, habitat loss	moderate	-----------	nml
° Episodic kills	nutrients, reduced circulation	unknown	small in extent, but occurring almost annually from 1974-88. 8,600 km^2 in 1976	nml

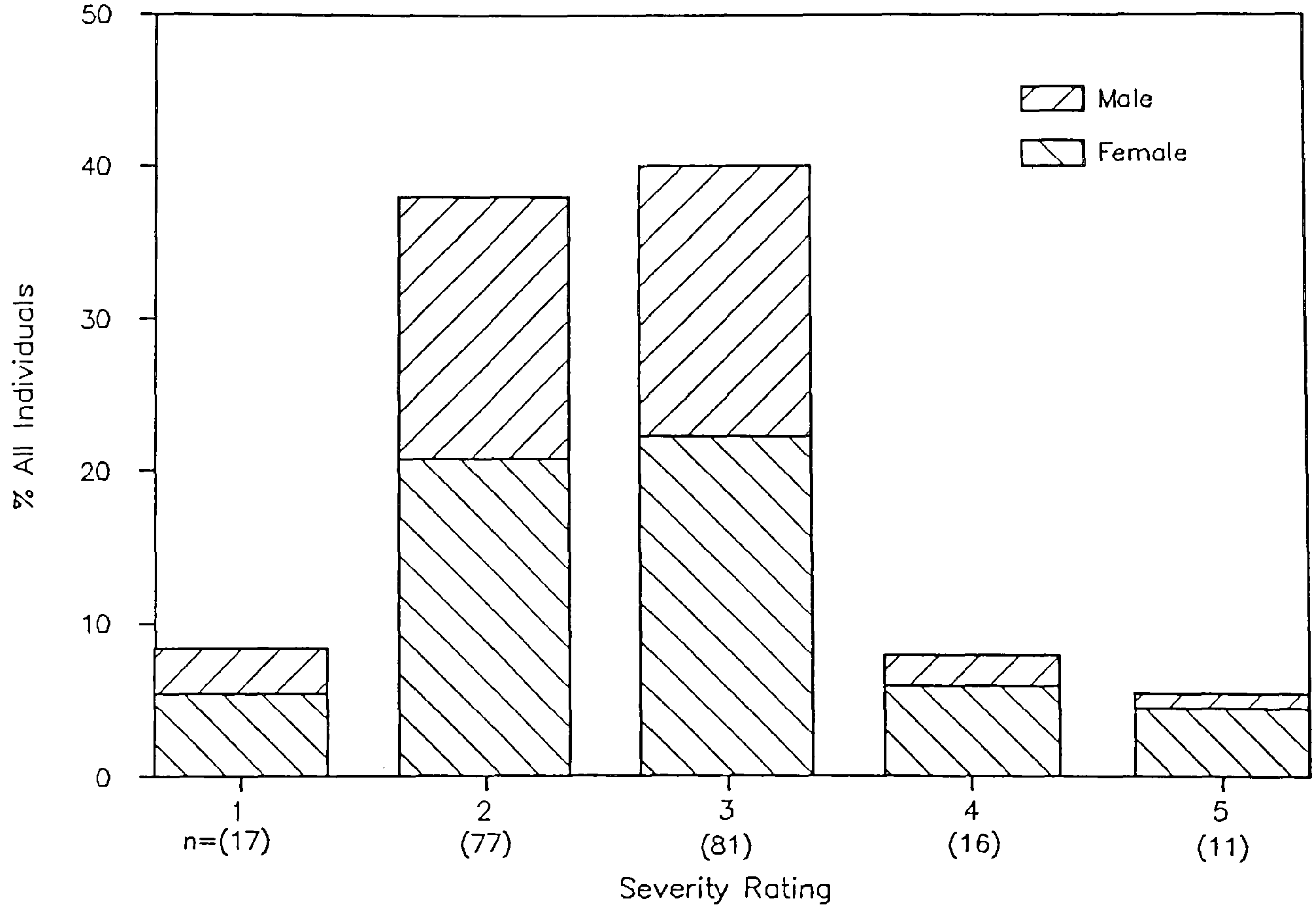

Figure 6. Shell disease prevalence and severity in Hudson Canyon, June 1988

Source: Young, 1990

canyons farther north were moderately or severely diseased giving the appearance in different areas that the shell was burned (Young, 1990). Young, however, notes that the disease prevalence was as high as 81% in 1884 from the same areas based on samples stored in the Smithsonian Institution. These latter samples were only slightly or very slightly diseased but can be considered to have been taken in non-polluted waters prior to impacts from the Industrial Revolution.

Causes of Impairment

Both types of disease are non-specific (their etiology is not clear). However, according to some studies, they are associated with toxicants in polluted or degraded environments, including many major harbors around the world. However, the 1884 crab collections certainly indicate the occurrence of the shellburn disease prior to any contamination of the Bight. While microbial infections are thought to be responsible for fin rot, there is evidence that persistent exposure to toxicants in sediment and seawater promotes the condition. Thus, flatfish are especially prone to this disease because of their direct contact with sediments. Shell disease is thought to result from various chitin-consuming bacteria and fungi. There is some very limited evidence that sewage sludge and contaminated dredged material may promote the condition. It is not known if or to what extent these diseases cause a decline in the affected species.

Economic and Social Impacts

The economic losses to fishermen from these diseases are not known, but are probably small, since fishes with fin rot may still be sold as fillets in the market and are safe to consume. Crustaceans with shell burn disease are also considered safe to eat and their meat can be marketed as a processed product. With lobsters and crabs, however, their market worth, at least in the U.S. market, is higher when sold whole, so there is some loss to fishermen marketing shell burn diseased crustaceans. Japanese fishermen apparently prefer some indication of shell disease as they associate the coloring of the diseased shell with the firmness of the meat (Young,1990).

Commercial and Recreational Fisheries - Distribution and Abundance

Areal and Temporal Extent of Impairment

Marine fish reproductive data are few, so information comes mainly from landings. There has been a distinct decline in abundance of fishes and shellfish in the past 100 years, judging by commercial landings (Figure 7). In 1957 there was a maximum of 3.2×10^5 metric tons landed. By 1987, that figure was down to 7.3×10^4 metric tons. Landings of major marine species have fluctuated over the years, even showing a slight increasing trend (McHugh and Hasbrouck, 1989). However, because the commercial fishing effort has increased substantially, the catch per unit effort has declined.

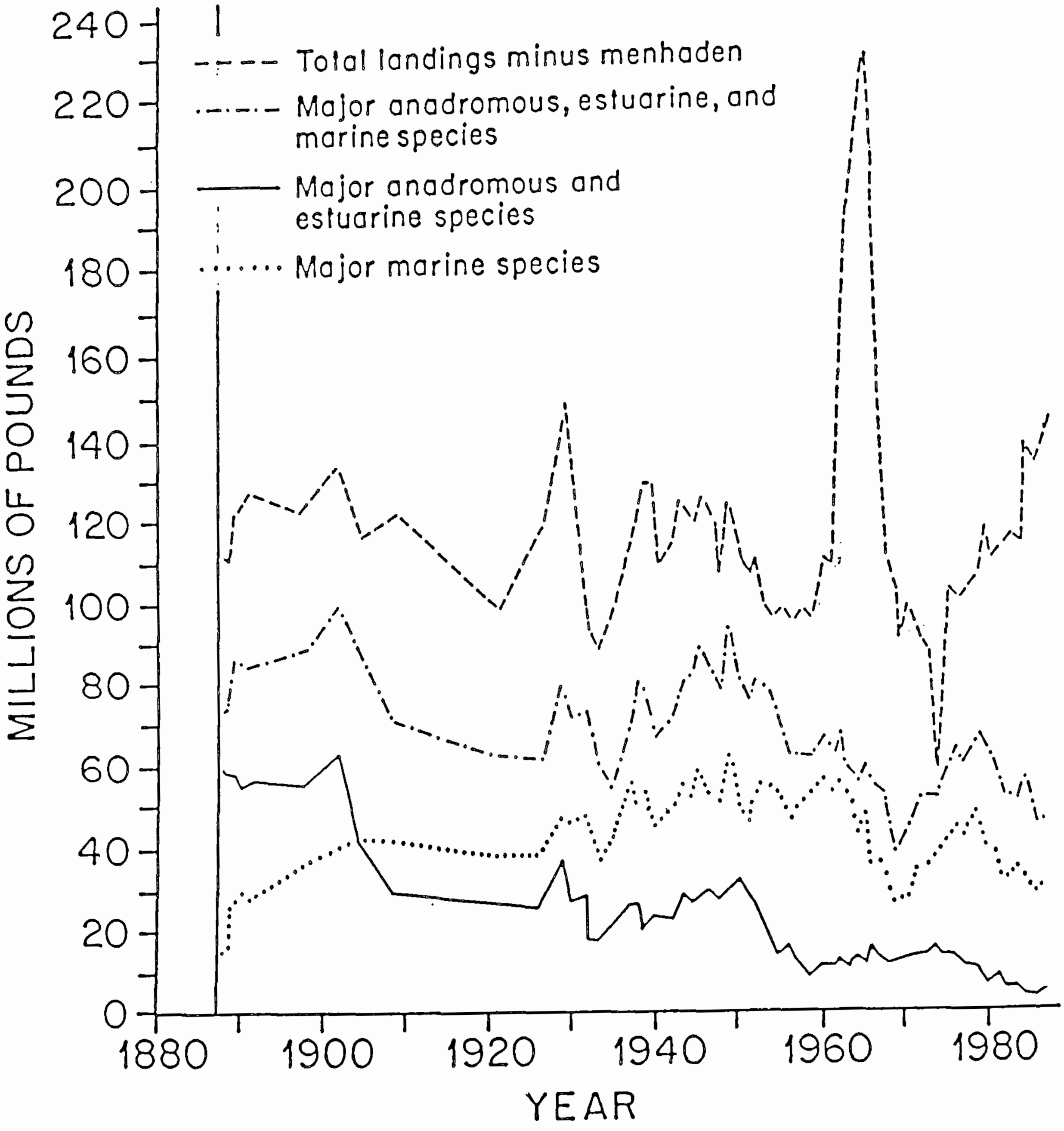

Figure 7. Commercial fish landings in the New York Bight between 1880-1987

Causes of Impairment

Overfishing is the chief factor responsible for the decline in fish abundance for commercial fisheries and probably for recreational fisheries, as well. Pollution has no doubt played a part in the decline of estuarine fisheries, since anadromous and estuarine stocks have declined much more than marine stocks (Mayer 1982; Rose, 1986; Summers et al., 1987). Estuarine and anadromous species are vulnerable to pollution and loss of habitat because their critical developmental stages are spent in the sites closest to shore and are therefore subjected to the brunt of pollution and human intrusion. Whether these effects are reversible or long-term damage has been done to any species are not known.

Economic and Social Impacts

The estimated loss in total expenditures to recreational fishing in both states is $1.25 billion for 1988. This estimate takes into account the decrease in demand from the perceived contamination of fish after the 1987 and 1988 floatable events. Commercial fishing losses in total expenditures were estimated at $24 million for New York and $36 million for New Jersey.

Commercial and Recreational Fisheries - Episodic Fish Kills

Areal and Temporal Extent of Impairment

In the 1970s and 1980s, periodic localized fish kills, generally of low numbers, have been reported in the New York Bight, particularly near the New Jersey coast. An anomalous benthic faunal kill in 1976, due to anoxic conditions over a 8600 km^2 area, resulted in mass mortalities of surf clam *Spisula solidissima* (62%), ocean quahog *Arctica islandica* (25%), and sea scallop *Placopecten magellanicus* (9-13%) (Sindermann and Swanson, 1979). Finfish generally avoid areas of low DO, so the impact is not known, but it may be limited to reduced spawning and to associated mortality of eggs and larvae.

Causes of Impairment

Hypoxic or anoxic conditions in the 1976 event were attributed to early and extreme spring warming, a deep pycnocline and, persistent southwesterly winds leading to onwelling of offshore waters and reversal of subsurface currents (Swanson and Sindermann, 1979). There were few storm events during that year to circulate the water, and a bloom of phytoplankton (*Ceratium tripos*) consumed the oxygen supply that was already limited as a consequence of physical processes.

The causes of the other fish kills are unknown, but low DO is the suspected cause. Algal blooms are an annual phenomenon along the New Jersey coast, and concomitantly low DO is probably a factor in these fish kills. These yearly algal blooms may be associated with eutrophication; and organic carbon and nutrient input to coastal waters of the Bight is certainly a contributing factor.

Ecological Significance of Impairment

It is unknown whether kills of marine organisms are on the rise or whether the reports of these kills are increasing. However, if the kills are increasing, the impacts are not significant at this time. These events are localized and sporadic, and the affected species seem to rebound from them when the chemical and physical conditions rebound. It is unlikely that any long-term impact on the affected species would result from fish kills in the open Bight where even short-term effects are less profound than in more enclosed areas.

Economic and Social Impact

Recovery of a species is dependent on recruitment time. Sea scallops and ocean quahogs have much longer recruitment times than do surf clams, for example. However, recovery is also dependent on other factors; for example, predator decline and lack of fishing pressure on a diminished species will allow that species to recover sooner. In the 1976 mass benthic mortalities, both of these factors aided the fast recovery of surf clams in the Bight. The economic impact of this event was originally estimated to cost in excess of $600 million, probably an overestimate (Swanson and Sindermann, 1979). No other data on economic loss from fish kills exist.

Birds, Mammals and Turtles - Abundance and Distribution

Extent of the Impairment

Birds, mammals and turtles are found seasonally throughout the Bight. Several species of endangered or threatened birds and turtles use parts of the Bight for critical or developmental stages of life. Data are generally not available on pollutant effects on population over time in this area, with the exception of effects of DDT and possibly PCBs on birds. The peak of these effects was in the 1950s and 1960s, but since the banning of DDT, there has been a steady rebound of affected bird populations from their previous steep declines. In 1985 and continuing through 1987, there was about a fivefold increase over the previous five years in the number of marine turtle strandings on New York beaches. For New Jersey, the increase jumped significantly in 1987 (by a factor of four) compared to the years 1979 through 1986.

Causes of Impairment

Toxicants, entanglement in plastic litter, and disturbance by man are the three most prevalent causes of endangerment to marine animals as a whole (Table 7). Boat hits are the major cause of mortality to turtles in the Bight. Turtles historically have only rarely laid eggs on Bight beaches, so reproduction is not jeopardized by toxicants in the Bight. However, toxicants are a major threat to bird reproduction in the Bight. Habitat loss, modification and disturbance along the coastal fringe have an even greater impact on bird populations in the

Bight. Birds, turtles, and mammals are particularly vulnerable to entrapment and entanglement in plastic waste such as six-pack rings, fishing line, and nets. Turtles and mammals are vulnerable to ingestion of plastic bags and balloons that are mistaken for squid, jellyfish, and other prey food items. The consequence of ingestion is often death.

TABLE 7. ECOSYSTEM HEALTH AND PRODUCTIVITY IMPACTS
COMMERCIAL/RECREATIONAL FISHERIES

Ecosystem Impact	Factors Causing Impairment	Ecological Significance of Impairment	Spatial and Temporal Extent	ECONOMIC IMPACT
° Abundance and Distribution	Floatables, toxicants and human use conflicts, habitat loss	Large for endangered or threatened species; less so for others	-----------	nml

The degree of impairment from toxicants is not known, but it is likely that the general health and reproductive success of birds, mammals, and turtles that inhabit polluted areas may be compromised. Frequently turtles and occasionally mammals are stranded on New Jersey and New York beaches from unknown causes. It may be that, like seal deaths in the North Sea, animals' immune systems are compromised by pollution.

Ecological Significance of Impairment

The ecological significance is great when endangered or threatened species are involved. Among the four species of turtles that are found in the Bight, there are two on the endangered list (leatherback and Ridley) and two on the threatened list (loggerhead and green) (Mager, 1985). There are four New York State designated endangered species of birds (peregrine falcon, roseate tern, least tern and piping plover) and three New York State designated threatened species (osprey, northern harrier and common tern) that use the coastal areas of the Bight (Buckley and Buckley, 1978).

Economic and Social Impacts

Economic losses are undeterminable; however, social consequences can be significant. The perceived degradation of the region's waters is especially amplified when mammals die in large numbers, such as occurred in the summer of 1987. The public's sense of aesthetics about the place where they live is also compromised when once thriving marine animals are threatened or no longer found in the region.

CONCLUSIONS

More than 20 million people live, work and recreate along the coastal waters of the New York Bight. Population densities vary from 2700 km^{-2} for New York City as a whole to approximately 80 km^{-2} at the eastern end of Long Island and southern New Jersey. Historically, it was the attraction of "The Great Port" that contributed to the development of the region and the associated degradation of much of the nearby coastal waters. The waterways were logical conduits for transport and dispersion of all types of wastes including domestic, industrial and even those of bone rendering facilities. Even though New York City was at the forefront of sewage treatment technology in the early to mid-twentieth century, waste disposal traditionally has been an afterthought in the metropolitan area.

Today, coastal waters of the Bight, which are geographically removed from the Hudson-Raritan Estuary, experience downstream effects of the estuary and its attendant pollution problems. The closure of shellfish beds at the mouth of the Hudson-Raritan Estuary, floatable debris on beaches, and the possible increase in hypoxia or eutrophication in the New York Bight and western Long Island Sound are but a few examples. Even the impacts of ocean-dumped sewage sludge and dredged materials and atmospheric fallout of pollutants originate with activities adjacent to the estuary.

Poorly controlled coastal development along New Jersey and Long Island portend the continuing deterioration of New York Bight resources even if conditions in the estuary are improved.

The population immediately surrounding the New York Bight will be in excess of 24 million by the year 2000. This is an increase of only about 15% over the period dating from 1985. However, it is perhaps the redistribution of the population that is more important with regard to marine water quality. Development will apparently continue to shift mainly away from the central city into the suburban counties, particularly into coastal areas. These realities are paramount considerations for the development of any long-term management plan addressing the quality of coastal waters.

Identification of the important components of the Bight ecosystem that can or even should be restored and the means to do so are to be accomplished by the New York Bight Restoration Plan. Planning restoration of the Bight based on today's understanding of the ecosystem is intriguing but frustrating: an appropriate approach to achieve positive and measurable results is not evident. We have examined impaired uses of the Bight -- identifying those uses that are recognized as important to our health and well-being, aesthetic sensibilities and livelihoods. On some levels, these use impairments can be measured and quantified. Some aspects of the impairments remain very difficult, if not impossible to assess (Table 8). The impaired uses that can be identified as significant in terms of social or economic values can be targeted for restoration. If the resources and technologies are committed and the citizenry is willing to modify its behavior, it is possible to implement actions to restore many of these uses. The success of these actions can be measured.

It is argued with increasing conviction that by targeting economically or socially significant impairments, the overall health of the ecosystem is ignored (Sagoff 1988). In fact, if significant strides can be made toward restoring uses, the overall health of the ecosystem is bound to improve as well. The converse, however, is not evident. Even if a few measures of the overall health of the ecosystem were to be greatly improved, it is not evident that specific uses would be recovered.

TABLE 8. SUMMARY OF THE ANNUAL ECONOMIC LOSSES FROM IMPAIRMENTS OF NEW YORK BIGHT (* IN MILLIONS OF 1987 DOLLARS)

	Direct Expenditures*	Total Expenditures*	Jobs (000)	Net Economic Benefits*
Beach Impairments				
-algae	nms	nms	nms	nms
-floatables	$539 to $2165	$1078 to $5413	18.1 to 73	$447 to $1515
-pathogens	$236	$472 to $590	7.9	$277
Pathogens in shellfish	$ 36	$73 to $109	nml	nml
Toxicants				
-commercial fish	$ 30	$90	nml	$ 90
-recreational fishing	$500	$1250	20	$250
Ecosystem Impacts				
Fish Kills				
-rec fish	nms	nms	nms	nms
-comm fish	nml	nml	nml	nml
Diseases				
-rec fish	nms	nms	nms	nms
-comm fish	nms	nms	nms	nms
Abundance & Distribution				
-rec fish	nml	nml	nml	nml
-comm fish	nml	nml	nml	nml
Damage to birds	nms	nms	nms	nml
-mammals	nms	nms	nms	nml
-turtles	nms	nms	nms	nml
Aquaculture	nms	nms	nms	nms
Navigational hazards	nml	nml	nml	nml
-Aesthetics (recreational boating)	nml	nml	nml	$25 to $250

nms = not measures, but likely to be small relative to the errors in measurement of those values that are estimated.
nml = not measured, but likely to be large relative to the errors in measurement of those values that are estimated.

The numbers generated for the economic part of this study are not precise. They cannot be derived directly from Bureau of Labor Statistics data, and very often the primary data upon which they are based are imprecise. However, we are confident that wherever we have ventured to provide numerical estimates, they are of the right order of magnitude.

The compartmentalization of the study into various impairments of specific uses excludes from consideration many economic damages from pollution. The quality of life is an important factor in business and industry decisions concerning where to locate their economic activity. Unfortunately, along with the additional economic activity generated by business and industry, they have also generally contributed to eventual environmental degradation. Witness the coastal area of the New York Bight that has many negative associations such as air pollution, population congestion, and crime. A better marine environment can offset some of these negative features and make the region a more attractive place for families and businesses.

The information in Table 8 is indeed alarming. Considering beach impairments, pathogens in shellfish and toxicants in marine foods, the total annual expenditures lost amount to between $3 billion and $7.5 billion. Similarly, the jobs lost could be in the range of 46,000 100,000.

Lost revenue and jobs on this scale typically would generate considerable political attention and perhaps trigger extensive remediation programs with considerable tax-supported assistance. Societal targets are diffuse in this situation; where the uses have become gradually impaired over many decades, the need for attention has not been so obvious. However, it would appear that now there are significant benefits to be derived from an improved marine environment.

Interestingly, the greatest identified economic loss is associated with the floatables problem, yet this loss can be alleviated easily. The sources of the problem are well known and the solutions to the problems have been identified.

There are already some programs and activities under way, particularly targeted towards the estuary, that will have beneficial effects on the quality of the Bight. The upgrading of sewage treatment plants, appropriate chlorination of sewage effluent, introduction of industrial pre-treatment programs, upgrading of combined storm sewer systems and the continued move of industry from the city should cause marked improvements in the water quality of the Upper and Lower Bays and the East River.

Perhaps as a result of these measures, we can anticipate the opening of several beaches in the estuary and shellfishing areas in the estuary and the Bight that are now closed. The reduction of toxins (dioxins, furans, dieldrin, lead and cadmium) in these waters may lead to lower concentrations of some of the contaminants in marine organisms. However, it is likely that bans and public health advisories will still be issued. These toxins persist in the marine sediments which serve as a continuing long-term repository of substances toxic to marine organisms. It is also possible that the EPA, state or FDA standards will become more restrictive as more is learned about the harmful effects of consuming contaminated seafood.

It would be naive to believe that the New York Harbor area is going to revert to a desirable marine recreational area because many uncontrollable problems remain. For example, seepage of contaminants from landfills, intentional and accidental spills, urban runoff, poor control of marina operations, and poor management of wastes at the individual and small business level will continue to plague the metropolitan area. Operation and maintenance resources for the infrastructure needed to ensure water quality will probably lag far behind optimal levels.

The New York Bight apex will be a prime beneficiary of improvement to the harbor complex, which is a major source of contaminants to the Bight. However, continued coastal development on Long Island and in New Jersey will add stress to the bays and lagoons of these coastal areas. To relieve this stress, direct discharges from sewage treatment plants to the ocean offshore will probably increase. Given current trends in coastal development, we can probably anticipate that the rather steep gradient of water quality from extremely poor in the harbor to clean in the east and south will begin to level off. More frequent beach and shellfish bed closures might be expected. Nutrients stimulating phytoplankton blooms may also be expected to increase as sewage treatment systems come on line. Control of coastal development and effective land use planning are imperative if the present status of marine water quality along coasts to the south and east of the Bight apex is to be maintained.

Improvement in the water quality of the Bight apex may result from improvement in the water quality of the Hudson-Raritan plume and also from the cessation in 1988 of ocean dumping of sewage sludge at the 12-mile site. Perhaps the shellfishing closure area surrounding this site will be reduced to some degree as a consequence of these actions.

Concern must be expressed with regard to the potential long-term effects of ocean dumping of sewage sludge and industrial wastes at the 106 mile site, although legislation intended to terminate this practice has already been signed (Ocean Dumping Ban Act of 1988). However, monitoring for long-term effects should be undertaken in case ocean dumping continues longer than has been legislated.

Overall, the quality of the waters of the New York Bight and particularly the Bight apex are probably typical of an over-populated and over-developed coastal region in the industrialized world. They can bear considerable improvement but there is room for conservative optimism. Technological solutions will only partially aid in reducing further degradation. More fundamental actions -- reducing the production of pollutants or reducing population density - will be needed to restore uses and enhance ecosystem quality. These solutions will be costly and depend upon residents' willingness to modify some of their cultural habits. For example, limiting coastal development would probably be the greatest positive influence, but that has many implications regarding transportation, business, industry and the associated tax base. The opportunity for conserving and improving water quality and wisely using coastal resources depends upon the individual and collective will of society, business and industry and government. Extending the notion of improved U.S. competitiveness through better cooperation between business and government should perhaps be broadened to include environmental quality.

Endnotes

1. Sewage sludge was ocean dumped at a site approximately equal distance from and 20 km off the New York and New Jersey coast from 1924 through 1986. In 1987 sewage sludge dumping was phased out of this near coastal site to the 106-mile site some 250 km east of Cape May, New Jersey. All sludge dumping at the near shore site ceased in December 1987.

2. Some institutions such as the Long Island Region of the New York State Department of Parks and Recreation compile annual attendance figures from the per-vehicle admission fee records. At some beaches (particularly town beaches) admission is gained by having the appropriate annual sticker on the car, so there is no daily census. The only comprehensive annual attendance figure for New York is for 1976, a year associated with an unusually large number of beach problems (washups of floatables and other wastes).

An estimate of total beach use was determined by assuming that attendance at New York State Park beaches is a constant fraction of total attendance. Based on these data, one could assume a baseline attendance at New York beaches of approximately 105 million user days (the average of the lower and upper bounds reported in a working paper prepared in connection with this report). This figure is representative of average attendance in years without a major pollution event. The comparable figure for New Jersey would be 93.6 million user days.

3. Direct expenditures have been estimated by examining average per-trip expenditures in other studies -- adapting those figures to 1987-1988. Direct expenditures do not take into account the additional expenditures generated as these dollars are respent. These indirect or "ripple effects" are determined through the application of a multiplier. Multipliers of 2 to 3 are generally employed in studies of this nature (Bell and Leeworthy, 1986 and New York State Department of Environmental Conservation, 1977).

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INTEGRATED ASSESSMENT OF CONDITIONS IN THE SOUND-HARBOR-BIGHT SYSTEM AND SOME THOUGHTS ON HOW TO IMPROVE THE SITUATION

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INTRODUCTION

There is a general public perception, in part related to concern over coastal water quality, that the coastal ocean, in general, and that the coastal environments of New York, New Jersey and Connecticut, in particular, are in decline (Morganthau, 1988; Smart et al. 1987; Toufexis, 1988). The quality of these coastal waters grades from nearly pristine on the east end of Long Island to one of the most degraded open coastal areas of the world, the inner New York Bight -- the Bight Apex. The gradient in environmental quality is one of the steepest in the nation's coastal ocean.

Ptolemy once remarked that it is the role of the scientist to "tell the most plausible story that saves the facts." Although Ptolemy didn't state it explicitly, he meant "all the facts". One problem we have in dealing with the environment is the use of selective subsets of facts to tell "short stories." Are things getting better in the Long Island Sound-New York Harbor-Bight system? Yes! Are they getting worse? Yes! The answer is an absolute and unequivocal "yes" to both questions. But, on balance what is the situation? What story is most consistent with all of the facts? In this paper we try to tell that story.

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The projected growth of population in coastal areas is cause for concern with regard to water quality. The figure is often quoted, but never documented, that by the year 2000, 75% of the population of the United States will live within 50 miles of the coast of the ocean and the Great Lakes. While this number may be exaggerated, it is clear that Americans like to live close to the margins. Degraded water quality, degraded habitats and degraded communities of living marine resources all are associated with major population centers and it is easy to envision steadily increasing impacts of society on the waters of the eastern end of Long Island Sound as coastal development proceeds.

People need to decide now what qualities they want their coastal environments to have in years to come, what uses they want them to serve and then to develop management policies and practices -- strategies -- to ensure that those goals are met. Technological fixes can alleviate the potential problems to some degree, but we should not be fooled into thinking that technology will keep ahead of the potential for coastal degradation. It will not! And, once coastal marine environments are lost or seriously impaired because of over-development, the costs to rehabilitate are high and the results uncertain.

"Water quality" can be described by a variety of different measures, ranging from relatively intangible concentrations of chemicals to more tangible effects of impaired water quality or impaired uses of the water body and its resources (e.g., the frequency of fin rot in fish; miles of beach closed to bathing; areas of shellfish beds closed to harvesting). Measures of water quality generally take on significance to the public only when compared to reference values that relate directly to the uses or values they consider to be important. Commonly used reference values include: regulatory water quality standards, average values in other states, historical values that permit comparison of current conditions with conditions of a decade ago or with pre-industrial conditions, and where one's local area ranks relative to the list of the nation's top 10 most polluted coastal marine environments.

This diversity of measures of water quality is emphasized because a number of commonly used "measures" are not descriptive of what most people consider to be indicators of water quality. Perhaps more importantly, many of these measures contribute little to management decisions that affect water quality. We present our interpretation of water quality in terms of more socially significant "impaired uses."

More than 13 million New Yorkers live, work and recreate along the marine coastal waters of New York State. The number of people living along the borders of Long Island Sound is close to 15 million. Population densities range from 7,000 per square mile in New York City to less than 200 per square mile at the eastern end of Long Island. It was the attraction of the "Great Port" that contributed to the development of the region and the associated degradation of much of the nearby coastal waters. The waterways were logical conduits for dispersal and dispersion of all types of wastes, including domestic and industrial wastes and even carcasses of animals from the numerous slaughter houses and bone rendering facilities. Proper waste disposal traditionally has been an afterthought in the metropolitan New York City area. And in this respect, New York City is the rule, rather than the exception among major coastal cities.

Even today, many of the downstate coastal marine waters relatively removed from the New York-New Jersey Harbor area experience downstream effects of the harbor and its attendant pollution problems. Consider, for example, the closure of shellfish beds at the mouth of the Hudson-Raritan Estuary, floatables on beaches, the impacts of ocean dumping of sewage sludge and contaminated dredged materials, and the possible tendency for increased hypoxic conditions or eutrophication in the New York Bight and western Long Island Sound. In a recent study of impaired uses of the New York Bight done for Region II of the U.S. Environmental Protection Agency, it was estimated that New York's share of the economic losses associated with impacts on beach use, fisheries, recreational boating, and marine birds, mammals and turtles was on the order of several billion dollars per year. Researchers at Rutgers University estimated the economic losses in direct expenditures for the State of New Jersey to be between $240 million and $1.4 billion annually (Waste Management Institute 1989).

The greatest impairments to the water quality of the Sound-Harbor-Bight system are low levels of dissolved oxygen because of eutrophication; restricted fishing because of pollution by toxicants and sewage and by non-point source runoff; beach clousures because of sewage inputs and non-point sources; and a variety of problems associated with floatable wastes, including medical-type wastes.

EXISTING CONDITIONS

Eutrophication

Concern has been expressed in the last decade as to whether portions of the New York Bight Apex (Figure 1) and western Long Island Sound are showing persistent and growing adverse signs of eutrophication. It probably is premature to so state this with certainty for either area, and particularly for the Bight Apex. It is important to monitor the situation closely and to implement appropriate remedial measures to reduce the probability of increasing the frequency, duration and geographical extent of such events.

Low levels of dissolved oxygen (DO) are observed in the near-bottom waters of the Bight, Harbor, and western Sound during the summer months of some years. In July and August of 1987 extremely low oxygen values, 0-2 parts per million (ppm), were observed in the waters of western Long Island Sound as far east as Greenwich, Connecticut. Such hypoxic events have adverse impacts on benthic organisms of the affected area, particularly sessile forms. The summer of 1987 was especially severe; many bottom-dwelling invertebrates died and fish avoided the area.

During the past decade, near-bottom water DO concentrations in the Harbor have improved, although in many areas values still fall below New York State water quality standards for fish propagation (5 ppm). Anoxia (0 ppm DO) often occurs in the Arthur Kill, Kill Van Kull, Harlem River, and the East River. Most

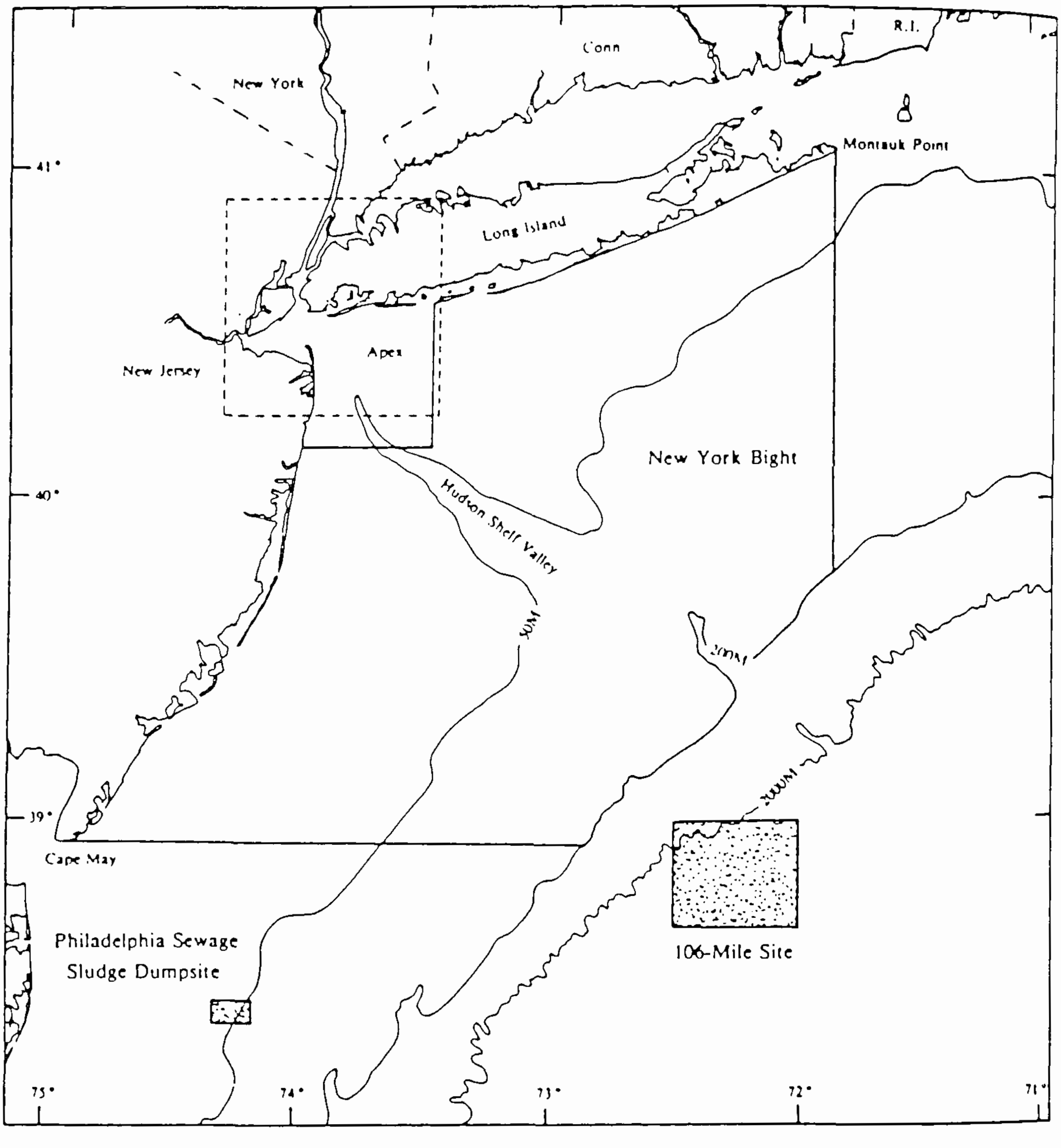

Figure 1: New York Bight and adjacent waters. Dashes outline area depicted in Figure 2.

From: Carriker, M.R., J.W. Anderson, W.P. Davis, D.R. Franz, G.F. Mayer, J.B. Pearce, T.K. Sawyer, J.H. Tietjen, J.F. Timoney, D.R. Young. 1982. Effects of pollutants on benthos in Ecological Stress and the New York Bight: Science and Management (Garry F. Mayer, ed.) Estuarine Research Federation, Columbia, South Carolina. pp 3-21.

bivalves, including clams and oysters, are unable to live in these waterways. Similar conditions exist in the Narrows between the East River and Long Island Sound.

The deeper basins of central and western Long Island Sound and several bays along the north shore of Long Island also frequently fail to meet DO standards. The recent improvements in DO levels in the waters of New York Harbor are a consequence of new and upgraded sewage treatment plants. However, nutrients formerly released to Harbor waters as organic matter now are dispersed in dissolved forms, to be assimilated outside the Harbor by phytoplankton. When these phytoplankton die, they constitute a source of biological oxygen demand that is dispersed from the Harbor to burden the western Sound and the inner New York Bight.

Unlike the nearshore zone of northern New Jersey, the nearshore zone of the south shore of Long Island has not experienced low DO problems to any appreciable degree -- a consequence of the differences in the oceanic circulation in the two areas.

Low DO routinely occurs in the Christiaensen Basin (Figure 2), the topographic depression at the head of the Hudson Shelf Valley, located between the dredged material disposal site and the former 12-mile sewage sludge dumpsite. While low DO conditions in the New York Bight Apex are controlled largely by oceanographic and meteorologic conditions, the oxygen demand from local dumping operations and particularly from the Hudson River plume add to the oxygen stress of the area. Long term monitoring in the Bight Apex has shown no indication of a trend of decreasing DO levels in near-bottom waters (Swanson and Parker 1988). The natural variability in these areas makes evaluation of the situation difficult. However, low levels of DO can be expected any summer given the appropriate combination of oceanographic and meteorological conditions.

Phytoplankton blooms, which often are responses to nutrient enrichment from human wastes, also can occur in response to natural events, although the specific causes of naturally induced blooms are poorly understood. Because of the massive quantities of algal cells characteristic of blooms, the affected waters can take on a distinct discoloration. Green tides and red tides have been observed in the Bight in recent years. Brown tides in the waters of the Peconics and other bays of eastern Long Island Sound and Great South Bay occurred from 1985 through 1988 and have been responsible for the collapse of the bay scallop fishery. The problem appeared to be ameliorating in 1989 and the bay scallop began to repopulate the Peconics-Flanders Bay system. The cause of the brown tide has not been identified unequivocally; it may well have been triggered in part by natural events such as drought conditions, but it may have been aggravated by human activities involving the use of new types of fertilizers and additives to detergents (Cosper et al. 1989).

Besides obvious aesthetic impacts of phytoplankton blooms and their potential for contributing to depressed DO concentrations in near-bottom waters, reports from bathers and lifeguards of nausea, sore throat, eye irritation, and lung congestion have been attributed to phytoplankton blooms.

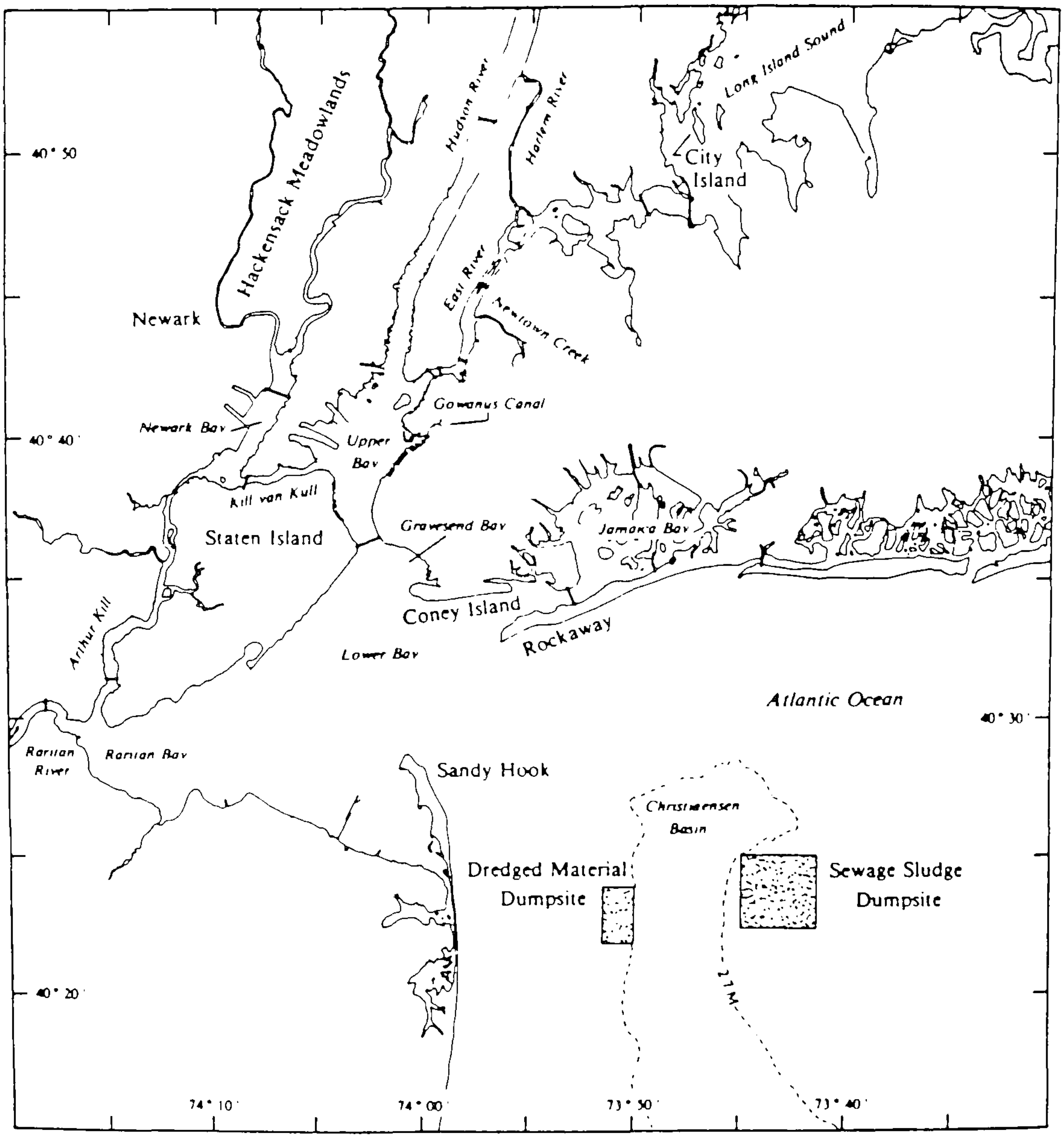

Figure 2: Lower Hudson-Raritan estuary and inner New York Bight.

From: Carriker, M.R., J.W. Anderson, W.P. Davis, D.R. Franz, G.F. Mayer, J.B. Pearce, T.K. Sawyer, J.H. Tietjen, J.F. Timoney, D.R. Young. 1982. Effects of pollutants on benthos in Ecological Stress and the New York Bight: Science and Management (Garry F. Mayer, ed.) Estuarine Research Federation, Columbia, South Carolina. pp 3-21.

Toxic Substances and Pathogens

Municipal sewage treatment plants contribute virtually all kinds of pollutants to the region's coastal marine waters. For nearly all pollutants, the direct inputs to coastal water by industrial discharges account for only about 1% by mass of the discharges of these same pollutants from sewage treatment plants. Sewage treatment plants dominate loadings of most human pathogens, some toxic metals, organic carbon, and synthetic organics excluding polychlorinated byphenyls (PCBs). The upper Hudson and other rivers and streams contribute most of the suspended solids, about two-thirds the PCBs and 25% of the nitrogen and phosphorus to the area's coastal marine waters.

Urban runoff is also a significant source of a number of contaminants, contributing about 35% of the oil and grease. It is worth noting that each year the quantity of oil and grease that reaches New York Harbor waters from sewage treatment plants and from industrial discharges throughout the drainage basin is equivalent to the amount of oil released by the EXXON VALDEZ oil spill. Rivers and streams together with urban runoff contribute more than 20% of the total loadings of arsenic, lead, nickel, selenium, and zinc.

The ability in the region to respond effectively to spills of oil and other toxic materials is poor. Facilities are primitive and management response mechanisms range from cumbersome to inoperative. If a major spill were to occur within the region, its impacts might well be greater than those associated with the EXXON VALDEZ. This is not because the region's natural ecosystem is more sensitive than Prince William Sound. It is not. It is because there are so many overlapping jurisdictions in this region and because there is no emergency response plan in place that would allow a rapid response. A high priority should be given to developing a comprehensive spill response management plan which is a composite of regional and sub-regional plans.

Indirect loadings of several pollutants to marine waters from the atmosphere through the entire Hudson watershed are significant. For example, in Long Island Sound, east of Greenwich Connecticut, atmospheric inputs alone can account for the entire sediment load of lead (Hirschberg et al. 1989). In the New York Bight, approximately 80% of the lead input is atmospheric (Hydroqual 1989).

Primarily because of PCB concentrations which exceed U.S. Food and Drug Administration (FDA) guidelines (viz. 2 ppm PCBs in fish flesh), the state departments of health for the tri-state area have issued health advisories. These advisories recommend limiting consumption of a number of popular finfish.

Pollutant accumulations in fish have also led to extensive restrictions on commercial fishing for a number of species. Since 1986, New York State has prohibited the sale of striped bass caught in all New York waters. Commercial fishing is banned in the Hudson from the Troy Dam to the Battery in New York City for all species except American shad, large Atlantic sturgeon and goldfish. The entire New York Harbor and Long Island Sound as far east as about Hempstead Harbor are closed to shellfishing because of human pathogens (as indicated by concentrations of coliform bacteria). In the New York Bight, a shellfishing closure area of 240 square nautical miles has been established around the former 12-mile sewage sludge dumpsite. In 1986 approximately one-third of the shellfish beds in the New York-New Jersey Harbor and New York Bight were closed because of pathogens. While these areas are large, there has been relatively little change in the total area closed to shellfishing for more than 15 years (Waste Management Institute 1989).

It is significant that since the early 1970s Harbor waters have shown a trend of decreasing levels of contamination by human pathogens (as indicated by counts of coliform and fecal coliform bacteria). In January 1990, however, shellfish harvesting was still prohibited in 82,445 acres of New York's Long Island Sound waters (about 18% of the total shellfish bottom) and Connecticut's Long Island shoreline had 78,009 acres (about 20% of the total shellfish bottom) closed to shellfishing. As expected, increasing concentrations of pathogens occur as one progresses from eastern Long Island Sound to New York Harbor. With few exceptions, the entire Hudson-Raritan Estuary has been closed to shellfish harvesting for direct consumption for over 60 years. New York Harbor has been completely closed to shellfishing for 30 years. It is alarming that with few exceptions, once an area has been closed to shellfishing, it has had to remain closed.

Western Long Island Sound waters conformed to bathing water standards (dependent of coliform levels) only 63% of the time during the summer of 1986. Conformance with bathing water standards within harbors along the north shore of western Long Island ranged from 25% to 100% of the time. Most beaches of the inner New York Harbor have been closed to bathing for more than 50 years because of sewage contamination, however, the beaches of the outer New York Harbor continue to show improvement and several have been opened in the past few years.

Two fish diseases prevalent in the lower Hudson and New York Harbor probably are pollutant-induced. Most of the Atlantic tomcod sampled from the lower Hudson, near Garrison, (New York) in 1983-1984 had liver cancer. Extensive chemical analyses of the same livers detected metals and synthetic organic compounds expected in an industrialized estuary. Erosion and progressive death of fin tissue (a disease termed "fin rot") has been observed in 22 fish species of New York Harbor and Bight. Fin rot has been described from polluted marine waters throughout the world. The cause of fin rot is uncertain, but several studies indicate that it is initiated by contact with contaminated sediments (Murchelano and Zishowski 1982).

Some laboratory studies have linked shellfish disease to human wastes. Crabs, lobsters and shrimp in the Bight exhibit erosion of their chitinous exoskeletons by bacteria and fungi. This "shell disease" of crustaceans has been found in up to 30% of the shrimp, <u>Crangon septemspinosa</u>, from the most contaminated areas of the Bight. Recently there have been reports in the press that shell erosion is occuring on Jonah crabs (<u>Cancer irroatus</u>) and red crabs (<u>Geryon quinquedens</u>) taken from several submarine canyons near the edge of the continental shelf to the northwest of Deep Water Dumpsite 106 (DWD 106). Allegations have been made by representatives of the commercial fishing industry that the cause of the disease is ocean dumping of sewage sludge at this newly designated sewage sludge dumpsite, 120 nautical miles from Ambrose Light. Recent research, however, has found that red crabs collected from the New York Bight in the later 1880s, prior to ocean dumping at DWD 106, exhibited shell disease which indicates that sewage sludge alone does not promote this condition (Young 1989). However, a better understanding of the causes of shell disease is necessary. It is important from the perspective of all parties that an objective assessment be undertaken.

Floatable Wastes

Floatable wastes are derived from a variety of sources, but the most objectionable ones are those associated with sewage. Diaper liners, condom rings, tampon applicators, and grease balls are aesthetically objectionable and their presence raises concern among beach users that there is a potential public health risk. More recently there has been concern about floatable medical-type wastes because of the fear of contracting AIDS.

Concern about the impacts of floatables on marine organisms has been focused on plastics which can entangle birds, fishes, and turtles. In some cases, plastics have been ingested by marine organisms, interferring with digestive processes and even causing death. Floatables have become a growing issue, perhaps largely as a result of the increasing use of plastics. These products began to appear on the market in the mid-1960s. The introduction of the plastic PET bottle in 1977 was a significant contributor to the floatable problem.

While beaches in the area are continually littered to some degree, there are occasions when the problem is so severe -- or perceived to be so severe -- that beaches have been closed. In 1987, 40 km of New Jersey beaches were closed in late May and 80 km in mid-August because of strandings of floatable wastes. In 1988, many beaches on both the north and south shores of Long Island and Westchester County, (New York) were closed for periods of hours to days because of reports of stranded floatable wastes, including medical-type wastes.

Even though bathing water quality standards (as measured by coliform concentrations) do not seem to be exceeded during floatable events, the public avoids beach areas during and after these episodes. Public perception can have a significant impact on beach related businesses. The losses to the region because of the floatables during the summer of 1988 has been estimated between 1.0 and 5.4 billion dollars (Waste Management Institute 1989).

The major floatable events on the region's ocean beaches appear to be related to persistent winds that tend to concentrate floating materials and strand them on downwind beaches. The most effective way of reducing the magnitude and severity of the problem is to reduce the quantity of material entering marine systems at their sources. Limiting the use of plastic items in the marketplace will also help to reduce the problem.

Combined storm sewers in the metropolitan area are probably the greatest single contributor of floatables to the region's coastal marine waters. Inappropriate, ineffective and sloppy solid waste handling that lead to the inadvertent release of floatable wastes into marine waters also add to the problem. The U.S. Environmental Protection Agency's floatable action plan developed and conducted in coordination with the U.S. Coast Guard, U.S. Army Corps of Engineers, the states of New York and New Jersey, and New York City is aiding in reducing the problem on an interim basis by its surveillance and harbor clean-up programs. Longer term solutions are more critical and are identified in the Marine Sciences Research Center's (1989) comprehensive floatables management plan that was developed with the full participation of all relevant federal, regional, state, county and town agencies.

FORECAST FOR THE FUTURE

Eutrophication

The ongoing program of upgrading sewage treatment plants in the metropolitan area should continue the trend of improving dissolved oxygen concentrations in near-bottom waters of the Harbor complex, the East River and the New York Bight Apex. The extent of further improvement, however, is difficult to predict.

Western Long Island Sound is the marine system of greatest concern with regard to the potential for eutrophication in the coming years. While there are insufficient data to establish a clear trend, there appears to be a slight increase in the frequency of low DO events in near-bottom waters in recent years. The upgrading of sewage treatment plants in the City may have exacerbated the situation in the western Sound by changing the forms in which nutrients are introduced, transported, and made available to phytoplankton. Certainly, the present situation in the western Sound warrants careful analysis and perhaps remedial measures once the mechanisms -- the causes of the problem -- are sufficiently well understood so that remedial measures can be selected with a reasonable degree of assurance of success. The costs will be high.

In the Bight Apex, there is no indication of a decreasing trend in near-bottom DO although there are localized "hot spots" along the New Jersey coast. Physical processes seem to dominate the annual cycle of the distribution of DO in near-bottom waters of the Bight Apex. One might expect that there would be some improvement in the summertime near-bottom DO levels as a consequence of the relocation of sewage sludge dumping from the 12-mile site to the 106-mile site. Localized oxygen depletion may occur because of phytoplankton blooms triggered either by natural or anthropogenic causes.

Toxic Substances and Pathogens

The population bordering New York State's marine waters is projected to increase to about 15 million by the year 2000. This is only a growth of about 15% from 1985 estimates. However, it is the redistribution of the population that is perhaps more important with regard to marine water quality. People will continue to move away from the central city and into suburban counties, particularly toward the eastern end of Long Island. Increased development will lead to increased stresses on coastal environments and their living resources unless the development is carefully planned and controlled.

The upgrading of sewage treatment plants, continual chlorination of sewage effluent, introduction of industrial pretreatment programs, improvement in the combined storm sewer systems, and the continued flight of industry from New York City should lead to continued improvements in the water quality of the Upper and Lower Bays of New York Harbor, the East River and the New York Bight Apex.

Perhaps as a result of these measures, we can anticipate opening of some beaches and shellfishing areas that are now closed. The reduction of inputs of contaminants to these waters may lead to a reduction of the concentration of these materials in marine organisms, but there will be a time lag. It is likely that bans and public health advisories will remain in effect, at least for the forseeable future. Because many contaminants have a high affinity for particles, they ultimately come to reside in the sediments. Reworking of sediments by animals and by waves and tides can enhance the exchange of contaminants with the water column, leading either to an increase in the uptake or release of contaminants by the sediments depending upon a complicated set of chemical conditions. Sediments may be a major and persistent source of contaminants to marine organisms.

New York State, the U.S. EPA, and FDA standards for contaminants in seafood may become more, or less, restrictive in the future as we learn more about the human health effects of consuming contaminated seafood, or as the level of public concern about these issues increases, or decreases.

Diseases in fishes and shellfishes also may be expected to decline as the concentrations of contaminants decrease. There was a ten-fold decline in the prevalence of fin rot in winter flounder in the New York Harbor between 1973-1978. The cause of this decline is not obvious.

Despite these optimistic views, it would be naive to believe that the New York Harbor area is going to become a desirable recreational area for water contact activities. Too many pervasive and almost unmanageable problems remain. Seepage of contaminants from landfills, intentional polluting activities, accidental spills, urban runoff, poor control of marina operations, and poor management of wastes at the individual and small business level will continue to plague the region's coastal marine environments and their living marine resources. Financial support for the proper rehabilitation, operation and management of New York City's water quality infrastructure will probably fall far short of what is needed to bring these facilities to optimum levels. While water contact recreation in Harbor waters will remain very limited, with proper planning, responsible and imaginative development and enlightened management, other forms of water-related recreational opportunities could be expanded and enhanced. But these too will be controversial.

The New York Bight Apex and western Long Island Sound will be prime beneficiaries of reductions in contaminant loadings to the Harbor complex because the Harbor complex is a major source of contaminants to these systems.

The continued eastward development on Long Island will add stress to the south shore bays, to central and eastern Long Island Sound and to the Peconics-Flanders Bay system. Unless decisive managment actions are taken, the rather steep gradiant of water quality from poor in New York Harbor to very good in the eastern Sound may begin to flatten out as a result of gains in the west and losses in the east. More frequent beach and shellfish bed closures might be expected in the east. Increased phytoplankton blooms may also be expected as the need for sewage treatment and the discharge of effluent to marine waters increases with population growth and with the growing inefficiency of many septic and cesspool systems. Control of coastal development and effective land use planning are imperative if the present status of good water quality in eastern Long Island Sound is to be maintained. Prevention is a far more effective management strategy and less costly than rehabilitation. It is not at all clear that an increase in the average water quality of Long Island Sound which results from minor gains in the west offset by minor losses in the East is a net gain for society. In our view, if a choice must be made, it would make more sense to ensure maintenance of the high quality in the eastern Sound even if it means postponing improvements in the western Sound.

New York Bight waters should remain in relatively good condition except in very nearshore area were local coastal development will be the controlling factor. The Bight Apex may show improvement as a consequence of gains in the quality of the Hudson- Raritan plume and also from the cessation of ocean dumping of sewage sludge at the 12-mile site. The area closed to shellfishing may be reduced to some degree as a consequence of these actions.

Concern must be expressed with regard to the long-term effects of ocean dumping of sewage sludge and industrial wastes at the 106 mile site. The problems associated with sewage sludge dumping are not with the sewage, but with the contaminants associated with the sewage particles. Long-term monitoring of the effects of dumping at DWDS 106 should be continued at least until the dumping is phased out as a consequence of the implementation of the Ocean Dumping Ban Act, and preferably longer to document the response to cessation of dumping. Dumping of sewage sludge in the ocean is a little like the trick birthday candles which, after being extinguished, reignite. Ocean dumping too may return, and we should learn whatever lessons we can from this valuable, expensive and unique experiment.

Recent summers have brought to our attention the sentivity of the public to having clean, aesthetically attractive and safe coastal marine environments. For the first time marine scientists have begun to work in a sustained and systematic way with economists and social scientists to analyze the costs associated with degraded coastal environments. These collaborations should continue and be expanded. It is alarming that New York lost several billion dollars in expenditures in the summer of 1988 because of the public's reaction to floatable and medical-type wastes.

SOME CLOSING OBSERVATIONS

The environmental problems of the region's coastal marine environments are not fundamentally different from those 10, 20, 30, even 50 years ago. They differ in degree, not in kind. There is not enough money to address all of the region's marine environmental problems, let alone all of its environmental, social and infrastructure problems. Because of this, money must be spent wisely and on projects of importance to the public. Choices must be made and strategies developed to ensure that funds are spent effectively. This requires an explicit definition of goals and objectives and a tracking (monitoring) of diagnostic properties to assess the efficacy of management strategies and engineering practices employed.

As far as selecting which marine environmental problems to address are concerned, we believe the following principles should apply. The first priority should be to take whatever measures are required to conserve those areas now in good condition; to ensure that there is do degradation. We should be very cautious in approving further development of coastal areas and do so in the context of larger, sub-regional to regional, comprehensive, land-water use plans. The second priority should be to invest in rehabilitating those areas where an investment will have a significant impact on use patterns by important species, including but not restricted to humans. In other words, the second priority should be to take those management actions that will produce predictable and desirable results at acceptable costs; results which will be manifested in enhanced or expanded uses and values considered to be important by society. The third priority should be to invest in those areas which will require large and long-term investments with uncertain payoffs. Cleaning up western Long Island Sound may be such a case. The strategies for cleaning up an environment differ from those needed to prevent further degradation. Strategies to achieve the latter should not be delayed.

Eventually, society will have to invest in strategies at all three levels of priority, but phasing is important: preventive medicine, restorative medicine and major surgery -- in that order -- and major surgery only after getting at least a second opinion.

Most environmental problems result from people -- too many of them -- and the ways in which they dispose of their wastes. Development also can destroy valuable habitat which may have profound, long-term impacts on ecosystem health. The metropolitan New York City area and the tri-state coastal region are no exceptions to these general problems; indeed they illustrate them vividly. Society must decrease the amounts of wastes it produces, simplify their compositions and enhance recycling and reuse to the maximum extent that can be sustained. This will require major, fundamental changes in lifestyles in many industrialized countries and particularly in the U.S. Having done this -- reduced, recycled and reused to the maximum extent possible -- society must look at the wastes that remain, those that cannot at the time be reduced, recycled or reused, and select the best -- the most appropriate -- disposal strategy. This is the strategy that reduces risk to human health to an acceptable level, at acceptable cost and that has the least adverse impact on the environment -- the total environment. Waste disposal options are limited. Wastes can be put either on the land, in the ocean, or in the air. Those are our only practical options. One lesson that has become increasingly clear is the interconnectedness of our environmental media; water, land and air. In selecting the environmental medium for disposal, careful, rigorous, cross-media analyses must be carried out;

analyses that are waste specific and that take proper account of the special characteristics of the region. This rarely is done. Wastes typically go into the medium for which there is the least public opposition. This does not ensure the best protection for our total environment and often significantly increases the cost of disposal.

The state and the federal government must make a significant and sustained investment to conserve and, where appropriate, to rehabilitate the region's coastal marine environments. The program must involve research, monitoring, modeling, education and action and it must be marked by patience and a constancy of commitment. So long as our coastal marine environments and their living resources are important to society, that is how long we will have to make a major investment to improve our understanding of them and to use that new knowledge to manage them more effectively.

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Conditions in the Sound-Harbor-Bight System Viewed in the National Context

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Conditions in the Sound-Harbor-Bight System

Viewed in the National Context

I have been asked to address the question: How do the problems in the Sound-Harbor-Bight system compare with those in other estuarine systems in the United States?

In response, I will attempt to address the environmental and management problems the Office of Marine and Estuarine Protection (OMEP) is addressing nationally, some of the strategies currently being used in our programs, some of the limitations we are facing, and current legislative activities in Congress that address coastal pollution problems.

Environmental and Management Problems

In developing the Near Coastal Waters Initiative, OMEP identified five nationally pervasive problems:

- eutrophication,
- pathogen contamination,
- toxic contamination,
- changes in living marine resources, and
- loss of habitat.

So when one reviews, for example, the Long Island Sound Project's list of priority problems- low dissolved oxygen, toxic contamination, changes in living marine resources, pathogens, and floatable debris, there is a certain similarity. Indeed, a survey of the priority problems identified in each of the estuaries in the National Estuary Program further illustrates that the nation's coastal waters are exhibiting similar signs of stress.

Nutrient enrichment and the resulting low dissolved oxygen problems are priority problems typical of the larger estuaries with agriculture watersheds- Albemarle/Pamlico Sounds, South Puget Sound. But nutrient enrichment is also typical of the smaller systems confronting rapid growth and development creating storm water run-off, septic and municipal treatment system pollution problems- Buzzards Bay, Delaware Inland Bays and Sarasota Bay. However, no other system appears to have the extensive nutrient pollutant loadings that the Sound-Harbor-Bight system has, compounded with nonpoint run-off.

Around the country toxic contamination is associated with industrial watersheds, port and harbor facilities, and depositional areas. In-place toxic contaminants are found in the largest systems- Narragansett Bay, Delaware Bay, tributaries to Albemarle/Pamlico Sounds, the urban embayments of Puget Sound, Boston Harbor, and the smallest systems- Casco Bay.

Pathogen contamination of shellfish, or suspected contamination, has closed shellfish beds in every system in the program. And, habitat loss due to dredging, fill, shoreline modification, and development is reported in every system.

So there are no real surprises. However, the types of problems being dealt with in the northeastern U.S. appear to be among the toughest- population growth, development, the value and cost of land, the decaying infrastructure, aging municipal plants without expansion room. These problems are critically impacting coastal waters in the northeast and raising tough management issues. Can you imagine a coast line the size of California's with only <u>one</u> combined sewer overflow to permit?

The northeast can take heart on a few issues. The loss of wetlands on the West Coast is worse. In San Francisco Bay the estimated loss is 90%, and of the remaining 10% most are only "seasonally wet". And, the situation in Puget Sound isn't much better. Environmental resource managers in the south east, gulf region and the west coast are also dealing with another problem that we should pay attention to- fresh water diversion. During drought and low flow conditions- the estuary is the lowest priority. East coast folks should take heed. It has been predicted that the increase in population, and its corresponding demand for water, may result in a fresh water draw down for the Chesapeake that may completely change the salinity of the system in twenty years- defeating all efforts to restore the system today.

<u>Challenges and Strategies</u>

The unique set of problems in every estuary presents a certain challenge- and there are several different approaches being taken.

<u>"Taking on all sources of pollution"</u>: Puget Sound

"WE SIMPLY HAVE TO DO EVERYTHING WE DO BETTER". In Puget Sound, the Puget Sound Water Quality Authority chose to "take-on" all sources of pollution simultaneously. Through a series of issue papers which identified the nature and extent of the problems and through a critical evaluation of the state of Washington's in-place programs to address those problems, the Authority made strong recommendations to the State about what needs to be done. And in response to public concern the state legislature responded with substantial increases in resources for the agencies responsible for pollution abatement and control, enforcement, and other programs to implement the Authority's recommendations.

<u>In-place contaminants</u>: Puget Sound and the Great Lakes

Both the Puget Sound and the Great Lakes programs have focused on the elimination of all current point sources of certain pollutants found in contaminated sediments. As a result of the urban embayment strategy for Puget Sound, NPDES permits have been revised and reissued with new limits on certain pollutants, previously unpermitted discharges have been identified and permitted, and best management practices have been developed and specified in permits. Increased inspections, compliance and enforcement actions have also been used as effective tools. The Great Lakes remedial actions plans will implement similar strategies.

The identification of biological impacts associated with sediment contamination has also led to the development of sediment criteria by the state of Washington. In order to establish effluent limitations for NPDES permits, the State is developing sediment criteria in the absence of national criteria. It appears that natural sedimentation may be the only safe way to ensure that these systems recover, assuming that we can ensure that the new layer of sediments being deposited is free of contaminants. Efforts to determine when mitigation, or remediation, is appropriate have also expanded.

Taking on all sources of selected priority problems: Chesapeake Bay

The Chesapeake Bay program selected the priority problem of nutrient loading and initially set out to reduce all sources of nitrogen and phosphorous to the system. Advanced wastewater treatment at the Blue Plains plant restored the Potomac River- but the cost/benefit analysis of putting the same treatment in on other tributaries vs. agricultural best management practices, is still debated. To ensure further reductions in nutrient loadings, a "gentleman's agreement" between the governors of the states establishes a goal of a 40% reduction in nutrient loadings to the Bay. Load reductions are determined segment by segment and tributary by tributary, by the states issuing permits and conducting wasteload allocations. But, it took the commitment of the governors to direct state and local officials to get the job done.

Living Resources: How much pollutant reduction is enough?

One of the principal goals of the Clean Water Act is to ensure balanced indigenous populations of fish and shellfish in the nation's waters. And, the public is demanding restoration of the abundance and productivity of living resources. The bottom line is simple- people want to be able to go fishing and eat the fish they catch. And, as environmental resource managers, we certainly recognize that fish and shellfish are indicators of the health of any waterbody.

Both the Puget Sound and Chesapeake Bay programs have "stumbled" into a hard reality- finfish and shellfish do not "magically" reappear with the improvement of water quality. Improvements in water quality have to be accompanied by the preservation or restoration of habitat, and protection of certain species. And, fishery management becomes critical to ensuring success.

In Puget Sound recent studies indicate that harvesting of intertidal organisms by the public along the shoreline may have to be controlled to protect the foodchain. These impacted species are species that were never thought to need protection. In the Chesapeake a Living Resources Committee is examining critical habitat requirements of Bay species. Where these requirements can be translated to water quality criteria and standards- dissolved oxygen standards and other habitat characteristics, they will be incorporated into state water quality management plans.

As resources managers we have simple biology, but tough management questions to address. Consider the aquatic turtle. If every mile of shoreline is developed, bulk-headed, or obstructed- the species declines because it cannot climb onto the shore, build a nest, and lay eggs. What percentage of shoreline is critical? In which tributaries? And, how do we ensure that a percentage of the total shoreline is left unaltered in the right places? Or consider striped bass. Where is it critical to reduce or eliminate low dissolved oxygen in the mainstem of the Bay? Are there critical migratory routes or refuges that the species must have access to in mid-summer in order to survive?

Interestingly enough the debate, and the need to translate the water quality objective into water quality standards and criteria and NPDES permit conditions, has the Chesapeake Bay program scurrying to determine an appropriate concentration of dissolved oxygen for the Bay- one that will adequately protect living resources. In every case, the ultimate abatement and control tool has proven to be the water quality standard and designated use, and the numeric criteria that ensure that the standard will be met. The numeric criteria provide the derivation of an NPDES permit effluent limitations, wasteload allocations and daily maximum loads for certain pollutants from both point and nonpoint sources. In the case of living resources, the water quality standard may have to begin to address land use planning and development "permits".

Water Quality Standards

State water quality standards form the backbone of surface water programs. If we are to target coastal areas that need additional controls and redirect state programs, we must rely on water quality standards. Standards and designated uses provide not only the water quality goals of "fishable, swimmable" for a water body, they provide the scientific and regulatory basis for additional control measures. And, the Clean Water Act places the responsibility on the states to adopt water quality standards to protect designated uses.

EPA develops basic scientific and technical information and publishes water quality criteria guidance for selected pollutants to protect public health and aquatic life. Those of us who worry about the coasts, frequently find EPA's fresh water orientation frustrating, and the process of developing criteria entirely too slow. For us, there are two important messages. In the absence of federal criteria, the states can develop and adopt their own criteria. And a state can adopt a criterion that is more stringent that a national criterion to ensure the attainment of water quality standards. The Great Lakes states, the state of Washington, and the states of Maryland and Virginia, are all ahead of the national criteria and standards program.

The point source control program is rapidly improving capabilities to address impacts on living resources by implementing water quality based toxic controls, wasteload allocations, and daily maximum loads. The immediate need is to develop and implement practicable control measures for nonpoint sources, particularly in coastal counties and targeted watersheds. And baseline controls for non-traditional point sources of pollution, combined sewer overflows and stormwater discharges must be top priority. We cannot overemphasize the importance of taking action now to improve base programs while more advanced science and ecological work is done. Both the National Estuary and Near Coastal Waters programs place the highest priority on an action now agenda and the demonstration of new techniques and management strategies to address nontraditional sources of pollution.

Future Direction and Legislation

In 1991, the Agency and the Congress will be involved in reauthorization of the Clean Water Act. The direction water pollution control programs take over the next 5-10 years will be established with reauthorization. In addition, the Coastal Zone Management Act is being reauthorized this year and current drafts of the bill directly address water quality impacts of land use practices. Coastal resource managers should be asking themselves some hard questions about how these pieces of legislation might better address coastal pollution problems; they should be working with EPA and representatives to Congress in the drafting of new statutory provisions where appropriate. Coastal issues are in the forefront; numerous pieces of legislation being developed now propose changes to the Clean Water Act and the National Estuary Program which may or may not be appropriate. If you are not familiar with the proposed legislation before both the House and Senate, referred to as the Coastal Defense Initiative, you should be. You are the experts in coastal protection; let EPA and Congress hear from you.

PRELIMINARY CONCLUSIONS ON THE CONDITIONS OF OUR COASTAL WATERS: STATUS, TRENDS, AND CAUSES

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As an introduction to his talk yesterday, Administrator Reilly referred to an article in the New York Times about a speech coach who is advising businessmen to emulate Winston Churchill. Even if I were up to doing it this morning, I think a "we will fight them on the beaches" kind of talk wouldn't be appropriate. As we approach the twentieth anniversary of Earth Day, Pogo's view of the enemy, at least in part, is still with us. That is "we have met the enemy and it is us." This doesn't prevent us from setting priorities, and I can take one piece of advice from the speech coach and that is, to get right into it.

The table shown below was circulated to each group yesterday and was used to identify the primary factors causing use impairments and other ecosystem impacts. This table (Table 1) is a summary of the fourteen table 1's that we had last night. You can see that all of the items identified at least came out as having some significance. In the habitat category, for each of the areas in question, all came out high. On the Sound, clearly the nutrient and organic enrichment issue was identified as the most important. As far as the Harbor is concerned, four of the five subject areas were put into the high category. For the Bight, two of the five were ranked high. Systemwide, habitat and toxics were identified as highest.

TABLE 1. PRIMARY FACTORS CAUSING USE IMPAIRMENTS AND OTHER ADVERSE ECOSYSTEM IMPACTS

	SOUND	HARBOR	BIGHT	SYSTEM
Nutrient/Organic Enrichment	H	M	M	M
Pathogens	M	H	M	M
Floatables	M/L	H	H	M
Toxics	M	H	M	H
Habitat	H	H	H	H

Now, as all of you know who participated in the groups, there was considerable variance and we're putting up a mean. To give you a little bit of a flavor for the variance, in Table 2 I've underlined the highs where there was almost complete unanimity, with a double line for the high for the Sound, single line for the highs for pathogens and habitat in the harbor. Also, in some areas, there was a lot of variance and so I put highs and lows in parentheses where there was a fair amount of disagreement.

TABLE 2. PRIMARY FACTORS CAUSING USE IMPAIRMENTS AND OTHER ADVERSE ECOSYSTEM IMPACTS (WITH VARIANCES HIGHLIGHTED)

	SOUND	HARBOR	BIGHT	SYSTEM
Nutrient/Organic Enrichment	H	M	M	M
Pathogens	M(H)	H	M(L)	M(H)
Floatables	M/L	H	H	M
Toxics	M	H	M(H)	H
Habitat	H	H	H	H

If you analyze some of the individual reports, you find that in some of the areas a number of people said high and an equal number said low for some of the categories. So, analyzing the variance in these tables would be quite complicated.

For the additional categories, in Table 3, and these are in no particular order, a number of groups identified the impact of fisheries activity, especially the harvest itself. Intensity of use in general was identified in different ways in several table 1's (numbers of people, boating activity, etc.). Also, a couple of the groups emphasized oil spills, no doubt because of the recent events on the Arthur Kill. One of the groups especially wanted to emphasize chronic oil and grease discharges and not just large oil spills as an important concern.

A number of items would be categorized as institutional/cultural. This heading was used by one of the groups to combine a number of categories, including legal framework, planning, regulations, lifestyle of people, resources allocation, and problems of integration of approach.

Solid waste was specifically mentioned by one of the groups, especially sludge and dredge spoil. Access to the shore was mentioned by a couple of groups. Growth and development, although clearly related to other categories, was singled out by a couple of the groups. And finally, esthetics -- when it's all cleaned and we look at it in the morning, it may still be ugly. That may be an issue to consider now.

TABLE 3. ADDITIONAL FACTORS CAUSING USE IMPAIRMENTS OR OTHER ADVERSE ECOSYSTEM IMPACTS

Nutrients and Organics
-- gradients, circulation patterns
-- intermediate concentrations
-- interaction with toxics
-- role of sediments
-- causes of low O_2 event off New Jersey

Pathogens
-- relationship to indicators
-- methods for studying viruses
-- data on harbors as well as beaches

Toxics
-- role of sediments, especially shellfish

Habitat
-- relate loss to real use impairments
-- predict effect of land use on water quality
-- need for long-term data

Fisheries
-- overharvest

Intensity of Use
-- numbers of people, boats, etc.

Oil Spills (also chronic)

Institutional/Cultural
-- legal, planning, regulatory
-- lifestyle resource allocation
-- integration approach

Solid Waste (especially sludge and dredge spoils

Access

Growth and Development

Aesthetics

Several groups felt we needed more information on gradients of nutrients and organics, especially in Long Island Sound. Differences between the western Sound and eastern Sound were clearly identified. Also, in the Sound and other areas, there's a question of tributaries versus the open waters. Clearly, circulation patterns need to be better understood as well as how circulation affects patterns of nutrients and organics. There's a question concerning the effects of intermediate concentrations of oxygen, e.g., numbers on the order of 4 milligrams per liter or less. We also need to know about the interaction between low levels of oxygen and toxic nutrients and organics. The role of sediments in these interactions is especially in need of study. They interact with the water column during resuspension and may become redeposited in other areas. One of the groups mentioned the causes of the low oxygen conditions on the Continental Shelf off New Jersey. We do not fully understand how unusual circulation events interact with nutrients in the system to produce this disastrous effect.

Pathogens -- there's a question as to whether the indicators really show what pathogens occur in particular environments. There are new biotechnology methods for looking at pathogens, and we need to know more about viruses. Several groups mentioned this problem, and one of the groups mentioned that we needed data on harbors as well as beaches -- especially in the Sound.

With regard to toxics, some of you emphasized the role of sediments especially for shellfish. One of the groups suggested that we really need to know how loss of habitat relates to real use impairments. Also, we need to predict the effect of land use on water quality. And, finally a couple of groups mentioned the need for long-term data sets.

I think rather than say any more, I'd like to open it up to discussion and see if there were other things that were important that I missed in going through the tables or if there are some new issues that somebody particularly wants to mention.

[Questions from people in the audience were not picked up by the recorder. The following summarizes the responses.]

Differences between the eastern and western Sound, hotspots, tributaries, and areas of heavy port activity were mentioned. Understanding a more complex matrix of sites is clearly going to be important in future studies in these areas. I have a slide that I meant to put up based on our discussion last night. It says that "the pigeon holes were not always appropriate and that we relied on a democratic process as much as on a consensus-building process." A lot of people made additional categories since the classification was different in different groups. We could not work toward a consensus because there wasn't enough time to get into a detailed consideration of the data. This meant that participants who were not reasonably familiar with the data contributed less.

The vision of the future is not shown in Table 1. The table is your perception of what the situation is now. Projection of a matrix of public concerns assuming implementation of a successful management plan would be interesting. Some of the groups talked a little bit about resource allocation -- by that they mean the distribution of money to attack these various problems. We might also think in terms of good ideas, that's another kind of resource. We do not think of ideas in terms of allocation -- this indicates one of the problems with the usual approach to resource allocation.

It has been pointed out that the general public is not well represented here. Although not the main purpose of this meeting, the estuary programs are trying to understand from the grass roots what the people are most concerned about. To reach a consensus in a public forum, we would need extensive presentation or expert opinion during discussion. We all agree that, in general, the public needs better access to data.

WORKSHOP SESSIONS ON THE PRIMARY FACTORS CAUSING USE IMPAIRMENTS AND OTHER ADVERSE ECOSYSTEM IMPACTS

NUTRIENT/ORGANIC ENRICHMENT

NUTRIENT/ORGANIC INPUT AND FATE IN THE HARBOR-SOUND-BIGHT SYSTEM

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Principal Engineer
HydroQual, Inc.

The waterways of the tri-state metropolitan area, New York-New Jersey Harbor, Long Island Sound, and New York Bight, are enriched with nutrients and organic materials from a variety of sources, both man-made and natural. Carbonaceous organic materials, commonly measured as biochemical oxygen demand (BOD), will undergo bacterial oxidation in receiving waters and will cause some level of direct reduction of dissolved oxygen. Nutrients, nitrogen and phosphorus, stimulate the growth of algae which may depress dissolved oxygen in the lower layers of receiving waters by respiration and by undergoing decomposition in bed sediments after settling. Nitrogen in the form of ammonia may also depress dissolved oxygen directly by undergoing bacterial oxidation in the water column. Depression in dissolved oxygen concentration by any of these factors below 3.0 mg/l is termed hypoxia and may adversely impact living marine resources.

Hypoxia is a recurrent problem in certain portions of the harbor-sound-bight system. Federal and state planning initiatives are currently underway within each of these areas in order to develop both short and long range conservation and management plans. With regard to control of hypoxia, the following questions have been posed within the context of these programs:

1. What are the loadings of BOD, nitrogen and phosphorus to the harbor-sound-bight system?

2. What are their relative contributions to hypoxic conditions and the development of undesirable algal species?

3. What do we know at this point about the level of load reductions required to meet existing standards or alternative end points?

4. Do we have the necessary system-wide analytic effort underway at this time to determine the required level of control?

The purpose of this paper is to provide some responses to these questions.

POLLUTANT LOADINGS

Pollutant Sources

Organic carbon and nutrients enter receiving waters from a variety of sources which may be categorized as follows for this discussion:

- Point sources consisting of municipal and industrial wastewater discharges and collected stormwater discharges including combined sewer overflows and storm drains,
- Non-point sources including uncollected surface runoff, landfill leachate, and atmospheric fallout,
- Tributary rivers carrying pollutants originating from both point and non-point sources within their watersheds,
- Oceanal disposal activities including dredged material disposal and sewage sludge disposal.

For the present discussion, the geographical limits of New York-New Jersey Harbor, Long Island Sound and New York Bight are those as shown on Figure 1. In New York-New Jersey Harbor, approximately 75 municipal and industrial point sources discharge effluent to receiving waters (HydroQual, 1989a). In addition, more than 600 combined sewer overflow (CSO) outfalls are distributed throughout the harbor area. Storm drains are also in substantial numbers. Principal tributary rivers include the Hudson, Raritan, Hackensack, Passaic, Rahway and Elizabeth Rivers.

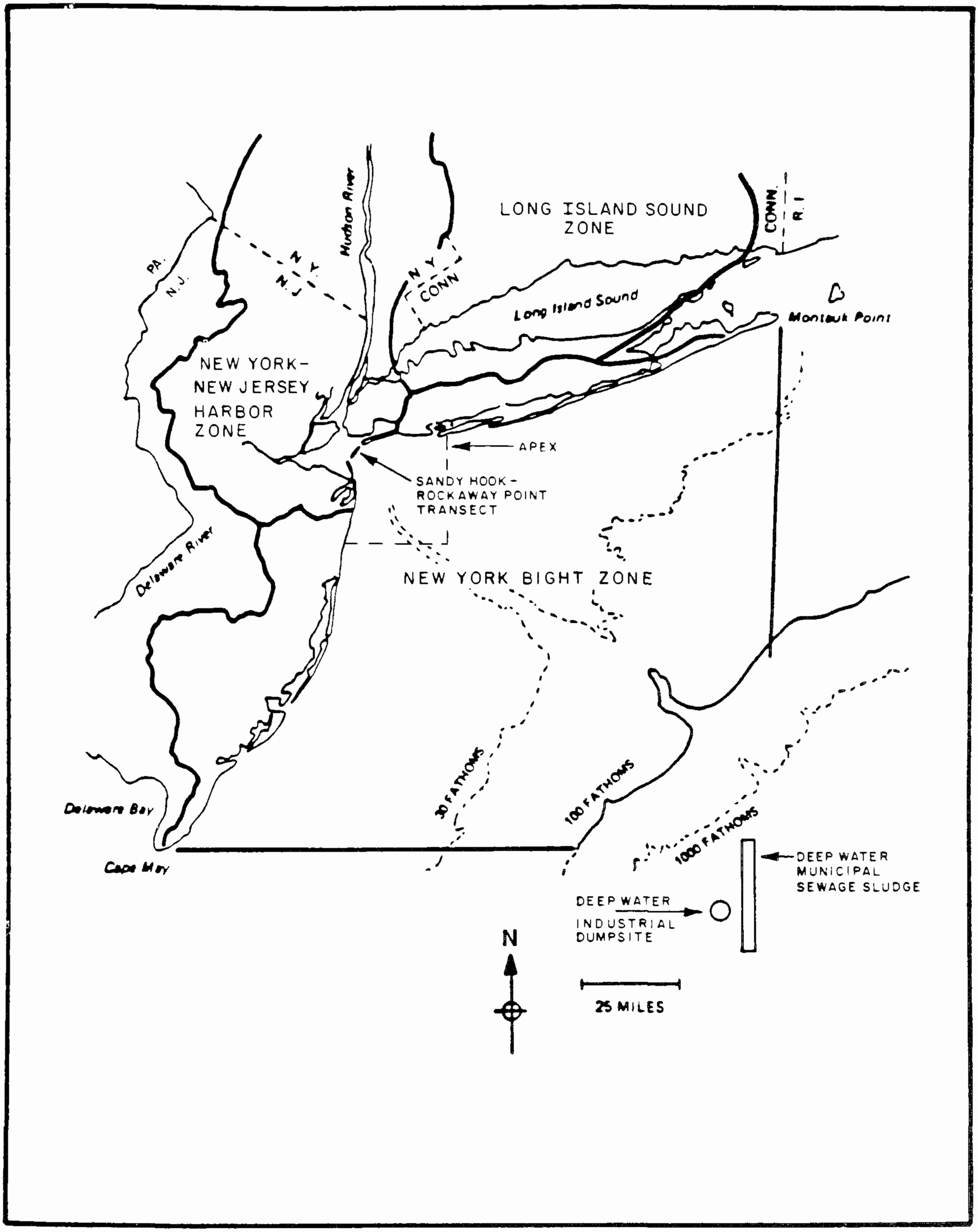


Figure 1. Location map.

In Long Island Sound, from Throgs Neck to the Race at Orient Point, there are approximately 35 municipal and industrial discharges. Some localized CSO discharges exist but most collected stormwater is discharged from storm drains. Atmospheric fallout can be a substantial non-point source due to the large surface area of the sound. Eight rivers enter the sound through six outlets, the largest of which are the Connecticut and Housatonic Rivers.

In New York Bight, there are less than 20 direct municipal and industrial point source discharges and most of these are distributed along the New Jersey shoreline between Sandy Hook and Cape May (HydroQual, 1989a). Some localized storm drainage is discharged to the bight on the New Jersey shore. As with the sound, atmospheric fallout can be a significant source of pollutant inputs due to the large surface area of the bight. Dredged material continues to be discharged at the Mud Dump within the apex but sewage sludge disposal has been relocated to the 106-mile deep water site.

In addition to direct inputs to the various waterways as described above, pollutants may be transported from one geographical area to another by net flow and dispersion in the interactive harbor-sound-bight system. As depicted on Figure 2, pollutants may be transported between New York-New Jersey Harbor and Long Island Sound by net tidally-averaged flow and dispersion in the East River. The magnitude, direction and variability of such flow is very important in this regard but poorly defined at present. Similarly, materials discharged to New York-New Jersey Harbor will be transported to New York Bight across the Sandy Hook-Rockaway Point transect at the harbor entrance. As with the East River, the magnitude, direction, and variability of the net tidally-averaged flow at this location is very important for definition of pollutant transport. The net flows, and therefore the inter-area pollutant transports, are related to hydrological factors such as the freshwater river flows, hydrodynamic factors such as tidal elevations and water density, and meteorological conditions such as wind.

In addition to pollutant transport from New York-New Jersey Harbor, the bight also receives mass transport of pollutants with the coastal oceanic drift which enters the bight along its eastern boundary and flows toward the southwest. Even though pollutant concentrations may be low, this mass input may be substantial as the coastal flow is quite large in magnitude. The bight may also receive a periodic mass influx of nutrients and organic material from transport across the continental shelf break.

As also shown on Figure 2, pollutants discharged into receiving waters may undergo various reactions and transfers both in the water column and bed sediment while being

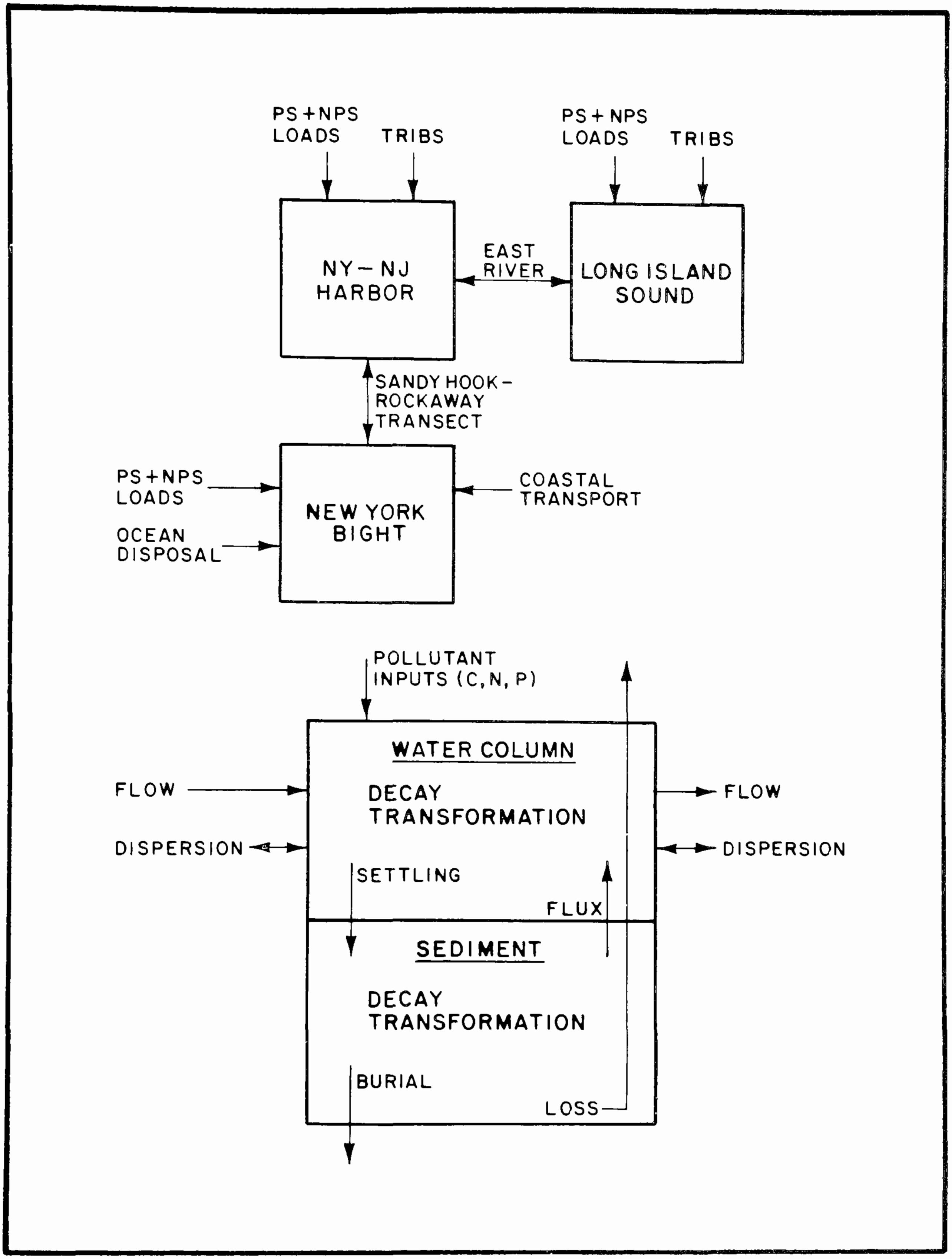


Figure 2. Pollutant sources, transport and fate.

advected with the net flow and dispersed from one area to another. These factors must also be defined to determine export from one area to another, e.g. harbor to sound or harbor to bight.

Pollutant Loadings

Inputs of BOD, total nitrogen and total phosphorus to the harbor-sound-bight system are summarized on Figures 3, 4 and 5 respectively. Each diagram indicates the total pollutant loading to each geographical area and the relative proportions originating from the various pollutant sources (HydroQual, 1989a). For organic enrichment as measured by BOD as shown on Figure 3, 82 percent of the total loading to the harbor originates from point sources of which about two-thirds originates from wastewater treatment plants with the balance from stormwater. In the sound, most of its loading (40 percent) is from the Connecticut tributaries with approximately 22 percent of the total from point sources located from Throgs Neck to the Race. It is observed, however, that a substantial fraction (37 percent) of the total is assumed to be transported into the sound from another water body, in this case, the East River. In the bight apex, the total input is estimated to be from dredged material disposal at the Mud Dump (44 percent) or transported in from the harbor (48 percent).

Figures 4 and 5 show a somewhat similar pattern for nutrients, total nitrogen and total phosphorus. Figure 4 indicates that most (66 percent) of the nitrogen loading to the harbor originates from point source discharges with approximately one-third of the total from tributaries and non-point sources. In the sound, most of the nitrogen loading is assumed to be transported in from the East River (39 percent) with another substantial fraction contributed by the Connecticut tributaries (30 percent). Other point and non-point sources comprise the balance (16 and 15 percent). In the bight apex, almost all of the loading is assumed to be transported in from adjacent water bodies, either from the harbor or with the coastal drift. In general, similar patterns are observed for phosphorus on Figure 5.

The information used to develop the loading diagrams of Figures 3, 4 and 5 ranges from good to poor. The most uncertain parts of the estimated inputs are those which deal with inter-area transports, that is, from the East River to Long Island Sound and from New York-New Jersey Harbor to New York Bight. These uncertainties must be resolved for effective management planning.

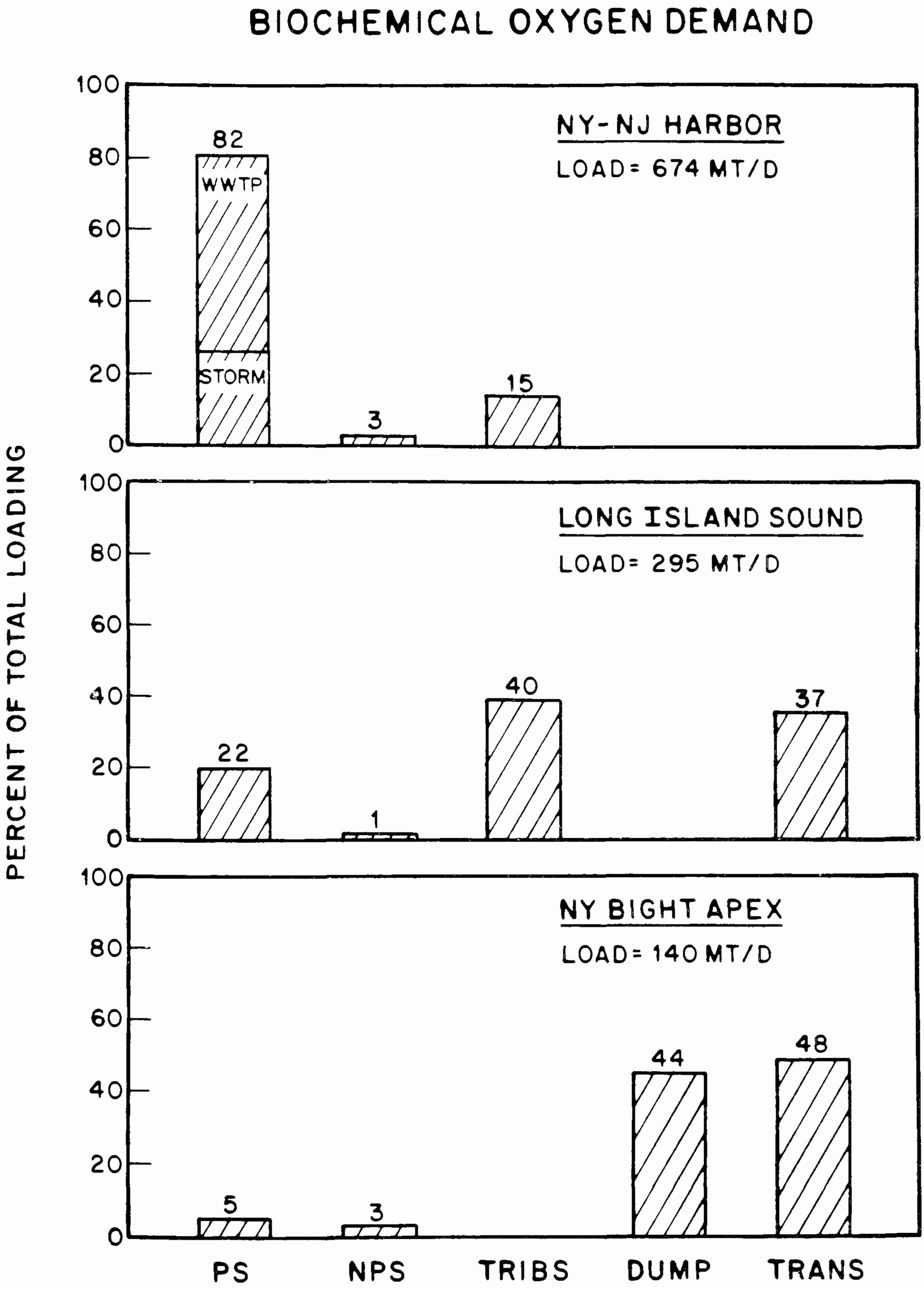


Figure 3. BOD loadings to harbor, sound, and bight apex.

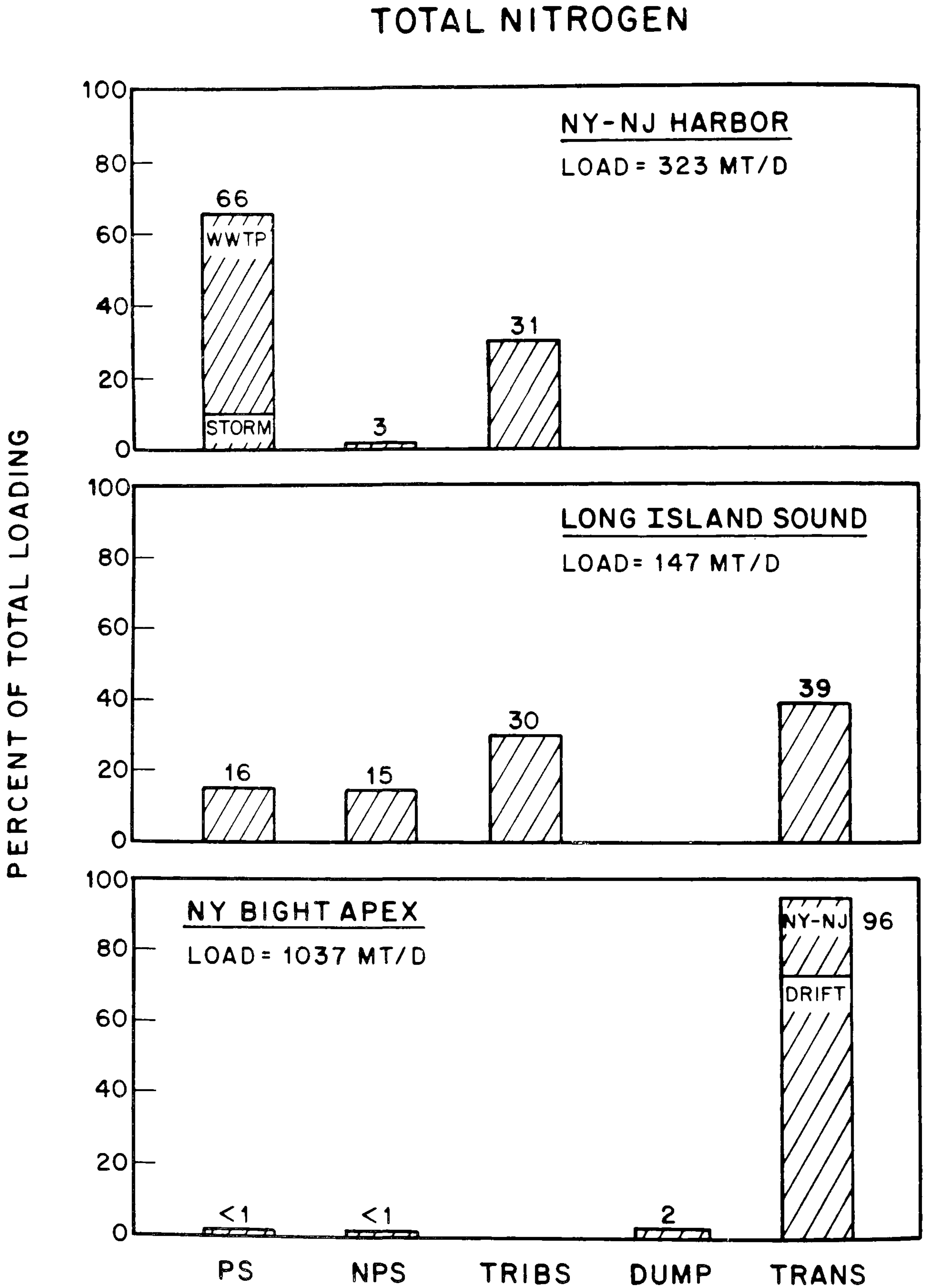


Figure 4. Total nitrogen loadings to harbor, sound and bight apex.

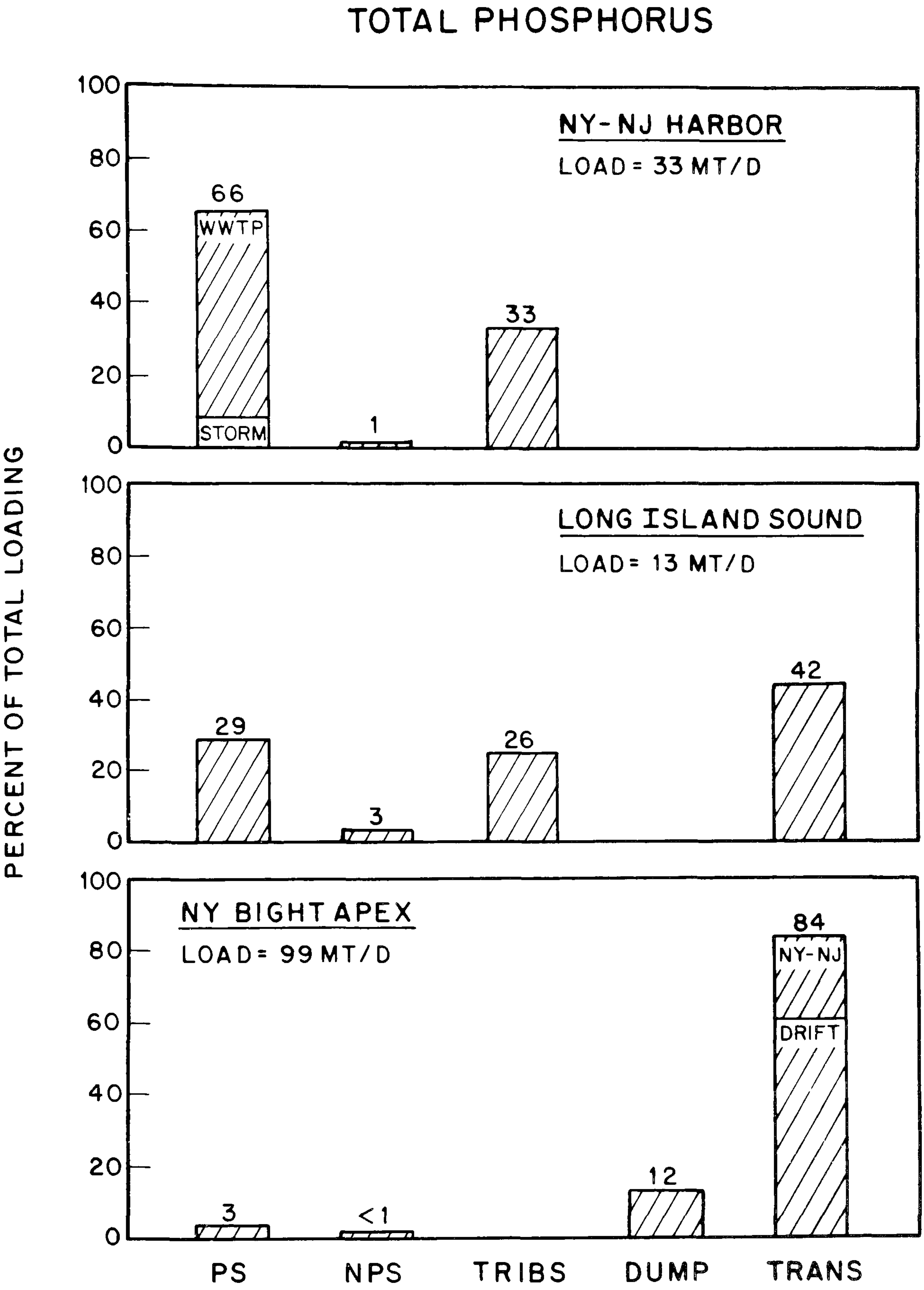


Figure 5. Total phosphorus loadings to harbor, sound and bight apex.

POLLUTANT IMPACTS

The estimated effects of pollutant loadings on hypoxic conditions in the harbor-sound-bight system are shown on Figure 6. For New York-New Jersey Harbor, the East River was selected for analysis, a major waterway with more depression in dissolved oxygen than other harbor locales. Summer 1984 conditions are shown as analyzed previously (HydroQual, 1984) for the New York City Department of Environmental Protection (NYCDEP). In this analysis, the dissolved oxygen was 3.4 mg/l, producing a dissolved oxygen deficit (depression below the natural dissolved oxygen saturation value) of 4.3 mg/l. The New York Harbor Water Quality Model developed during the 208 Areawide Wastewater Management Planning Study was applied to analyze 1984 conditions in the East River. As shown on the diagram, it is estimated that greater than 70 percent of the oxygen depression is caused by bacterial oxidation of organic carbon inputs (BOD). Approximately 15 percent of the oxygen depression may be related to nutrient impacts (NUT), primarily from sediment oxygen demand associated with decaying, settled algae, with the balance of the depression, 10 percent, from boundary conditions (BC), that is, from pollutants and effects in adjacent waterways. It is judged that these results for the East River are representative of the harbor in general.

In Long Island Sound, August 1988 conditions in the Western Narrows were selected for evaluation. In this case, the approximate level of dissolved oxygen in bottom waters was 2.0 mg/l producing a deficit of 5.5 mg/l. For the cause and effect analysis, the two-dimensional (vertical, longitudinal) water quality model, LIS.2, being developed (HydroQual, 1990) as part of the Long Island Sound Estuary Study was used. This interactive water column-sediment model relates nutrient and organic inputs to the development of algae and performs a dissolved oxygen balance of the various sources and sinks. As shown, it is estimated at present that, in contrast to the East River, the major cause of dissolved oxygen depression is nutrient related, approximately 70 percent of the total, as caused by algal respiration in the subpycnocline water column and algal related sediment oxygen demand. Organic carbon in the form of BOD from pollutant inputs is estimated to cause approximately 15 percent of the total oxygen deficit and boundary conditions, the balance.

In the New York Bight Apex, modeling studies conducted to date are very preliminary in nature. An analysis (O'Connor and Mancini, 1979) was conducted of August 1974 conditions with a bottom dissolved oxygen concentration of approximately 3.0 mg/l in the

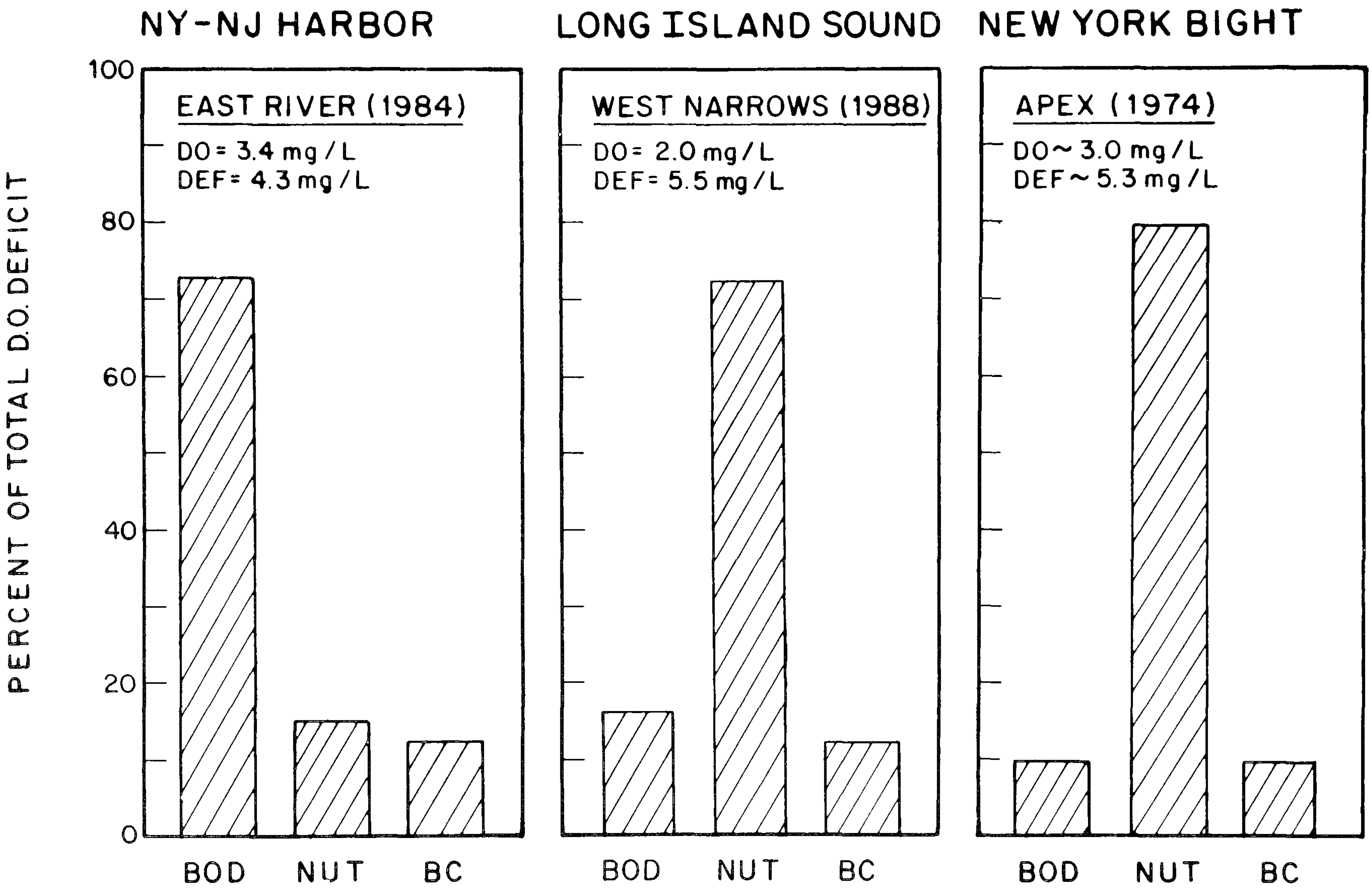


Figure 6. Dissolved oxygen depression by cause.

bight apex. On the basis of the modeling analysis, it was estimated that approximately 80 percent of the oxygen depression was related to nutrient-algal effects with the balance divided between organic effects and boundary influences. It is noted that the organic carbon effect appeared to be related to sewage sludge disposal extant at that time at the 12-mile site, and since relocated.

In summary, analyses to date indicate that dissolved oxygen depression in New York-New Jersey Harbor is primarily related to organic carbon inputs while that in Long Island Sound and New York Bight is primarily nutrient driven.

Nutrient enrichment also contributes in part to the development of nuisance algal blooms, that is, more localized intense concentrations of objectionable species which appear periodically in area waters, especially along the New Jersey shoreline. Historical monitoring by the New Jersey Department of Environmental Protection and EPA indicates that such localized, intense blooms often begin in northern coastal waters, Raritan and Sandy Hook Bays, in spring and early summer and then appear to move to open coastal waters with tidal currents and the coastal drift. Understanding of the causes of nuisance algal blooms requires research on the nutrient requirements and kinetic growth characteristics of the various organisms. Effective control of this problem is contingent upon the development of scientific understanding of the nutrient and other requirements of the nuisance organisms and the environmental dynamics which trigger the blooms.

REQUIRED LEVELS OF LOAD REDUCTION

On the basis of current knowledge, some information on the required level of load reduction to achieve dissolved oxygen standards or alternative endpoints is summarized in Table 1. In the harbor, modeling analyses to date have indicated that secondary treatment for reduction of carbonaceous material at the various wastewater treatment plants will be satisfactory to achieve existing dissolved oxygen standards for current water use classifications in the open waters. In some confined tributaries, control of CSO discharges may be required to abate localized oxygen depression; this is currently under study by NYCDEP in the City-Wide CSO Studies. Generally, nutrient removal from loadings within the harbor is unnecessary to manage oxygen in harbor waters, but may be required to abate hypoxia in the sound or bight depending upon the export of harbor loadings to those locales. Nutrients and algal effects appear to be of significance in the dissolved oxygen balance of Jamaica Bay.

REQUIRED LEVEL OF LOAD REDUCTION
ABATEMENT OF HYPOXIA

	NY-NJ HARBOR	LI SOUND	NY BIGHT
ORGANIC CARBON	* SECONDARY TREATMENT	* PROBABLY NONE ??	* POSSIBLY SOME ??
	* STUDY CSOs		
NUTRIENTS	* NONE FOR HARBOR	* PROBABLY SUBSTANTIAL ??	* POSSIBLY SUBSTANTIAL ??
	* SOME FOR SOUND/BIGHT ??	* DEFINE HARBOR EXPORT	* DEFINE HARBOR EXPORT
	* ASSESS FOR JAMAICA BAY		* ASSESS MANAGEABILITY

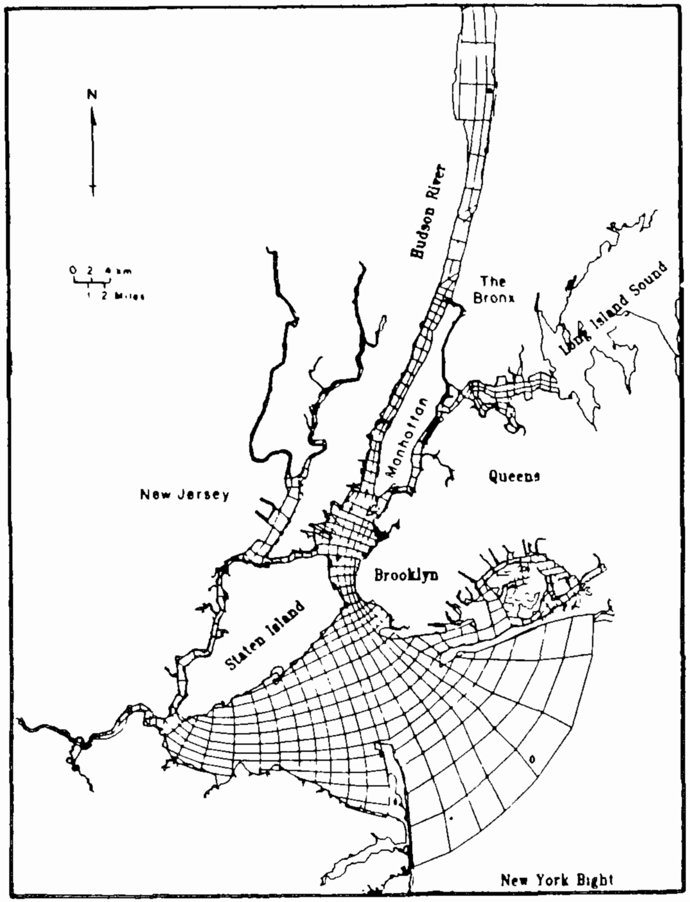
In Long Island Sound, as dissolved oxygen depression in bottom waters is related primarily to nutrient induced effects, it is probable that substantial nutrient reduction will be required for management, but the appropriate level is yet to be determined by the Long Island Sound Estuary Study. An important issue which must be resolved in this regard is the export and impact of nutrient materials discharged to the harbor which may affect conditions in the western sound by transport through the East River. It is unlikely that control of organic carbon inputs to the sound will be effective for hypoxia management but this is yet to be determined.

The situation in New York Bight is essentially similar to that of the sound. The issue of the magnitude and impact of nutrient export from harbor to bight is very important in terms of assessing the manageability of the periodic hypoxia. The relative influence of "background" nutrient concentrations within the coastal drift and the effect of relatively small, but perhaps locally important, discharges along the New York-New Jersey shorelines must be evaluated. The effect of reducing organic carbon discharges to the bight is likely to be minor.

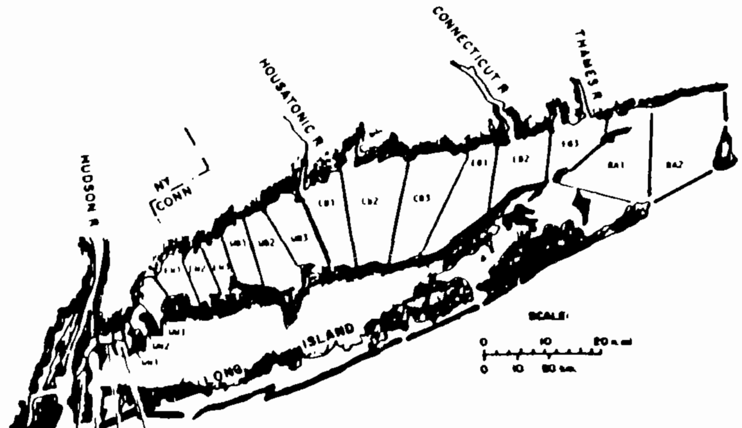
SYSTEM-WIDE ANALYSIS

At present, initial steps toward a system-wide analysis of the harbor-sound-bight system are in progress but no integrated analysis is yet in place. The Long Island Sound Estuary Study includes various mathematical modeling techniques to define the cause and effect relationships between nutrient and organic carbon inputs and hypoxia in order to assess the effectiveness of various levels of control. The preliminary two-dimensional hydrodynamic model shown on Figure 7 will be developed further to a coupled three-dimensional hydrodynamic and water quality model for this purpose. A special task currently in progress will quantify flow and pollutant transport characteristics in the East River to assess the significance of New York-New Jersey Harbor inputs on dissolved oxygen problems in the western sound. It is judged that the studies currently underway in Long Island Sound will permit development of an effective management plan for hypoxia.

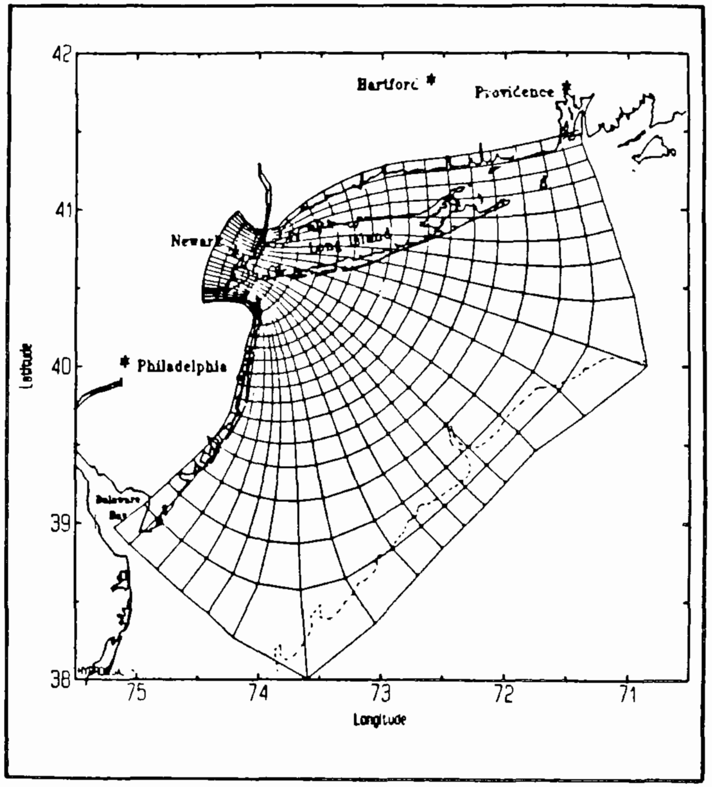
A similar but preliminary modeling study is beginning in New York Bight as part of the Bight Restoration Plan. In this study, circulation analysis will be performed by a model similar to that shown on Figure 7 (HydroQual, 1989b) which will incorporate hydrodynamic features of all three geographic regions: bight, sound and harbor. A companion water



Updated New York Harbor Model Grid



LIS-II SEGMENTATION



THE COMPUTATIONAL DOMAIN AND CURVILINEAR, ORTHOGONAL GRID

Figure 7. Model grids for the harbor, sound and bight.

quality model for nutrient/organic-algal-dissolved oxygen interactions will begin at the Sandy Hook-Rockaway Point transect and will be confined to the western portion of the bight proper at this time. It is almost certain, however, that if the hypoxia problem in New York Bight appears to be manageable, that is, if "controllable" inputs in New York-New Jersey Harbor have a significant impact on bight hypoxia, then an integrated analysis of the harbor-bight system will be required. For this purpose, the updated New York Harbor Model also shown on Figure 7, a three-dimensional coupled hydrodynamic and water quality model being prepared at present for NYCDEP in the CSO studies, could be linked to the bight model for the analysis. The harbor model, presently focusing on coliform bacteria and dissolved oxygen, would be developed further to incorporate nutrient-algal interactions. Circulation patterns and nutrient and organic carbon dynamics in the harbor would then be evaluated to determine pollutant export from harbor to bight, a key concern. Thus, "controllable" nutrient sources would be linked directly to the hypoxia problem in the bight in order to assess management requirements.

Ultimately, it would be desirable to link all modeling frameworks together, harbor-sound-bight, to provide a comprehensive analytical tool for the entire interactive system.

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NUTRIENT/ORGANIC ENRICHMENT

ECOLOGICAL EFFECTS AND ACCEPTABLE AMBIENT LEVELS

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ECOLOGICAL EFFECTS

The ecological effects of nutrient and organic enrichment in regional marine waters are described elsewhere in this volume and in several other publications (Riley, 1972; Malone, 1978, 1982; Yentsch, 1977; Falkowski et al., 1980; Swanson and Sindermann, 1979; Parker, 1990; Welsh and Elder, 1990). So, I describe only broadly the dynamics of carbon, oxygen and nutrient cycling, and human influences on theses cycles. Emphasis is placed, rather, upon the estimation of hypoxic effects in New York-New Jersey Harbor, New York Bight and Long Island Sound, and the best ways to portray the improvements expected from alternative management decisions.

We are concerned about the effects of nutrients and organic carbon in waters around New York only because their natural cycles are out of kilter. For millions of years the NY-NJ Harbor Estuary, the Long Island Sound, and inner NY Bight have cycled nitrogen, phosphorus, other plant nutrients, and organic carbon. The cycles of these materials have been in approximate balance as portrayed in Figure 1.

For millions of years this cycle mineralized the organic carbon produced by a few large animals, and lots of smaller plants and animals. These organisms remained in balance with nutrient and carbon cycles, partially because they didn't have the destructive behavior of congregating at the margins of surface waters.

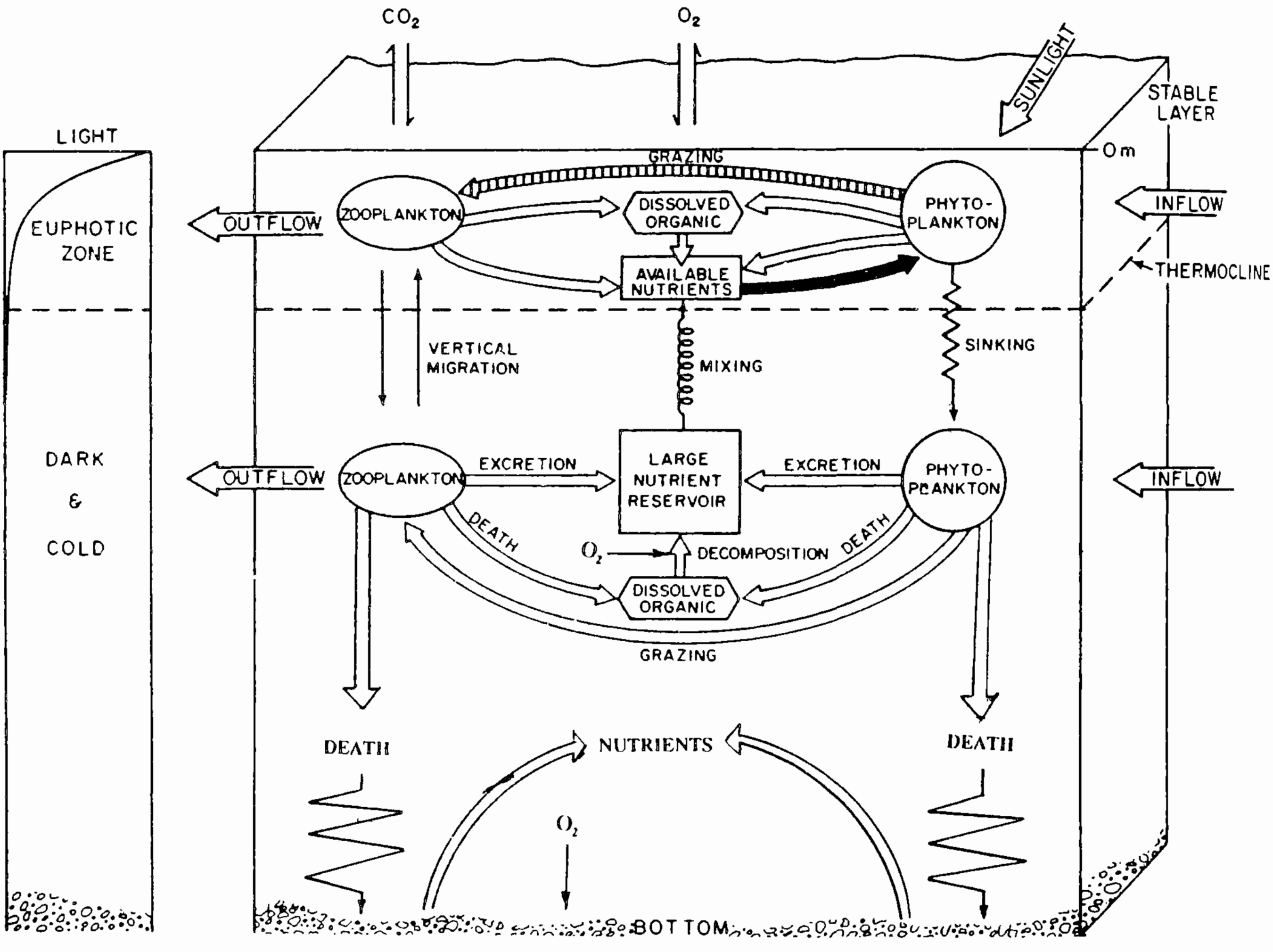


Figure 1. Nutrient and organic carbon cycling in marine ecosystems. (Adapted from B.H. Ketchum. 1967. Symposium on Primary Productivity and Mineral Cycling in Natural Ecosystems. AAAS, Washington, D.C.)

Only recently has European man deforested the region, fertilized it for crops and channeled most human waste into rivers and estuaries. Only since then has the organic carbon accumulated much faster than it can be mineralized, even with the help of several large STPs. These STPs don't get rid of the carbon or nutrients, they mineralize the carbon to CO_2 and the nutrients originally in the organic matter. The nutrients are then discharged to water and are quickly taken up by phytoplankton the nutrients again become incorporated in organic carbon.

First some generalizations about the biological importance of dissolved oxygen (DO):

- o DO is needed by all marine organisms except sulfur bacteria
- o low DO concentrations have serious biological effects at much higher concentrations than are required to cause death
- o biological effects of low DO are modified greatly by water temperature, toxicants and other stressors.

We know little very about historical trends in DO concentrations until they were measured directly in this century.

Over the past several decades there have been clear trends in minimal summer DO concentrations in some water bodies of the region. Most areas of New York-New Jersey Harbor, during the summers of recent years, had substantially more DO in bottom waters than was present before large-scale upgrading of sewage treatment (NYC DEP, 1990; Suszkowski, this Proceedings). Conversely, and perhaps as a partial consequence of more complete and effective treatment of sewage discharged to the Harbor, bottom DO concentrations in western Long Island Sound have declined on average for at least the past 20 years (Parker, 1990). In addition the summer hypoxic areas (however defined) of the Sound are becoming larger (Parker, 1990). Similar trends in the New York Bight are not evident.

From a management perspective, however, much longer trends are of more interest. The total extent of human activity that has altered natural nutrient cycles is some indication of how much effort is required to reverse the trend toward worsening hypoxia. Historical trends in nutrient loadings will suffice as a measure of hypoxic severity today relative to European settlement. Century-long estimates for the Hudson and Raritan River watersheds are presumed to be broadly comparable to trends in watersheds of Long Island Sound and the New York Bight.

Since initial deforestation of the region, increasing nitrogen loadings have been due primarily to fertilizer usage and human waste. By 1880 total nitrogen loadings must have already increased to several times those of the natural watersheds, due primarily to deforestation and the wastes of several million inhabitants (Van Bennekom and Salomons, 1980; Ayres et al., 1988). These early increases in nitrogen loadings may well have been greater than later increases from 1880 to the present. Total nitrogen loadings to the Hudson-Raritan Estuary from all sources appear to have increased only about 40% from 1880 to 1980 (Ayres et al., 1988).

However, the increment in total phosphorus loadings to the Estuary from 1880 to 1980 exceeds 300% (Ayres at al., 1988). Since all human influences have increased riverine phosphorus inputs to the oceans by about four-fold (Van Bennekom and Salomons, 1980), this more than three-fold increase in the past century may be a large fraction of the total increase over natural conditions.

Now the human population of the New York region is approaching 20 million (a common Year 2000 projection). It is not surprising that our wastes have altered greatly the nutrient and carbon cycles outlined in Figure 1:

- o organic carbon has accumulated in water and sediments
- o all or most of the bottom DO is used up in mineralizing the carbon during late summer
- o as a result, the mineralization process is slowed down in late summer
- o also as a result of low DO concentrations, organisms suffer a variety of stresses including mortality in extreme situations
- o oxygen depletion in turn alters other geochemical cycles, notably the sulfur bacteria act on organic carbon to release hydrogen sulfide
  In shallow bays the hydrogen sulfide escapes to air, causing well-known odors and blackening of lead paint.

Lots of quantative information exists about particular biotic effects of particular DO concentrations. Unfortunately direct field evidence is difficult to get. It is quite expensive to be in the field at precisely the right places and times, and field measurements as always are quite variable. Still, the State of Connecticut Department of Environmental Protection is making surprisingly good field measurements of hypoxic avoidance by lobsters and some bottom fishes. Also, NY State's Department of Environmental Conservation has been able to document hypoxic mortality of lobsters in pots. Both of these field measurements are valuable, particularly in helping define the areal extent of hypoxia with clearly defined impacts.

Figure 2 gives some perspective on the biological effects that occur as DO concentrations decline in marine waters.

The most rigorous evidence as to the lowest DO concentrations that do no harm will continue to come from controlled laboratory studies. Laboratory investigations of low DO effects are continuing a EPA's Environmental Research Laboratory, Narragansett, Rhode Island. The Narragansett Laboratory has exposed several organisms to low DO, and finds that 4.3mg DO/l is, so far, the highest DO concentration required to protect the organisms tested.

DO Concentration	Effect
0 - 0.5 mg/l	Death of living organisms, except sulfur bacteria
0.5 - 1	Some benthic organisms can live for a few days
0 - 1.5	Phosphorus liberated from sediments very rapidly
1.5 - 3	Many organisms leave or die; some benthic invertebrates die within days to weeks
~ 3	50% mortality in some organisms after 96-hour exposures in the laboratory
3 - ?	Lobsters and some fishes leave or avoid hypoxic Long Island Sound waters
4.3	Atlantic silverside chronic effects value; effects possible at even higher DO concentrations

Figure 2. Ecological effects of hypoxia. (Adapted from Mountford and Reynolds [1988].)

RELATIONSHIP BETWEEN PHYTOPLANKTON CONCENTRATIONS AND PERCEIVED WATER QUALITY

Biotic effects of low DO from phytoplankton blooms are probably seen as the most important manifestation of degraded water quality, but additional effects are often seen as very important:

o reduced water clarity ("dirty water")
o surface slicks
o odors from algae or anaerobic muds
o some species of algae can decimate shellfish stocks
o poisonous shellfish, from toxicants produced by phytoplankton.

People often perceive dense phytoplankton concentrations and their consequences as serious. Perhaps this is partially because some hypoxic impacts are so tangible; they can be highly visible (e.g., fish kills) and they can smell strongly.

EXISTING STANDARDS AND CRITERIA

Surface marine waters of the region have been classified by New York, New Jersey and Connecticut as to their "best use." Some are classified as usable for bathing and shellfishing, others support the propagation of resident biota, others support only the maintenance and migration of fishes. There are variations on these basic categories. Within each classification a minimal DO concentration, a standard, has been defined to support these uses (NYS DEC, 1989; NJ DEP, 1985; Connecticut DEP, 1987).

These standard or minimally acceptable DO values are shown in Figure 3. The standard values range from 3 to 5 mg DO/l through out the Harbor area. The DO standards for LIS and the New York Bight are primarily 5 mg DO/l with some Connecticut waters having standards of 6 mg/l.

At present there are no DO criteria for marine waters. Criteria, or carefully documented estimates of the DO concentration that fully protect most marine organisms, are now being developed for the LIS region. These marine criteria are being developed by EPA's Environmental Research Laboratory in Narragansett, Rhode Island. When developed, these criteria will synthesize all sources of quantitative evidence that particular DO concentrations harm organisms (through reduced growth, impaired reproduction, avoidance behavior, etc.)

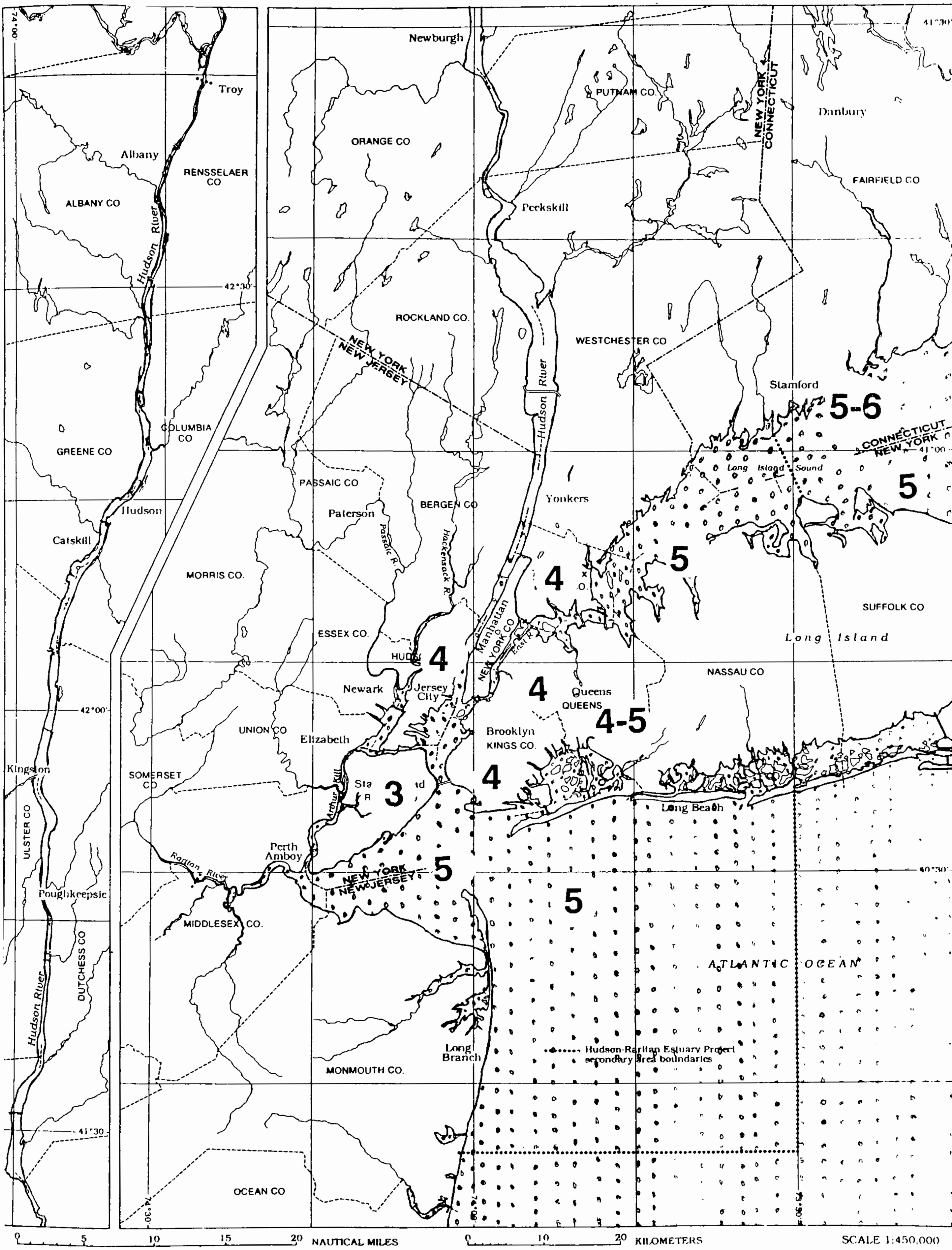


Figure 3. Marine water quality standards for dissolved oxygen concentrations (mg DO/l).

Existing DO standards have limited value as endpoints for management decisions. Routine, seasonal violations of DO standards for many years, in the Sound and elsewhere, have not yet prompted responses that achieve DO standards. Many reasons have been given for these shortfalls, but one issue may be particularly important for our purposes. The total societal costs of DO concentrations falling below standard, say 5 mg DO/L, are not clear. Indeed, if the decline is not far below 5 mg/l, does not persist, and is limited to a small area of the Sound, the costs may well be negliable arguably nonexistent.

More difficulty arises over more severe, persistent DO declines over larger areas. At some stage the severity, persistence and areal extent become management issues. However, existing standards provide minimal guidance in this matter; all we know is that DO concentrations should not fall below 5 (or 6) mg/l anyplace in the Sound.

FORMULATING DO ENDPOINTS

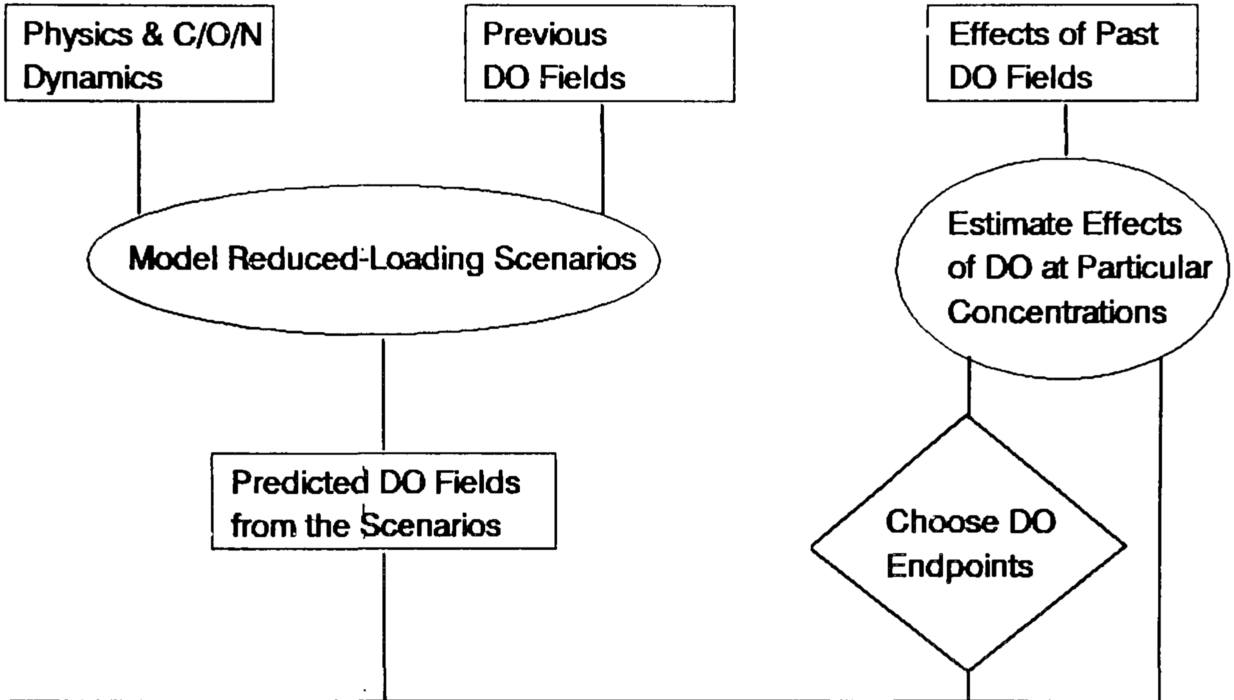
It is relatively easy to understand hypoxia, its causes and its effects, at least imprecisely. It is much harder to say what can be done about it. How can we frame the issue in the Sound most usefully for environmental managers? A number of us from agencies concerned with the Sound are trying to frame the probable consequences of particular alternatives for remediating hypoxia in the Sound (see Acknowledgements). We wish to illustrate these alternatives and their likely results in the most useful way.

First it seems evident that some form of control over nutrient and carbon loadings to the Sound is the only practical way to reduce hypoxic impacts. (I intentionally avoid the issue of whether N, P or both is the best nutrient to limit.) So we assume that the impacts of hypoxia are direct functions of nutrient loadings, recognizing perhaps very long lags in response to reduced loadings, and recognizing that weather is a major influence on the severity of hypoxia. At least in the mean, hypoxia in the Sound can be remediated only by limiting nutrient and carbon loadings.

Figure 4 illustrates an overall strategy to frame these management options for remediating hypoxia. Other strategies are possible of course, but broadly they might well be variations on this theme designed for Long Island Sound.

As with most strategies, this one starts out with what we already know, in the three boxes at the top of Figure 4:

o physics and the dynamics of carbon, oxygen and nutrients
o DO concentrations (fields of bottom DO)
o biological effects of low DO within these maps or fields.



Management Options & Benefits

Option	Ecological	Cultural	$ Benefits	$ Cost
	Benefits			
Do Nothing	–	–	–	Unchanged
Reduce N15%	+	+	+	–
Reduce N30%	+	+	+	–
Reduce N50%	+	+	+	–

Figure 4. Estimating the benefits of control programs.

We are not so much interested in the DO values, per se, as in their biotic effects. Effects are outlined broadly in Figure 2, but we need quantitative measures of effect - better ones than we have. These are being estimated through both lab and field work as indicated at the right of Figure 4. Given reliable relationships between DO concentrations and ecological effects, we can estimate the effects of past hypoxic events to the extent that past DO fields are quantified. Existing data permit rough approximations of the areal extents and durations of low DO fields for very few recent years.

So far we can estimate the ecological effects of past hypoxic events for which DO fields are known. To estimate future benefits of different nutrient management options we must model what is expected to happen when nutrient loadings are limited by specified amounts (see Figure 4).

I use the notion of a "DO endpoint" as a managerially useful description of DO effects after a particular limitation on loadings, accounting for the time lag in effects of course. What kind of endpoint is most useful? The most obvious way to frame the issue is to predict the improvements in hypoxic effects that would result from limiting the loadings by different amounts. How much nutrient limitation is required to meet the state DO standards, or the EPA DO criterion when defined? How much is required to meet other DO endpoints?

An important point of departure is the minimal DO concentration at which chronic exposures (over one to a few weeks) will protect sensitive species of the region against adverse sublethal effects. This "final chronic value" is being defined by EPA. For the sake of discussion now, consider the minimal DO concentration that will protect against known (and incompletely measured) adverse chronic effects: about 4.3 mg/l. (The EPA regional DO criterion will also probably specify an acute criterion value, but this complication is not considered here.) So we assume (perhaps optimistically) that hypoxic effects will not occur in LIS unless DO concentrations fall below 4.3 mg/l for a week or so.

But the managerial significance of DO concentrations below 4.3 mg/l depend importantly upon the area of habitat affected. If, say, 300,000 acres of the Sound were hypoxic (<4.3 mg/l) during the worst recent summer, how many acres would be hypoxic if nutrients were reduced by 15%, and how long would it take to reach better DO conditions? How much improvement could be expected from 30% to 50% nutrient reductions? A predictive model to answer these sorts of questions is being developed by HydroQual, Inc. in collaboration with NOAA.

Say we were confident that 50% nutrient reduction would reduce the now 300,000 acre hypoxic area to the neighborhood of 50,000 acres within a decade. Intermediate nutrient reductions would be expected to result in intermediate hypoxic acreages (Figure 4). For each nutrient reduction scenario the acreages subjected to even lower DO concentrations (below 3, 2 and 1 mg/l) are also estimable.

From these sorts of endpoints, outlined at the bottom of Figure 4, we can foresee estimating ecological benefits more reliably than from alternative ways of describing "hypoxia." I should acknowledge that this general approach to characterizing DO endpoints was outlined independently, but earlier, by the Chesapeake Bay Program (Mountford and Reynolds, 1988).

There is now very little to say about the cultural and economic benefits from remediating hypoxia in the Sound. Perceptions of these benefits should be enhanced greatly by reliable, however imprecise, knowledge of the corresponding ecological benefits (Figure 4).

ESTIMATING BENEFITS OF CONTROL PROGRAMS

Comprehensive and quantitative knowledge of existing hypoxic impacts, however imprecise it must remain, is obviously essential for estimating the benefits of control programs. The long Island Sound Study (LISS) continues to acquire this knowledge.

The best way to estimate the benefits of control programs is to keep careful tabs on the LIS system after nutrient controls have been implemented. It is particularly important to monitor nutrient loadings and the areal extent of the lowest DO fields with enough reliability to detect changes of the order expected. This implies monitoring that is costly enough to justify a lot of care in defining the sampling designs. Neither the sampling strategies nor the intensity of environmental monitoring programs are generally adequate for their objectives (NRC, 1990). The principles of sampling design to minimize costs are well known, but they are hard to apply in a situation like the Sound. For instance, there are such large uncertainties in even current nutrient loadings from the East River to the Sound that feasible sampling efforts could not adequately keep track of presumed nutrient limitations. Adequate resolution of these East River nutrient loading requires better understanding of transport in the East River in addition to nutrient distributions (St. John, this proceedings). DO monitoring in the Sound might be more efficient if the timing of expensive, full-scale surveys could be optimized by prior, cheaper surveys that predicted the timing of maximal DO declines.

Among the largest sources of uncertainty in estimating nutrient control benefits will be our estimated relationship between improved DO conditions and the response of biota. Better estimates of low DO effects on sensitive organisms and life stages is probably one of the most cost effective ways to better estimate the benefits of control programs. Of particular value would be controlled, laboratory exposures of animals to low DO over the same durations of hypoxic exposure experienced in nature. These natural exposures are often weeks long in western Long Island Sound. Despite the difficulty of conducting such experiments, they could substantially strengthen our knowledge of safe lower bounds on DO concentrations (Boswell et al., 1987).

Any further insight into hypoxic effects is almost certain to increase the known concentration of DO that causes effects; it is unlikely that new knowledge will reduce the minimal DO concentration of concern. This sort of research, in the field or laboratory, is cheaper than the monitoring required, and it could lead to recognition that the benefits of nutrient controls are greater than we now realize.

Improved oxygen regimes would result in benefits apart from enhancing the quality of the Long Island Sound ecosystem. These economic and cultural benefits are expected to derive largely from ecological improvements, but are perceived as monetary gains to the regional economy and as largely undefined public satisfactions. At least some of the economic benefits are estimable in principle. However, useful measures of them require prior estimates of both existing ecological impacts and the reduced impacts resulting from nutrient controls. The LISS expects to estimate both the ecological and economic estimates.

The variety of expected cultural benefits can not be captured by existing measures. As is true of environmental improvements generally, the importance of the cultural benefits must be assessed by governments with minimal technical guidance.

ACKNOWLEDGEMENTS

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Controlling Point and Nonpoint Nutrient/Organic Inputs: A Technical Perspective

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An Unfinished Agenda

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The over-abundance of nutrients and organic pollutants continues to be one of the most serious water quality problems faced in water bodies like the Chesapeake Bay. Eutrophication is a process where excess nutrients result in the over stimulation of algal growth. During eutrophic conditions, abnormally large growths of algae upset the balance of the river's ecosystem. The effects of such algal growth in aquatic systems may include fish kills, lower species diversity, reduced light penetration, odor problems, visual annoyance, low dissolved oxygen, and decreased assimilation of pollutants.

Nutrient controls for point and nonpoint sources are continuing to evolve. As the options for the control of nutrients increase in scope, the need for cost and effectiveness comparisons among different management options becomes essential to achieve an equitable allocation of resources. Cost information has been historically difficult to obtain that would be directly associated with the removal of nutrients from the water system. For example, agricultural best management practices have been used for decades as a means of reducing soil loss from erosion. Only recently however, have they been associated with the reduction of nutrients from agricultural runoff. Therefore, the installation of agricultural best management practices may be economically justified by reducing soil loss before calculations are made on the amount of nutrients saved. Similarly, only in recent years has sufficient experience and data become available to quantify point source and urban runoff control costs. This report will concentrate on the direct benefits of reducing nutrients and will over-simplify a complex situation of economic benefits for the sake of comparison between different sources. Its purpose is to give the policy maker a sense of the possible with respect to effectiveness and costs of the control options available.

Data utilized in this report is generally drawn from the experiences and study of nutrient controls for the Potomac River Basin, which covers 14,000 square miles across the states of Pennsylvania, West Virginia, Virginia, Maryland, and the District of Columbia. The Potomac is the second largest tributary to the Chesapeake Bay estuary system, which is over 64,000 square miles. Major progress over the past 20 years has been made in restoring the Potomac River estuary through point source nutrient and organic controls. A major Chesapeake Bay-wide restoration effort is now in high-gear, with a year 2000 goal of a 40% reduction in nitrogen and phosphorus now being implemented. Continual improvement in the Potomac and achievement of the Chesapeake Bay restoration goal will require continued implementation of a mix of point, agricultural, and urban controls. While there are numerous variations and considerable range in the costs and cost-effectiveness of the options covered in this report, the authors believe that the data is a reasonable representation of the state-of-the-art controls available at the start of the last decade of the 20th century.

Methodology

This report looks at the nutrient/organic removal options available to the environmental decision maker for both point and nonpoint sources. Cost estimates based on the amount of nutrients saved (removed) per year will be used to evaluate the tradeoffs between various nutrient reduction technologies. In addition, prevention methods reducing nutrient inputs before they enter the waste stream for both point and nonpoint sources will be presented.

Biological nutrient removal (BNR) will be highlighted as an advanced method of reducing both nitrogen and phosphorus from the municipal point source waste stream. Further, traditional methods of chemical addition will be looked at for phosphorus and nitrogen removal. The implementation of phosphate bans will be described as a method of preventing nutrients from entering the waste stream.

Urban runoff controls will be reviewed for a variety of different control structures under several different development scenarios. Preventive measures will be addressed including the use of street cleaners and leaf collection.

Agricultural nutrient control options will be looked at including pasture, cropland, and animal waste. These areas of runoff will be reviewed with an emphasis on the cost of controls installed in the Potomac River Basin. Preventive measures of nutrient control including nutrient management techniques, the conservation reserve program, and conservation tillage will be evaluated.

Point Source Control Options

The control of nutrients from <u>municipal point sources</u> continues to be the focal point of most nutrient reduction strategies. Municipal wastewater treatment plants remove nutrients with even the most basic forms of treatment. Nutrients tend to bond to sediment and can be consumed by micro-organisms which are then removed from the waste stream. Nutrient removal systems generally increase the amount of sludge created at wastewater treatment plants. Advanced tertiary treatment can produce effluent containing low nutrient concentrations.

In primary treatment, a portion of the suspended solids and organic matter is removed from the wastewater. This removal is usually accomplished with physical operations such as screening and sedimentation. The effluent from primary treatment will ordinarily contain considerable organic material and will have a relatively high biochemical oxygen demand (BOD)(Tchobanoglous, 1985).

The effluent from primary treatment is further processed to remove organic matter and suspended material in secondary treatment. Ingeneral, biological processes employing micro-organisms are used to accomplish secondary treatment. The effluent from secondary treatment usually has little BOD and suspended solids and may contain several milligrams per liter of dissolved oxygen (Ibid., 1985). The EPA National Municipal Policy has resulted in secondary treatment levels in the majority of municipal wastewater treatment plants in the U.S.

Biological nutrient removal (BNR) systems for municipal wastewater treatment have been recommended as a means of reducing nutrients which cause water quality problems. BNR systems can be installed in new plants instead of traditional secondary treatment or can be retrofitted in existing plants. Biological nutrient removal systems are very new in this country and are currently being tested under a variety of situations. Their advantage is for modest additional capital investment, secondary treatment facilities can have enhanced nutrient removal.

Blue Plains and other advanced plants in the Washington D.C. area use the more traditional method of chemical addition for phosphorus removal. However, as more becomes known about BNR technology, it is expected that a number of plants will evaluate the applicability of BNR, particularly if nitrogen removal is necessary to protect the Chesapeake Bay.

Nitrification, is a biological process implemented to remove organic nitrogen and ammonia loads. Nitrification provides some removal of total nitrogen and has been used successfully for over a decade in the metropolitan Washington region.

What is BNR?

Biological nutrient removal (BNR) is a biological system to reduce the amount of nitrogen and/ or phosphorus in sewage treatment plant effluent. BNR strategies involve the movement of primary effluent through aerobic, anoxic, and anaerobic zones (see Figure 1.). The aerobic zone consists of aerators which add oxygen thereby causing nitrification -- the transformation of ammonium nitrogen into nitrate nitrogen. The anoxic zone causes denitrification -- the transformation of nitrate nitrogen into nitrogen gas. Internal mixers in the anoxic zone facilitate the release of nitrogen gas into the atmosphere. The anaerobic zone is for the removal of phosphorus and this process is also facilitated by the use of mixers. These different zones contain micro-organisms that are constantly recycled back into the system to maintain steady biological conditions. To achieve greater phosphorus removal, BNR systems can be supplemented by traditional chemical addition (the addition of metallic salts).

BNR systems vary according to design, effectiveness, cost, consistency, and removal efficiency. Some of these differences are summarized in Table 1. The table lists systems for the removal ofphosphorus and/or nitrogen. For example the phostrip process only removes phosphorus, the Bardenpho system only reduces nitrogen, and the VIP process removes both phosphorus and nitrogen.

One of the basic differences between different BNR systems is the hydraulic residence times (HRT) -- the time wastewater is being processed by the different biological processes. Basically, the longer the residence time the higher the cost of removal and the greater the removal of nutrients. For example, the Bardenpho system in Table 1 has a long residence time resulting in a high cost and excellent nitrogen removal.

New plant costs in Table 2 illustrate the different levels of costs associated with an increase in hydraulic residence time. These costs are based on the construction of a new generic plant to handle 21 million gallons per day (mgd) of waste. The costs of the different options must be looked at in conjunction with the treatment levels achieved with a specific plant design. For reduction of both nitrogen and phosphorus to low permit limits the use of BNR with chemical addition allows for the most flexibility while still remaining on the low end of costs. Costs for a new BNR plant are in the same ballpark as secondary treatment as shown in Table 2.

Retrofitting currently operating plants with nutrient removal technologies is difficult and expensive compared to installing these options when a facility is first built. The current conditions at a facility need to be taken into account to determine the most cost effective alternative. For example, compatibility with existing treatment processes, hydraulic limitations, site constraints, wastewater characteristics, sludge handling impacts, and permit compliance during construction -- are all considerations that need to be factored into a retrofitting

Figure 1
BNR Process Schematic

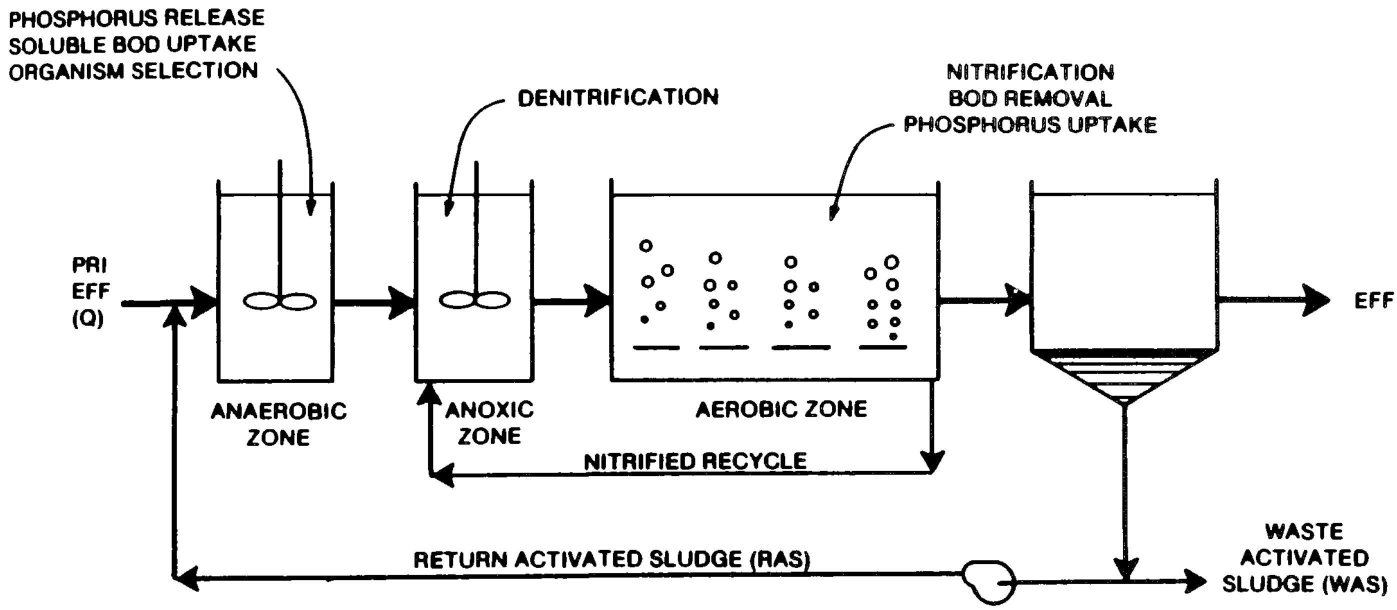


Table 1

Comparison of BNR Process Characteristics

Process	Nutrient Removal Capability Phosphorus	Nitrogen	Operational Flexibility	New Plant Costs
Bardenpho	Least	Best	Least	High
A2/O	Moderate	Moderate	Least	Low
UCT	Good	Moderate	Moderate	Moderate
VIP	Good	Moderate	Moderate	Moderate
AO	Moderate	Least	Least	Low
Oxidation Ditch	NA	Good	Moderate	Low
Phostrip	Best	Least	Good	Moderate
Chemical Treatment	Best	Least	Best	High

NA - Not Applicable
Modified from CH2M Hill report by Glen T. Daigger, 1988.

Table 2
New BNR Treatment Options

Treatmtent Process	TP (mg/l)	TN (mg/l)	Avg. Cost 21 mgd plant ($ millions)	O&M Costs ($ millions)	Yearly Capital Costs ($ millions)	Cost per Pound TP $/lb/year	TN $/lb/year
Secondary Treatment	6	18	$55.76	$3.26	$5.60	NR	$11.54
BNR (6-hr HRT)	4	10	$55.80	$3.51	$5.60	$71.20	$7.12
BNR (6-hr HRT) + Chemical Addition	2	10	$59.67	$4.04	$5.99	$39.23	$7.85
Secondary Treatment + Chemical Addition	1.0	18	$62.86	$4.12	$6.31	$38.87	$13.63
BNR (16-hr HRT) + Chemical Addition + Filtration	1.5	3.0	$73.56	$4.14	$7.39	$43.19	$7.20
BNR (16-hr HRT) + High pH Phosphorus Precipitation	0.2	3.0	$106.94	$7.61	$10.73	$49.43	$10.62

Total yearly capital cost based on 8% yearly interest spread over a life of 20 years. The total phosphorus with no treatment was assumed to be 6 mg/l and with nitrogen to be 30 mg/l. Based on December, 1989 Dollars using the Consumer Price Index for all cities in the U.S. Modified from CH2m Hill, 1988.

decision. As a result, it is very difficult to determine an average price to retrofit a generic plant. However, the state of Virginia completed an extensive study examining the costs of retrofitting current WWTPs with nutrient removal technologies (CH2m Hill, 1989). The nutrient removal technologies in the study were not limited to BNR but were the most cost effective option for each plant. The large difference in costs found in this Virginia study associated with changing a plant to meet different permit requirements are shown in Table 3. In addition, it has been found that the seasonality of the permit limits would have a significant impact on the cost of nutrient removal.

Chemical addition is a method of removing phosphorous to very low concentrations by adding metallic salts. The most common additives include aluminum sulfate and ferric chloride. Metallic salts are added in solution to the wastewater and combine with the phosphorus which then precipitates out into the sludge train. This greatly increases the amount of sludge that needs to be removed from a plant. Chemical addition can be used on its own or as a backup forbiological removal.

Chemical and Physical Processes for Nitrogen Removal

There are several major methods of nitrogen removal besides the biological methods previously described. Ammonia stripping, selective ion exchange, breakpoint chlorination, and methanol addition are some of the most commonly used technologies. These methods tend to be more controllable under the constantly changing environmental conditions of most systems. As a result, chemical-physical methods are often used alone or as a process to refine biological nitrogen removal to meet permit requirements.

Ammonia stripping provides nitrogen removal by elevating the pH and allowing ammonia to be released into the atmosphere. The process involves elevating the pH of the wastewater to near ten. At this point ammonia can freely leave the water into the air. This process is further stimulated by the use of towers to expose the water and the ammonia to the air surface. These towers require pumping and large fans to maintain a high evaporation rate. Controls on the discharge of the ammonia into the atmosphere can be installed to utilize hydrogen sulfide as a stripper. The result is the production of ammonium sulfate which can be recovered and recycled. One draw back for this method is the failure of the system to work well under cold conditions (below 32 degrees F).

Selective ion exchange uses a naturally occurring zeolite, clinoptilolite for the selective removal of ammonia from wastewater. The clinoptilolite is exposed to the wastewater and it attracts ammonia ions to its surface. Once the clinoptilolite becomes full of ammonia ions and other particles it is regenerated by stripping the ions to form an ammonium solution to be used as a fertilizer. Then the clinopotilolite is reused over again to collect more ammonia ions. This method is currently being used by the Upper Occoquan Sewage Authority in Virginia to reduce nitrogen levels to the Occoquan reservoir. The selective ion exchange produces an effluent with about 1.6-2.0 mg/l total nitrogen. Using this method in conjunction with breakpoint chlorination can result in a plant meeting a 1.0 mg/l total nitrogen effluent limit.

Breakpoint chlorination is the process of removing nitrogen by chemically oxidizing ammonia into nitrogen gas. This proces is capable of nearly complete removal of nitrogen from the waste stream. In addition, this process is capable of adjusting to fluctuations in temperature and flow. Therefore, this proces provides a method of treating effluent to meet strict permit requirements. The drawback is the cost of using the heavy doses of chlorine necessary to reach the breakpoint where ammonia is transformed into nitrogen gas. In addition, safety concerns have been raised due to the large volumes of chlorine required.

Methanol addition was evaluated by Greeley and Hansen, Inc. (1984)as a means of removing nitrogen for Potomac estuary wastewater plants. In this process, methanol, a carbon source, was added to deep bed anoxic filters where biological denitrification would occur. This method was capable of achieving total nitrogen limits down to 3 mg/l. Cost data from that study, adjusted to 1989 dollars, is provided in Table 4. Generally, this method is highly reliable but capital and operating cost intensive, although comparable in cost to BNR retrofit costs on a per pound basis. Methanol addition can also be used to enhance BNR Processes (Tchobanoglous, 1985) in achieving lower total nitrogen concentrations.

Nonpoint Source

Urban Runoff Control Options

The nutrient loadings associated with urban runoff have been well documented (Beaulac, Reckhow, and Simpson, 1980). There are different loading rates for old urban areas with no runoff controls, recently built areas with peak flow attenuation, and new urban areas with stormwater nutrient control.

The best measure of urbanization within the basin is the

Table 3.
POTW Retrofit Cost Estimates for Nutrient Removal

POTW	Design Flow	TP = 2 mg/l Capital ($ millions)	TP = 2 mg/l O&M ($ millions)	Cost/lb/year TN	Cost/lb/year TP	TN=10 mg/l & TP=2 mg/l Capital ($ millions)	TN=10 mg/l & TP=2 mg/l O&M ($ millions)	Cost/lb/year TN	Cost/lb/year TP
Arlington *	40.0	0	1.88			44.28	6.57	11.31	-
Alexandria *	54.0	0	4.33		-	127.34	7.64	15.52	-
Lower Potomac *	72.0	0	4.53			66.23	9.13	8.99	-
UOSA *	54.0	0	8.83	-		24.22	12.95	5.01	-
Mooney *	24.0	0	1.18		-	11.08	2.54	6.24	-
Quantico *	2.0	0	0.16			1.55	0.29	9.23	-
Aquia *	6.0	0	1.33		-	3.62	1.49	12.65	-
Fredricksburg *	4.5	0	0.08			2.74	0.44	6.57	13.13
FMC	6.0	1.05	0.22	-	4.45	12.22	0.65	12.86	25.72
Massaponax	6.0	0.24	0.22	-	3.30	15.78	0.66	15.32	30.64
Little Falls Run	8.0	0	0.25		-	0.30	0.40	2.21	4.41
York	15.0	0.49	1.11	-	6.34	11.03	0.89	5.50	11.00
Richmond *	70.0	0	0	-	-	52.45	0.18	3.20	-
Falling Creek	10.0	0.08	0.37		3.06	4.01	0.30	2.87	5.75
Proctors Creek	27.0	1.35	0.67		2.47	14.57	1.29	4.18	8.36
Henrico	45.0	2.71	0.50		1.42	71.52	3.65	9.88	19.75
Petersburg	15.0	1.78	0.54	-	3.98	6.67	1.06	4.73	9.47
Hopewell *	50.0	0	0		-	71.52	11.62	15.43	-
Williamsburg	22.5	0.22	1.52	-	5.63	19.51	2.68	8.46	16.93
Fort Eustis	3.0	0.06	0.13	-	3.69	6.01	0.30	12.31	24.62
James River	20.0	0.41	1.40		5.92	13.09	0.72	4.17	8.33
Boat Harbor	25.0	0.52	1.51		5.12	78.05	2.50	16.97	33.95
Nansemond	30.0	6.31	1.50		5.83	36.80	1.80	6.44	12.89
VIP	40.0	0.77	0.17	-	1.94	45.64	3.27	8.05	16.11
Army Base	18.0	0.36	0.72		3.45	28.94	1.74	10.60	21.20
Chesapeake	24.0	0.44	1.45	-	5.12	62.30	0.93	12.28	24.55
Total	691.0	16.78	34.60	-		831.22	75.67		

Design Flow, Capital and O&M values are from Ch2M Hill, 1989. The cost per pound of nutrient removed is estimated based on the yearly total cost and the nutrients reduced based on an original effluent of 18 mg/l of nitrogen and 6 mg/l of phosphorus. Plants with an * already meet the proposed phosphorus effluent limits.

Table 4
Estimated Nitrogen Removal
Cost-Effectiveness
Potomac Estuary WWTPs Methanol Addition to TN = 5 mg/l

Plant	Flow	Incremental Capital Cost Millions $	Incremental Cost-Effectiveness $/lb/yr
Alexandria	49	22.8	2.43
Arlington	32	6.1	1.70
Dale City	6.5	3.9	2.62
Lower Potomac	50	6.4	1.65
Mooney	12	5.0	1.71
Quantico	1.5	1.4	4.58
Piscataway	34	9.7	1.61
Mattawoman	10	3.7	1.35
Blue Plains	370	220.6	2.75

Source: Adapted from Greeley and Hansen, 1984. Escalated 1982 dollars to 1989 dollars using the Consumer Price Index.

total impervious area (ie., the lump sum of all the highways, structures, parking lots, etc.) The impervious fraction of urban land produces the majority of the nutrient load, as well as the additional annual stormwater runoff volume. Schueler (1987) has studied the relationship between impervious area and urban runoff control and provides a detailed analysis of the best management practices to ameliorate urban runoff. Alternatives discussed by Schueler include detention facilities and infiltration controls. Removal efficiencies of a variety of different urban control practices is included in Table 5 (Ibid., 1987). Recent work by the Council of Governments (Galli, 1989) has examined a new technology termed a peat sand filter for urban runoff control.

Dry extended detention ponds rely primarily on settling to remove pollutants. Depending on how much and how long runoff is detained, it is possible to achieve moderate to high removal rates for particulate pollutants that are relatively easy to settle. However, removal rates for most soluble pollutants are quite low for dry extended detention ponds, although it is possible to enhance rates by incorporating biological removal mechanisms into the design of the pond (e.g., by establishing a shallow marsh in the bottom stage of a dry extended detention pond, or by using extended detention in combination with a wet pond).

Wet ponds have a moderate to high capability (up to 80%) of removing most urban pollutants, depending on how large the volume of the permanent pool is in relation to the runoff produced from the surrounding watershed. Wet ponds utilize both settling and biological uptake, and are capable of removing both particulate and soluble pollutants. In addition to increasing the volume of thepermanent pool, wet pond removal rates can be enhanced by establishing marshes around the perimeter, and by adjusting the geometry of the pond.

Infiltration Practices (trenches, basins, porous pavement)

From a pollutant removal standpoint, infiltration trenches, basins, and porous pavement behave in a similar manner, and can be treated as a group. Infiltration practices filter runoff through the soil layer, where a number of physical, chemical, and biological removal processes occur. Infiltration practices have a moderate to high removal capability for both particulate and soluble urban pollutants, depending how much of the annual runoff volume is effectively transported through the soil layer. Removal rates can be further enhanced by increasing the surface area reserved for transporting and adjusting the geometry of the practice to achieve a draining time of less than 3 days. It should be noted that infiltration practices should not be relied on to achieve high levels of particulate pollutant removal (particularly sediments), since these particles can rapidly clog the device. Rather, particulate pollutants should be

Table 5
Comparative Pollutant Removal Of Urban BMP Designs

BMP/design	SUSPENDED SEDIMENT	TOTAL PHOSPHORUS	TOTAL NITROGEN	OXYGEN DEMAND	TRACE METALS	BACTERIA	OVERALL REMOVAL CAPABILITY
EXTENDED DETENTION POND							
DESIGN 1	◕	◔	◔	◔	◑	⊗	MODERATE
DESIGN 2	●	◑	◔	◑	◕	⊗	MODERATE
DESIGN 3	●	◕	◑	◑	◕	⊗	HIGH
WET POND							
DESIGN 4	◕	◑	◔	◔	◔	⊗	MODERATE
DESIGN 5	◕	◑	◔	◔	◕	⊗	MODERATE
DESIGN 6	●	◕	◑	◑	◕	⊗	HIGH
INFILTRATION TRENCH							
DESIGN 7	◕	◑	◑	◕	◕	◕	MODERATE
DESIGN 8	●	◑	◑	◕	●	◕	HIGH
DESIGN 9	●	◕	◕	●	●	●	HIGH
INFILTRATION BASIN							
DESIGN 7	◕	◑	◑	◕	◑	◕	MODERATE
DESIGN 8	●	◑	◑	◕	●	◕	HIGH
DESIGN 9	●	◕	◕	●	●	●	HIGH
POROUS PAVEMENT							
DESIGN 7	◑	◕	◑	◕	◑	◕	MODERATE
DESIGN 8	●	◕	◕	◕	●	●	HIGH
DESIGN 9	●	◕	◕	●	●	●	HIGH
WATER QUALITY INLET							
DESIGN 10	○	⊗	⊗	⊗	⊗	⊗	LOW
FILTER STRIP							
DESIGN 11	◔	○	○	○	◔	⊗	LOW
DESIGN 12	●	◑	◑	◕	●	⊗	MODERATE
GRASSED SWALE							
DESIGN 13	○	○	○	○	○	⊗	LOW
DESIGN 14	◔	◔	◔	◔	○	⊗	LOW

KEY:

- ○ 0 TO 20% REMOVAL
- ◔ 20 TO 40% REMOVAL
- ◑ 40 TO 60% REMOVAL
- ◕ 60 TO 80% REMOVAL
- ● 80 TO 100% REMOVAL
- ⊗ INSUFFICIENT KNOWLEDGE

Design 1: First-flush runoff volume detained for 6-12 hours.
Design 2: Runoff volume produced by 1.0 inch, detained 24 hours.
Design 3: As in Design 2, but with shallow marsh in bottom stage.
Design 4: Permanent pool equal to 0.5 inch storage per impervious acre.
Design 5: Permanent pool equal to 2.5 (Vr); where Vr=mean storm runoff.
Design 6: Permanent pool equal to 4.0 (Vr); approx. 2 weeks retention.
Design 7: Facility exfiltrates first-flush; 0.5 inch runoff/imper. acre.
Design 8: Facility exfiltrates one inch runoff volume per imper. acre.
Design 9: Facility exfiltrates all runoff, up to the 2 year design storm.
Design 10: 400 cubic feet wet storage per impervious acre.
Design 11: 20 foot wide turf strip.
Design 12: 100 foot wide forested strip, with level spreader.
Design 13: High slope swales, with no check dams.
Design 14: Low gradient swales with check dams.

Reproduced from Controlling Urban Runoff: A Practical Manual For Planning and Designing Urban BMPs by Schueler (1987).

removed before they enter the structure by means of a filter strip, sediment trap or other pretreatment device.

Peat sand filters have recently been developed to use peat as a medium to increase infiltration and promote biological activity to remove pollutants from wastewater. In the Washington metropolitan area there are several demonstration projects being constructed to manage stormwater runoff utilizing this practice. These projects will provide more information on the actual effectiveness and implementation costs of peat sand filters.

Cost of Urban Pollutant Removal

The costs of implementing the different kinds of BMPs was studied for the Washington region by Wiegand, et al, (1986). This paper evaluates the installation of extended detention ponds, wet ponds, infiltration basins, infiltration trenches, porous pavement, and porous pavement with extra storage. The results of this cost analysis can be found in Table 6. These costs are based on nutrient removal efficiencies determined by field studies by MWCOG, 1983. In addition, annual operating costs were determined by using a project life of 20 years and an 8% discount rate.

Based on the analysis of costs and cost-effectiveness of various urban BMPs discussed, some general conclusions can be drawn. First, although somewhat variable, BMP construction costs can be reasonably explained by a regression model in which base construction costs are a function of storage volume. The resulting regression equations can, in turn, be used to generate planning level estimates of comparative BMP construction costs. Second, the incremental costs of building a multi-purpose water quality BMP,in lieu of the conventional stormwater management dry pond, vary with land use and watershed size. In general, structures serving larger drainage areas are more cost-effective. Finally, economic factors, while important, are often not the only consideration in urban BMP selection. Other factors such as pollutant removal capability, and aesthetic and recreational values are becoming more important factors in the selection of stormwater management BMPs.

Agricultural Runoff Control Options

Agricultural BMPs have been in existence since the 1930s to aid farmers with the control of erosion and sediment control. Many of these same practices have been found to be effective in the control of sediment related pollutants such as phosphorus and some pesticides. In addition, there has been many recent changes in agricultural practices that can reduce the amount of nutrients entering river systems. Examples of these new methods include conservation tillage, fertilizer management, and nutrient management of manure. The three main types of agricultural runoff include cropland, pasture, and animal waste.

Cropland runoff contributes nutrients at a site specific rate according to slope, soil, crop, tillage practice, fertilizer input, and BMPs installed. Different tillage practices leave the soil exposed to erosion forces in varying ways. For example, conventional tillage requires plowing the ground. Soil is easily eroded when there is no vegetation to hold the soil in place. An assortment of other BMP practices have been designed to keep the soil on the land. In addition, there are new methods of nutrient management to more accurately provide nutrient needs for plant uptake.

Pasture runoff can be a significant source of nutrients. For example, over grazing reduces the total amount of vegetation available for nutrient uptake and reduces the vegetative cover keeping the soil in place. Grazing can compact the soil decreasing soil permeability resulting in greater runoff rates. In addition, where livestock congregate for drinking water, eating, and cooling, there is the potential for increased nutrient release from animal waste. Therefore, the periodic moving of eating and drinking sites will help alleviate local overuse problems.

Animal waste nutrient contributions are difficult to estimate as each individual farmer deals with this resource differently. Nutrients from animal wastes are taken up by crops, pasture, volatilize into the atmosphere, and digested by microbes. This results in a substantial reduction of nutrients from the time nutrients leave the animal until they reach the water system. In addition, the implementation of BMPs such as manure storage facilities, ponds, and lagoons can further reduce the nutrient load to the water system. Large animal waste sources are now subjectto permits in the State of Virginia.

The cost-effectiveness of various agricultural BMPs have been evaluated over the years for their on-farm benefits and have been considered economically beneficial to the farmer and in turn to society in the form of constant and inexpensive food sources. Off-farm environmental benefits have been a consideration, but have not been looked at in the cost-effectiveness of most practices. There is little information available on the effectiveness of agricultural BMPs in the reduction of nutrients for both groundwater and surface flow. Further, when information is available it relates to site specific cases and cannot be used to generalize across an entire watershed. There is information on practices installed on specific soils, fertilizer rates, crop type, and cropping practice. This makes it very difficult to determine the effectiveness of an average BMP.

Table 6

Cost-Effectiveness of Urban BMP's in Nutrient Removal

Development Scenario	Ponds		Infiltration		Porous Pavement	
	X-D	Wet	Basin	Trench	No Extra Storage	With Extra Storage
Incremental Cost, $/lb/yr - Total Phosphorus removed						
Single-Family Residential						
1 acre		-	262	886	-	
10 acre	29	367	112	356	-	-
25 acre	28	282	37	255		-
Townhouse Residential						
1 acre	-	-	149	534		546
10 acre	24	112	42	248	-	637
25 acre	20	86	22	143	-	660
Commercial Shopping Ctr.						
1 acre	-	-	104	480	2	79
10 acre	23	64	14	194	62	22
25 acre	20	54	7	143	89	107
Incremental Cost, $/lb/yr - Total Nitrogen removed						
Single-Family Residential						
1 acre	-	-	37	128	-	-
10 acre	7	94	16	51	-	-
25 acre	7	72	6	44		-
Townhouse Residential						
1 acre		-	22	77	-	79
10 acre	6	28	6	59	-	92
25 acre	5	22	3	26	-	96
Commercial Shopping Ctr.						
1 acre		-	15	69		63
10 acre	6	16	1	28	9	71
25 acre	5	14	1	21	13	66

All costs are expressed in December, 1989 dollars from the Consumer Price Index. Annual payment calculations are expressed in 1989 dollars and assume a twenty year note and a 8% interest rate. Table was modified from Wiegand, et al, 1986.

For the sake of comparison, the effectiveness of some of the common practices used in the field have been estimated in the Virginia BMP Handbook (1979). The efficiencies listed in this reference may be optimistic regarding the effectiveness of agricultural BMPs. Once the removal efficiency of a BMP is determined there is the consideration of how many nutrients runoff a particular land use. For this paper the use of median runoff values from Beaulac, Reckhow, and Simpson, (1980) were used. Normally a range of values needs to be used to address the potential effectiveness of a particular practice. The end result of these calculations will enable a calculation of the amount of nutrients saved by a particular BMP project.

Information was readily available on the number of agricultural BMPs installed in the Potomac River Basin in 1987 from the U.S. EPA Chesapeake Bay Liaison Office (Schuyler, 1988). The information included the type of BMP installed, the total area treated by each BMP, the sediment reduction, the cost-share amount, and the total cost of the BMP. The acres treated were then multiplied by a nutrient export coefficient and by the removal efficiency of the particular practice. This resulted in a gross estimate of the nutrient removal of the practice based on average nutrient export from that particular land use. These values were then multiplied by the life span of the practice to determine the total

Table 7

Incremental Costs of Nutrients Removed From ASCS Federal Cost Share in Potomac Basin Counties in 1987

BMP	Life Span of Practice	Removal Efficiency TN	TP	TN $/lb/yr	TP	Number Installed
Cropland						
Strip Cropping	1	60	60	27	165	78
Terrace System	10	60	60	7	43	3
Diversion	10	30	30	32	198	18
Cover Crop	1	30	30	12	73	218
Critical Area Planting	5	60	60	53	325	26
Sediment Basin	10	45	45	39	237	20
Sod Waterways	1	30	30	1329	8174	158
Pasture						
Permanent Vegetation Improvement	5	60	60	5	32	705
Grazing Land Protection	10	60	60	14	89	185
Pond	5	60	60	7	46	16
Permanent Vegetation Cover	5	30	30	17	109	94
Stream Protection	10	15	15	293	1883	7
Forest Tree Plantations	5	60	60	20	129	48
Animal Waste						
Animal Waste System	10	80	80	0.75	8	36
Animal Waste Control	10	80	80	1.75	20	44

The costs shown here have been adjusted to December, 1989 prices using the Consumer Price Index. Removal efficiencies are for illustration only and may not represent expected values in the field for a particular BMP.

nutrient reduction expected to occur during the life of the practice according to Soil Conservation Service regulations. The total cost share was then divided by the total nutrient load to arrive at an estimation of the cost per pound of nutrient saved. The results of this analysis are shown in Table 7.

These values provide a rough estimate and were calculated specifically for this report and are not meant to provide true field costs or removal rates of nutrients. More research in this area needs to be performed and calculated in the future to enable an interdisciplinary approach to the cost effectiveness of various nutrient control alternatives.

The cost-effectiveness of agricultural BMPs has been studied using CREAMS modeling. An example of the CREAMS modeling results can be found in a paper by Crowder and Young (1988) evaluating the cost effectiveness of BMPs in Pennsylvania. This paper supplies a range of cost effectiveness for a variety of nutrient control alternatives for agriculture (Table 8) for comparison. The cost effectiveness found in Table 8 are significantly lower than the estimates derived above from the implementation costs of BMPs in the Potomac Basin (Table 7).

The cost-effectiveness of the various agricultural BMPs shows the expected cost per pound of nutrient saved. The various BMPs are being compared for their effectiveness for nutrient removal only and do not represent the true worth of a practice to the farmer or to reductions in sediment. For example, sod waterways are shown as an expensive method of reducing nutrients. The sediment reduction benefits of this practice however, make sod waterways an important part of an agricultural cost share program.

There is little known about the total maintenance costs of agricultural BMPs. The Soil Conservation Service performed a study in the late 1980s that found a wide range of levels of maintenance of practices installed in the field. Field practices installed 30 years before were found to be still working extremely well, when well maintained by the farmer. However, there were BMPs that had just recently been installed with little or no maintenance performed. In the future a major priority of the Soil Conservation Service should be to include maintenance as a cost consideration when allocating cost share funds.

Preventive Methods of Controlling Nutrient and Organic Inputs

Several of the more significant pollution prevention options are discussed below. Many of these options can significantly reduce nutrient loads and costs either alone or in conjunction with the technologies described previously.

Point Source Controls

Phosphate bans.

A ban on detergents and cleaning agents containing phosphates represents one of several control strategies successfully employed in the Chesapeake Bay watershed during the last five years.

Phosphate Ban Impacts

Since implementation of the three phosphate bans in the Chesapeake Bay, evaluation of the subsequent impacts has focused on the reduction of operating costs at wastewater treatment plants(WWTPs). Having passed the first phosphate ban legislation in the Bay area, the state of Maryland was also the first to document the impacts. In a 1987 study of 62 WWTPs representing 550 million gallons per day (mgd) of wastewater flow, the State Water Management Administration reports savings of $4.4 million resulting from an average reduction of 82 tons per day of alum (a phosphorus-removing chemical precipitant.) Cost reductions attributable to a drop in sludge production of 28 dry tons per day could not be assessed but are thought to be substantial (MDE, 1987).

A 1988 study of conditions at the Blue Plains Area Treatment Plant yields similar results (Bailey, 1988). The study reports a reduction in iron dosage of 10.5 tons per day, a decrease of more than 25%, accounts for $2.1 million per year savings in chemical costs. A drop in sludge volume of 254 wet tons per day, a 14% decrease, accounts for an additional $4.4 million savings annually. (Of the total reduction in sludge volume, approximately 200 wet tons per day can be attributed specifically to the ban, while the remaining 54 wet tons per day can be attributed to refinements in the treatment process.) Total annual savings amount to $6.5 million or 10% of the operating budget, the majority of which can be linked directly to the phosphate ban.

A 1988 study of WWTP performance in Virginia revealed a decrease in the influent phosphorus concentration by 31% as a result of the phosphate ban. In addition to the expected decrease in influent values, there was an added benefit of lowering the effluent phosphorus concentrations by 50%. This increased removal of phosphorus resulted from WWTPs operating more efficiently with lower amounts of phosphorus having to be processed (VWCB, 1989).

Summary of Phosphate Bans and Regional Impacts

The effect of the phosphate bans on influent phosphorus concentrations in Maryland, Virginia, and the District of Columbia are

Table 8.
Cost-Effectiveness of Soil Conservation Practices Compared with Conventional Practices on a Representative Field

Conservation practice	Cost of soil saved (per ton)	Cost of N saved (per pound)	Cost of P saved (per pound)
		Dollars	
(1) Permanent vegetative cover 2/	14.35	3.21	5.09
(2) Contour tillage and shorter slope length	2.07	.45	.22
(3) Winter cover crop/residue management 3/	6.49	.90	2.48
(4) Reduced tillage and residue management/ winter cover 4/	1.82	.31	.59
(5) No-till and residue management/winter cover 4/	1.26	.22	.54
(6) Sod waterway	1.21	.29	.54
(7) Terrace system	8.60	2.07	3.68
(8) Diversion system with 20-foot sod filter strip	2.69	.62	1.00
(9) Reduced tillage and sod waterways	2.05	.39	.77
(10) Reduced tillage along the field contour, winter cover crop, sod waterways, terraces	9.55	2.13	3.86
(11) No-till planting along the field contour with residue management/winter cover	2.16	.37	.86

1/ The per-acre losses for conventional practices were taken from continuous corn grain on the representative field (Duffield silt loam, 5-percent slope, Lancaster County, PA), with 40 tons of manure applied per acre per year: 11 tons of soil loss, 123 pounds of N loss, and 31 pounds of P loss.

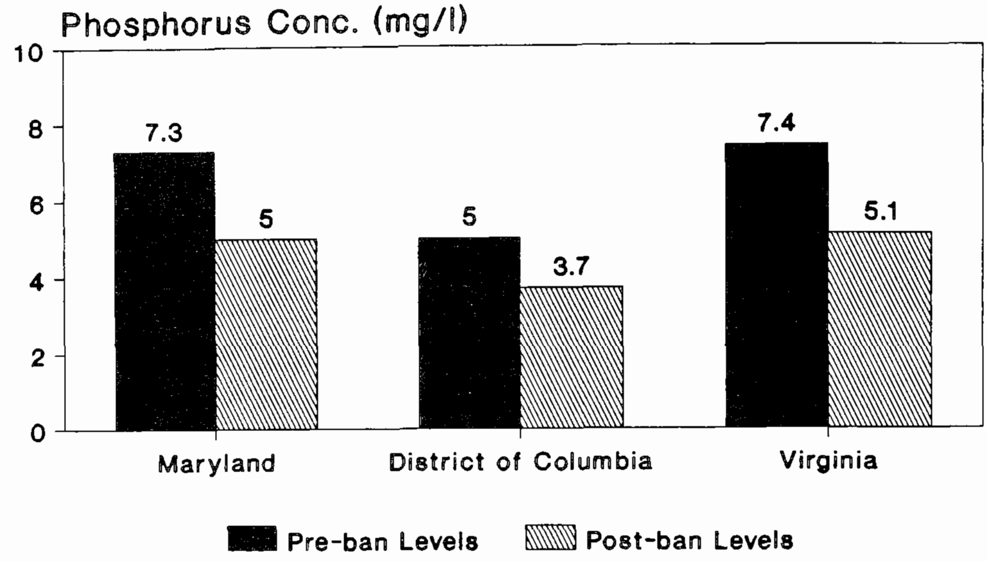
2/ The cost-effectiveness of this practice is much greater relative to other practices on steeper slopes/more erodible land. Unlike this representative field, it is not broadly applicable for gently sloping land.

3/ The cost-effectiveness of residue management varies significantly with respect to the crop grown during the prior year, with a previous crop of hay requiring no expenses for residue management, while a winter cover crop must be planted when no residue is left from the prior crop (which was corn silage).

4/ Proper residue management is necessary for conservation tillage practices to be effective. For continuous corn grain, management involves cutting and disking the corn stover after the grain is harvested.

Reproduced from Managing Farm Nutrients by Crowder and Young (1988).

Figure 2
Phosphate Ban Effects
Influent Phosphorus Reductions At Major Wastewater Treatment Plants



shown in Figure 2. Maryland reported a 30% reduction in influent phosphorus from 1985 to 1986. Similarly, the reduction from pre to post-ban levels was 26% in the District of Columbia and 31% in Virginia.

Industrial Pretreatment

Industrial pretreatment programs have been in place for many years. Initial designs were installed to insure the reliability of municipal wastewater treatment systems. However, industrial pre-treatment also can be considered a pollution prevention method. This method can help reduce or prevent excess municipal nutrient and organic loadings. In addition, pretreatment is usually the first method of reducing toxins in any municipal system with effluent toxicity problems.

Prevention Alternatives For Urban Land Uses

The ultimate source of urban pollutant runoff is what falls or is transported onto impervious surfaces. The use of land use controls to limit growth in areas adjacent to river bodies and flood plains can reduce the urban nutrient load. The use of forested buffer strips along stream channels decreases channel erosion and filters out sediments and nutrients. Tree ordinances that require trees to remain on urbanized land or that require a builder to plant as many trees as they remove are ways to decrease nutrient runoff. Street cleaners have also proven to be an effective method of reducing the impact of atmospheric deposition. Maintaining urban areas to keep refuse off the streets and parking lots reduces loads. In addition, reducing nutrients at the source by decreasing the atmospheric deposition rates with special emphasis on nitrogen oxide reductions can also help control urban runoff.

Preventive Measures For Agriculture

Preventive measures are probably the most cost effective agricultural runoff controls but it is not easy to calculate their effectiveness. Examples of these preventive measures include conservation tillage, nutrient management of manure wastes, fertilizer management, and the conservation reserve program. Conservation tillage has proven to be cost effective for farmers to use once the original capital costs are recovered. Nutrient management has proven to be an effective method of reducing the amount of fertilizer in the Chesapeake Bay area states. Fertilizer usage has decreased between 1980 and 1986 by 35% in Pennsylvania, 21% in Maryland, and 16% in Virginia (Swartz, 1990). As a result of decreased fertilizer applications, it is assumed that there is reduced amounts of runoff from agricultural land. In addition, timing of manure or fertilizer applications geared to plant uptake is helping to insure reduced runoff concentrations from agriculture. Nutrient management planning for farms as a result of the 1985 and pending 1990 farm bills should lead to further reductions in agricultural runoff, much of it due to preventive approaches with nutrient applications and control of animal wastes. The latter approach includes fencing around stream banks to keep livestock from overgrazing an area. This is an extremely effective measure that has limited structural cost, a fence, but provides a major reduction of animal waste inputs into the river system.

Conclusions

A significant array of nutrient and organic control alternatives exist today. Their cost-effectiveness ranges by several orders of magnitude from a few dollars per pound removed per year to over $100 per pound removed per year. Biological nutrient removal is a very promising option for point source control. Urban runoff can be reduced substantially by detention ponds. Agriculture can be best controlled in a total farm nutrient management system.

Continuous implementation of nutrient controls combined with active research in the Potomac and Chesapeake Bay basins provides a rich source of data and experience with which to develop a nutrient control policy for other major estuary systems. ■

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COASTAL CONFERENCE
CONTROLLING NUTRIENT/ORGANIC INPUTS
A REGULATORY PERSPECTIVE

Robert L. Smith
Director of Planning and Standards
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Table of Contents

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I. HISTORICAL PERSPECTIVE

Modern day water pollution control programs really began in the mid to late 1960's. Connecticut's current program began with the passage of its Clean Water Act of May 1, 1967. This Act was the result of a one hundred member, bi-partisan task force that declared Connecticut's waters were fouled with untreated sewage and industrial waste and that this is inimical to the public health, safety, and welfare of our citizens. The Act broadly defined water pollution as any substance or material that made the waters of the state "unclean or impure" and gave the Water Resources Commission strong enforcement authorities. By the first Earth Day in April of 1970 a paper describing the water pollution control strategy had been released entitled "Clean Water by 1972". In retrospect, the collective niaivite regarding the extent and severity of water pollution was astounding.

Nonetheless, an aggressive program had begun focusing on point source controls. Connecticut's treatment standards were:

A) Sewage Treatment Plants

Secondary treatment was required as the minimum with effluent limits set at 30 mg/L for both biochemical oxygen demand (BOD) and suspended solids (SS). On smaller high quality streams, sand filtration was required and permit limits were established at 20 mg/L for both BOD and SS.

B) Industrial Waste

a) Organic

Facilities discharging carbonaceous organic waste were required to provide the equivalent of secondary treatment and most had limits of 30 mg/L for both BOD and SS.

b) Metal Finishing

Historically, metal working and metal finishing have been the predominate industries in Connecticut. By 1970, Connecticut was requiring treatment to meet limits of 0.1 mg/L cyanide, 0.1 mg/L hexavalent chromium and 1.0 mg/L individual heavy metals with certain limited exceptions. By 1972, a statewide pretreatment program was underway requiring virtually identical treatment for metal finishing industries discharging to public sewers.

By the mid 1970's, the majority of metal finishers had controls in place and operating. Strict compliance with permit limits was certainly not up today's standards. However, great improvements were made. Rivers once severely polluted were recovering and the future looked bright for the restoration of the state's inland waterways. The Naugatuck River, virtually devoid of aquatic life in 1970, had significantly better aesthetic value and there was clear evidence of the hardier forms of aquatic life returning. Literally tons of heavy metals and sewage had been removed in just a few short years.

Despite this progress and optimism, it was also becoming clear that for certain rivers, secondary treatment would not be sufficient to meet Connecticut's Water Quality Standards of 5 mg/L dissolved oxygen. Thus began the development of numerical water quality models which predict the degree of treatment necessary to restore these remaining water quality limited stream segments to Class B, Fishable/swimmable standards.

The first water quality model in Connecticut was developed in 1975 for the Quinnipiac River, the stream tributary to the New Haven Harbor estuary. That model generated permit limits requiring 97% removal of Ultimate BOD and 95% removal of SS for municipal effluents discharged to the river. Subsequently, these removal efficiencies have been confirmed with more advanced models and ammonia limits have been added to protect against ammonia toxicity. Since 1975, DEP staff have completed, or are in the process of completing models for 10 rivers. 7 sewage treatment plants are operating at advanced treatment levels, 6 are under construction, 1 is under final design and 7 are in the process of facilities planning. In total, of 83 municipal treatment plants in Connecticut, 21 are required to provide advanced treatment at this time. In addition, there are 6 small plants with sand filters that provide AWT quality effluent. Advanced treatment at these facilities will eliminate dissolved oxygen depletion below the 5.0 mg/L standard and ammonia toxicity bringing water quality limited stream segments to the adopted Class B Fishable/swimmable goal. Table I shows the status of advanced treatment requirements in Connecticut.

Table I

Advanced Treatment Requirements in Connecticut

Municipality	River	BOD/SS	Ammonia	Dechlorination
Winsted	Still	No	Yes	Yes
Plymouth	Pequabuck	Yes	Yes	Yes
Plainville	Pequabuck	Yes	Yes	Yes
Farmington	Farmington	No	Yes	Yes
Danbury	Still	Yes	Yes	Yes
Vernon	Hockanum	Yes	Yes	Yes
Manchester	Hockanum	Yes	Yes	Yes
Southington	Quinnipiac	Yes	Yes	Yes
Meriden	Quinnipiac	Yes	Yes	Yes
Cheshire	Quinnipiac	Yes	Yes	Yes
Wallingford	Quinnipiac	Yes	Yes	Yes
North Haven	Quinnipiac	Yes	Yes	Yes
Torrington	Naugatuck	No	Yes	Yes
Thomaston	Naugatuck	No	Yes	Yes
Watertown	Steel Bk.	Yes	Yes	Yes
Waterbury	Naugatuck	Yes	Yes	Yes
Ledyard	Williams Bk.	Yes	Yes	Yes
Ridgefield,Main	Norwalk	Yes	Yes	Yes
Ridgefield Rt. 7	Norwalk	Yes	Yes	Yes

Comprehensive Conservation and Management Plan including the hypoxia management recommendations will be completed in September 1991. At that time, the facilities planning process can fine tune the recommendations to the final modeling results.

Although facilities planning would begin with some uncertainty of the final target for nitrogen control, failure to begin the process until the final plan is completed would result in a one year delay in implementation.

D) River Loadings

As an example, the Housatonic River contributes approximately 10% of the nitrogen loading to Long Island Sound. Further, this source is in the western end of the Sound and likely to be significant in its effect on water quality by virtue of its proximity to the problem area. Although the river is treated as a point source in the modeling exercise, its load is a combination of point sources, non-point sources, atmospheric deposition and natural contributions. The basin drains approximately 2,000 sq. miles including approximately 15-20% of Connecticut and smaller portions of New York and Massachusetts. Clearly, if we are to spend hundreds of millions of dollars rebuilding municipal sewage treatment plants in Connecticut, we must also develop a strategy for controlling nitrogen loads from this and other important tributary rivers. In this basin, only 40% of the total nitrogen load can be linked to point sources leaving other sources accounting for 60% or more of the the load. Also, the fate of nitrogen from point sources discharged many miles from the mouth is unknown. Natural denitrification may remove a significant portion of the load before it reaches the Sound.

At the time the preliminary plan is published, it will be appropriate to recommend a reasonable goal for a percentage reduction of nitrogen for the entire Housatonic basin. Very preliminary estimates show that if there were no anthropogenic sources, the Housatonic River basin would contribute 1500 tons per year and the present loading is 5100 tons per year, a 250% increase. Under the TMDL/WLA process this basin would also receive a load allocation. A reasonable assumption at this time is that the load allocation will be some percentage of the current load, say a 25% reduction.

However, the preliminary plan will not be able to make specific recommendations to accomplish a 25% reduction. What is needed is a comprehensive evaluation of the basin loadings and development of a specific nitrogen control plan. This will literally take years to accomplish and becomes one part of the "unfinished agenda". Connecticut will have to commit to accomplishing this task and future activities will include trend monitoring and enforcement as necessary to manage this giant complex.

E) Urban Stormwater Runoff

Along Connecticut's coastline, urban and residential development has been identified on a preliminary basis as a significant source of nitrogen. In fact, the Southwestern Coastal Basin, which includes much of Fairfield County, accounts for 600 tons per year of nitrogen from urban runoff. Further, this loading is at the western end of the sound where its contribution is more significant.

Table II

Nitrogen Loadings to Long Island Sound

Source	Annual Loading Tons/yr.
Waste Water Treatment Plants	18,875
Industry	1,054
Urban Runoff	3,665
Cropland Runoff	1,857
Forestland Runoff	50
Upstream Sources	24,698
	Total 50,200 Tons/yr

III. NITROGEN, A POLLUTANT

As the LISS has progressed, extensive monitoring and investigation into hypoxia is leading to the conclusion that nitrogen enrichment is the primary cause of hypoxia. Algae blooms in mid winter and mid summer are being described by researchers as the cause of hypoxia. Water quality data does not show high levels of organic contaminants sufficient to cause such extensive oxygen depletion. Water quality modeling is focusing heavily on nitrogen loadings and effects. The implications of phosphorus and organic loadings are also being explored but their control does not appear to be a viable management alternative at this time. Clearly, there is a strong consensus developing that recommendations for nitrogen control are an inevitable outcome of the LISS.

Connecticut water pollution statutes broadly describe pollution as anything that renders the waters of the state unclean or impure including physical, chemical and biological changes. At this time a strong argument can be made that nitrogen is a pollutant and that sources should be required to provide treatment to remove it. The concept is the same as the approach used after the passage of Connecticut's Act in 1967 which established a standard of technological feasibility and Best Available Treatment (BAT) on the national scale.

IV. ASSIMILATIVE CAPACITY

Long Island Sound, as other water bodies, has an assimilative capacity for pollutants including nitrogen. That is the amount of a pollutant that can be discharged without preventing the attainment of water quality goals or impairment of designated uses. In this case, the assimilative capacity for nitrogen is being exceeded and the result is hypoxia.

The first purpose of the Long Island Sound model is to develop the assimilative capacity for nitrogen, called the Total Maximum Daily Load (TMDL). To identify this load, Water Quality Managers must first define the condition to which the Sound must be restored. On inland waters this is a much simpler task with attainment of the numeric criteria for dissolved oxygen as the usual end point. However, in LIS this is much more complicated. First, New York and Connecticut have different standards of 5.0 mg/L and 6.0 mg/L respectively. Secondly, the scientific justification for dissolved oxygen

To summarize the historical perspective, when the New England River Basins Commission initiated their study of Long Island Sound in 1971, Connecticut was struggling to restore degraded inland waters. Although rapid progress in water quality management was made in the 1970's, it was not yet time to focus attention on the open waters of Long Island Sound. By the mid 1980's, control of pollution of inland waters was becoming manageable. Connecticut was ready in 1985 when the Long Island Sound Study (LISS) was initiated and now is the time to move forward rapidly to manage water quality in the Sound, the ultimate receptor of Connecticut's water borne pollutants.

II. LONG ISLAND SOUND - THE HYPOXIA PROBLEM

A) Discovery of Hypoxia

The late Professor Gordon Riley of Yale University performed hundreds of dissolved oxygen measurements over the entire Sound from 1952 to 1955. Not a single data point showed dissolved oxygen levels less than 3.0 mg/L, the level below which is generally considered "hypoxic". In contrast, Professor Barbara Welsh of the University of Connecticut in 1987 found bottom waters in large areas of the Sound west of the Housatonic River below 3 mg/L and some bottom waters less than 1.0 mg/l, a condition called anoxia. Some near coastal waters, noteably Hempstead Harbor, had severe oxygen depletion throughout the entire water column. Measurements were repeated in 1988 and the hypoxic condition was confirmed although minimum values were not as low as in 1987. The contrast between the data sets seems to indicate that hypoxia has been worsening over the last thirty five years. In Chesapeake Bay, hypoxia has now been described as a persistent condition for the summertime over much of the upper bay. A Chesapeake Bay researcher recently observed that the conditions in the Sound look similar to the conditions in the Bay thirty years ago. Perhaps this is a chilling prediction of the Sound's fate if nothing is done now to halt the advance of chronic hypoxia.

B) Loadings and Sources

Early in the LISS, two primary issues were identified for study: nutrient and organic enrichment or eutrophication and toxic contamination. After discovering the extent and secverity of oxygen depletion, eutrophication gave way to hypoxia, a more direct term indicating the effect of nutrient enrichmnent and this focused the study. Algae blooms were associated with hypoxic events and the theory quickly emerged that nitrogen enrichment was causing marine algae blooms leading to the depletion of dissolved oxygen when the algae dies and decays. Among other pollutants, an inventory of nitrogen loadings was accomplished by the National Oceanic and Atmospheric Administration(NOAA) as part of their National Coastal Pollutant Discharge Inventory(NCPDI). The NCPDI estimates of pollutant loadings used current wastewater discharge permit information and the LISS sponsored monitoring to confirm and/or adjust these loadings.

The NCPDI inventory indicated that the total nitrogen loading to LIS is approximately 50,000 tons/yr. It must be noted that 40% is attributed to the Connecticut River at the easterly end of the Sound. Table II summarizes the NCPDI loading estimates for nitrogen.

criteria is much less certain. In simplistic terms, one of the most critical tasks is for the Long Island Sound Management Conference to collectively agree on a condition that represents restoration of the Sound to a level at which water quality goals are met. Once this is accomplished, the model can calculate the load of nitrogen that results in this condition, or the TMDL. This will be presented in terms of pounds/day for the Sound as a whole or for certain geographic areas.

V. WASTE LOAD ALLOCATIONS/PERMIT LIMITS

After developing the TMDL, it must then be allocated among sources. This is called a Waste Load Allocation (WLA) and describes the total daily load allowable in pounds/day for each source including permitted facilities. For the Sound, the modeling will not be sensitive to individual sources except the very largest. For example, the model may indicate the Sound is sensitive to the loading of the Housatonic River but it will not show sensitivity to single point sources such as the City of Milford's STP at the mouth of the Housatonic River. It can be expected that the model will demonstrate water quality impacts in the western basin (and maybe the central basin). From the combined loadings from Connecticut's major shoreline sewage treatment plants.

Therefore, the net result of the modeling analysis is likely to be a WLA for Connecticut's major shoreline STPs and each plant will be required to remove a percentage of their individual nitrogen loads. There will not be a technical justification for fine tuning the loads among individual facilities and politically it is probably not feasible to do so anyway. Permit limits will be developed reflecting the allocated loads.

The allocation among point sources will also reflect non-point sources and atmospheric deposition and the practical ability to control these other sources. Although the costs for controlling nitrogen at point sources is high, this may be the only feasible way to make significant water quality improvements given the difficulty in controlling non-point sources. It must be recognized that the concept of a WLA is that this is a final load that a municipality must stay within from this point on. The existing concept of continually expanding sewer service to serve growth will have practical limitations because higher and higher efficiency treatment technology will have to be employed as discharge volumes grow in order to keep the total nitrogen load level. Municipalities will have to confront this issue head on and define the ultimate growth and development of their community.

VI. IMPLEMENTATION STRATEGY

After management options are defined by the modeling activities, implementation must be by a series of short and long term actions that collectively represent a logical management approach. Following are management concepts that need to be part of long term plans to control hypoxia.

A) Planning Policy

Since it is known that nitrogen controls are an inevitable management consequence, any municipal sewage treatment plant now undergoing renovations or rebuilding, including CSO projects, should incorporate future plans for nitrogen removal. This planning should begin immediately as design and construction taking place now will affect the communities ability to remove nitrogen later. Connecticut adopted such a policy in 1989 and has already worked with 5 municipalities to incorporate future nitrogen removal into their present activities. In certain cases minor design changes or additional construction now will save large amounts of money in the future.

B) Interim Action/Retrofit Existing Facilities

The City of Stamford has already demonstrated that minor equipment additions and process changes can remove nitrogen at existing facilities. In simple terms, a "dead zone" that is allowed to go anoxic is created at the head end of the secondary aeration tank and nitrified mixed liquor(a mixture of sewage and cultivated bacteria) from the end of the tank is recycled back to this zone. Microbes then use the oxygen atoms from the nitrate molecule (NO_3) and release nitrogen to the atmosphere as a gas. Stamford has been able to remove approximately 70% of the total nitrogen using this technique.

The Connecticut Department of Environmental Protection has explored the feasibility of doing this at 13 municipal plants along the shoreline from Greenwich to Branford. A preliminary estimate is that up to 50% of the total nitrogen load might be able to be removed at these plants. Conceiveably, there might even be a measureable improvement in Long Island Sound water quality with this interim action. Costs for interim retrofits can be expected to be between $50,000 and $100,000 per facility.

Given the moderate costs and potential success of this action, it should be considered as the first phase of municipal nitrogen removal. The Long Island Sound Bi-State Committee, Subcommittee on Water Quality has endorsed this concept. Connecticut is planning to implement a program of retrofits and is working with the legislature to create a one million dollar fund to assist municipalities. One of the benefits of this approach is that it can be implemented much more quickly than major renovations. In Connecticut we expect this program to be fully implemented within one year. It must be recognizedthat this is an interim action and recycle within the aeration system creates practical limitations in the amount of additional sewage that can be received.

C) Facilities Planning

The long term solution for Long Island Sound involves rebuilding and/or expanding existing municipal treatment plants to provide year round nitrogen removal at a relatively high level of removal. The engineering evaluation of site specific facilities, called "Facilities Planning" will result in recommendations for modifications and contruction of new facilities. The process takes one to two years and yields preliminary design criteria and cost estimates.

When the preliminary management plan for hypoxia is released in September of 1990, it will be appropriate to begin the facilities planning process for those municipalities that are within the management area. Since the preliminary plan will be based on the water quality model without the benefit of a completed hydrodynamic model, there will be a certain level of uncertainty in the recommendations. Therefore, initial facilities planning will have to begin based on a range of removal efficiencies that may be required. The Final

It is likely that modeling will show little if any response to these loadings, However, continued development of the shoreline will increase loadings and tend to gradually offset gains made by controlling point sources and river basins. The long term strategy must include goals for controlling nitrogen from this source. Perhaps the goal will be no increase over a base year to be accomplished by implementation of best management practices (BMP's) to control non-point sources of nitrogen. Since any new development, even with BMP's, will increase loadings, BMP's would have to be implemented for existing development to offset new development related increases. Like the river basins, a comprehensive evaluation of these sources and their controllability and specific recommendations is required. This will take years and is another part of the "unfinished agenda". Controllability and associated costs are a significant issue in this case and least return for the effort and money is to be expected. Regardless, a comprehensive plan for improving the Sound must address these issues.

F) Atmospheric Deposition

Estimates indicate that as much as 20% of the total nitrogen load to the Sound is from atmospheric deposition directly on the 1,300 mi. sq. of the Sounds surface. Further, wet and dry deposition are also integral parts of river basin loadings, urban runoff and non-point sources in general. Since atmoshperic fallout is evenly distributed over the entire area of the Sound, it may not be identified as a source, that if controlled, would result in measureable improvements to the water quality of the Sound. However, it is certainly contributing to hypoxia and cannot be ignored. The plan will probably identify some level of control of atmospheric deposition based on national policies for acid rain and air pollution control laws. To date, acid rain has not been identified as having a significant impact on Connecticut's water resources. Now there is a clear link between nitrogen compounds in air pollution and significant water quality problems in the state's most important water resource. Although this problem must be controlled nationally, the management plan for the Sound will probably include recommendations to implement efforts to control air pollution. Implementation will be through an entirely different route probably through the State's Air Pollution Program to urge adoption of national laws and policies.

VII. YEAR 2000 A REASONABLE TARGET?

Recent estimates are that to rebuild thirteen of the major plants along Connecticut's shoreline, it would cost close to $500 million. Assuming that facilities planning is completed by 1992 for these plants, it would leave eight years for design and construction if the goal is completion by the year 2000. On the average, this would mean a commitment of $60-65 million per year over and above the current rate of expenditure which is similar. A recent omnibus bonding bill introduced in the Connecticut legislature for a variety of environmental and agriculture projects amounted to $125 million. Of course, the jury is still out on this proposed bill but at least its not out of the question to discuss this sum of money publicly. Perhaps the issue is one of priorities rather than total dollar amount.

Other implementation requires rather lengthy investigations and planning and it is fairly reasonable to assume that substantial progress can be made by the year 2000. It must also be remembered that this will not be a one time effort but an initial surge followed by a permanent sustained effort. By the year 2000 much of the initial surge can be behind us and the focus of effort should be on monitoring and enforcement at sewage treatment plants, trend monitoring of water quality in the Sound and the wide variety of other management functions dealing with coastal development, non-point source management, habitat preservation and resource management.

VIII. CONCLUSION

It has taken over 100 years to degrade Long Island Sound to its present condition. The first report of the State Sewage Commission, to the General Assembly, published in 1899 stated that of eighteen principal cities in Connecticut having sewer systems, only Meriden and Danbury purify their sewage. The population in these cities was 481,000 according to census data. The report further stated that "All other cities discharge their sewage into water-ways: "water carriage and dilution"." Further, there were eight other buroughs having sewer systems and of these only Bristol and Litchfield purify theirs. Thus in 1899 there were at least twenty two substantial sewage collection systems discharging untreated sewage to the waters of the state. A chapter of the report was entitled "The Present Evils of the System of Water Carriage in Connecticut" so it is evident that all was not well. Danbury installed a treatment system after a landmark case in 1895 in which they were found liable for polluting the Still River and interfering with riparian rights of a downstream mill owner.

Great progress has been made since the passage of state and federal water pollution control laws in the late 60's and 70's. Now, however, the cumulative effect of nitrogen from a wide variety of sources has significantly contributed to the hypoxic conditions that have been documented in Long Island Sound. The Sound is not nearly as severely impacted as the Chesepeake Bay but conditions are almost surely getting worse. Connecticut's most precious water resource is in trouble.

On the positive side, we have the most sophisticated modeling tools that have ever been available to explore management options. The Sound is not dead, just exceeding its assimilative capacity. It is well within our abilities to restore water quality, not to the "pastoral setting", but to a good condition that is aesthetically pleasing and supports a healthy, marine environment. It is really a matter of the will of the people to do this. It is my opinion that the will and ability is there and that by the year 2000 great progress will have been made in restoring the Sound.

WORKSHOP SESSIONS ON THE PRIMARY FACTORS CAUSING USE IMPAIRMENTS AND OTHER ADVERSE ECOSYSTEM IMPACTS

PATHOGENS/FLOATABLES

PATHOGENS AND FLOATABLES IN THE SOUND-HARBOR-BIGHT SYSTEM: SOURCE, FATE, AND CONTROL

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Pathogens and floatables have a number of common characteristics, but they are also unlike. They are paired for these conference proceedings mainly because of their similar impact on our coastal waters. The common as well as the distinctive characteristics of these two pollutants are described in this paper.

PRIMARY SOURCES OF PATHOGENS AND FLOATABLES

A number of sources contribute microbial contamination and floatable debris into our coastal waters. The three major contributors, particularly in urban areas of the tristate coastal area, are combined sewer overflows (CSOs), sewage treatment plants, and stormwater runoff. A minor source of pathogens is bottom sediment. Minor sources of floatables are landfills and marine transfer stations, littering by beachgoers and commercial and recreational boaters, refloating of stranded debris, decaying wooden piers, and illegal dumping. The relative magnitude of these sources of pathogens and floatables varies within the Sound-Bight-Harbor system.

Ninety-nine wastewater treatment plants discharge into the Interstate Sanitation District's waters (Figure 1) (ISC, 1988). Of these, 15 provide primary treatment; 76, secondary treatment. Pathogens and floatables can enter a water body as a result of plant breakdowns, power failures, sanitary line breaks, and suboptimal disinfection (pathogens only).

CSOs are probably the greatest single source of pathogenic and floatable contamination. There are 677 CSO outfalls in the district, located primarily in the New York-New Jersey

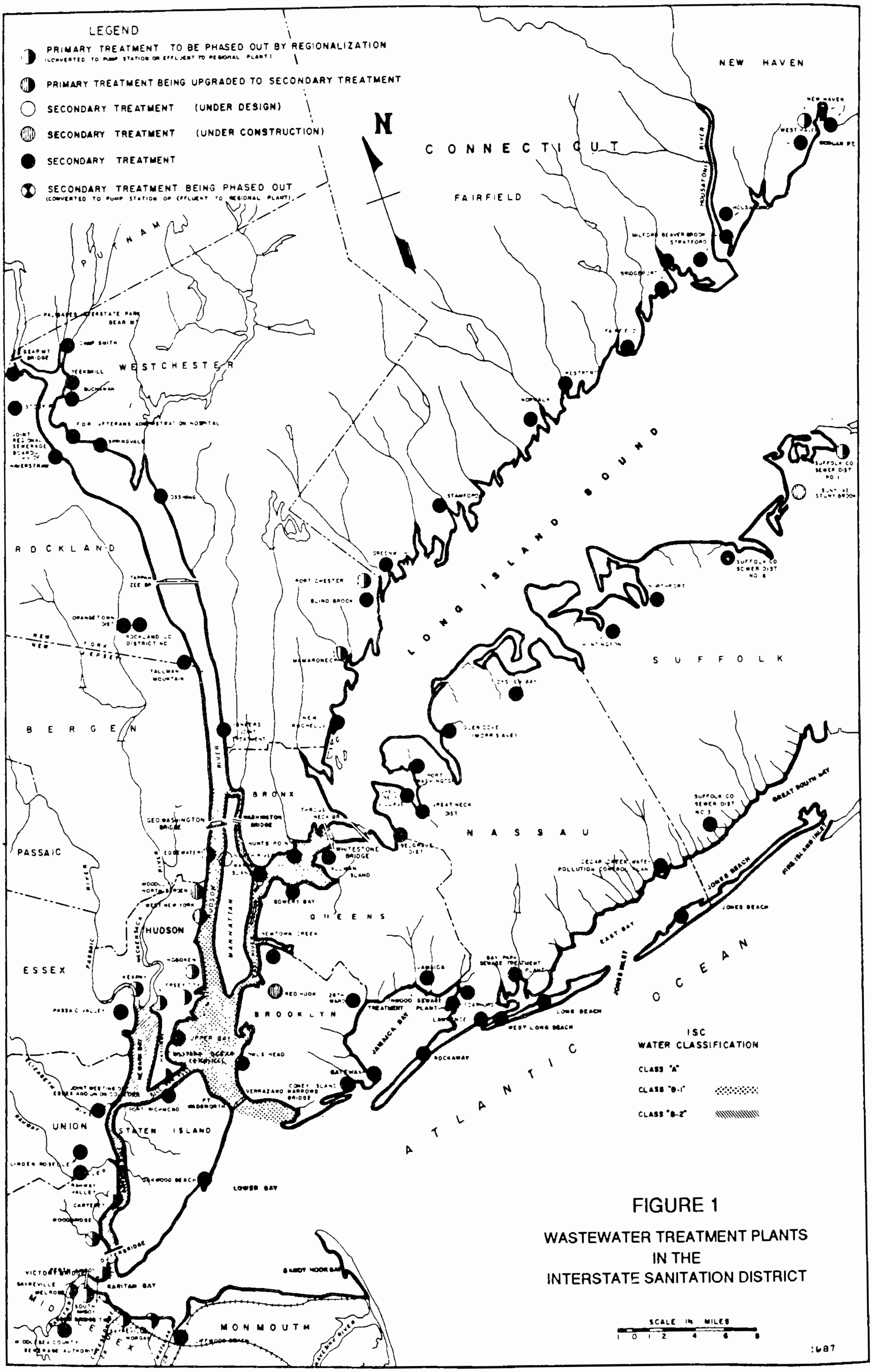


FIGURE 1

WASTEWATER TREATMENT PLANTS IN THE INTERSTATE SANITATION DISTRICT coastal regions (Figure 2). New York has the greatest number 511 followed by New Jersey with 101 and Connecticut with 65. Combined sewer systems have regulators that limit the flow of sanitary wastewater and stormwater runoff to the treatment plant to prevent hydraulic overloading. Overflows occur when the hydraulic capacity of the regulators is exceeded. Rainfalls as little as 0.04 in./hr can cause overflows. As a result, municipal sewage and urban refuse washed off streets are discharged untreated and unscreened into New York-New Jersey waters. The total CSO flow from the service areas of New York City's 14 water pollution control plants (WPCP) alone is 556 million gallons in an average storm, or 0.39 in. of rain in 6.7 hrs (O'Brien & Gere, 1986).

Pathogen Indicators

Water contaminated by this sewage poses a public health concern. Pathogenic organisms contained in sewage can cause typhoid, hepatitis, dysentery, and other gastrointestinal illnesses. The bacteriological quality of waters for contact and noncontact recreation as well as shellfishing is traditionally monitored by the use of two widely recognized indicators, total and fecal coliform. These indicators have numerical criteria set according to the intended use of the water body. For example, New York waters classified for bathing have a monthly median limit of 200/100 ml. The average fecal coliform content in CSOs is 3.5×10^6/100 ml.

Pathogenic organisms are more closely associated with human than animal waste, but the standard coliform analysis cannot differentiate the source. Another indicator, enterococci (a subgroup of fecal strep), is gaining acceptance, in part because it has demonstrated good correlation between levels and human illness. The Ambient Water Quality Criteria for Bacteria (EPA, 1986) recommends enterococci for marine waters and *E. coli* for fresh water. Currently, the tristate water quality standards specify two indicators for their coastal waters:

New York - Total and fecal coliform
New Jersey Fecal coliform and enterococci
Connecticut - Total coliform and enterococci

Fecal and total coliform and enterococci levels are reduced approximately 99.99% by chlorination (NJSDOH, 1988). However, organisms that resist chlorination are a concern. Viruses can still be present at significant levels in the treated effluent. Viral assays, however, are lengthy and difficult. Currently, experimental assays are being conducted on the f2 male-specific bacteriophage as a possible indicator of viral contamination. (A bacteriophage is a virus that infects bacteria and, like viruses, it is resistant to chlorination.)

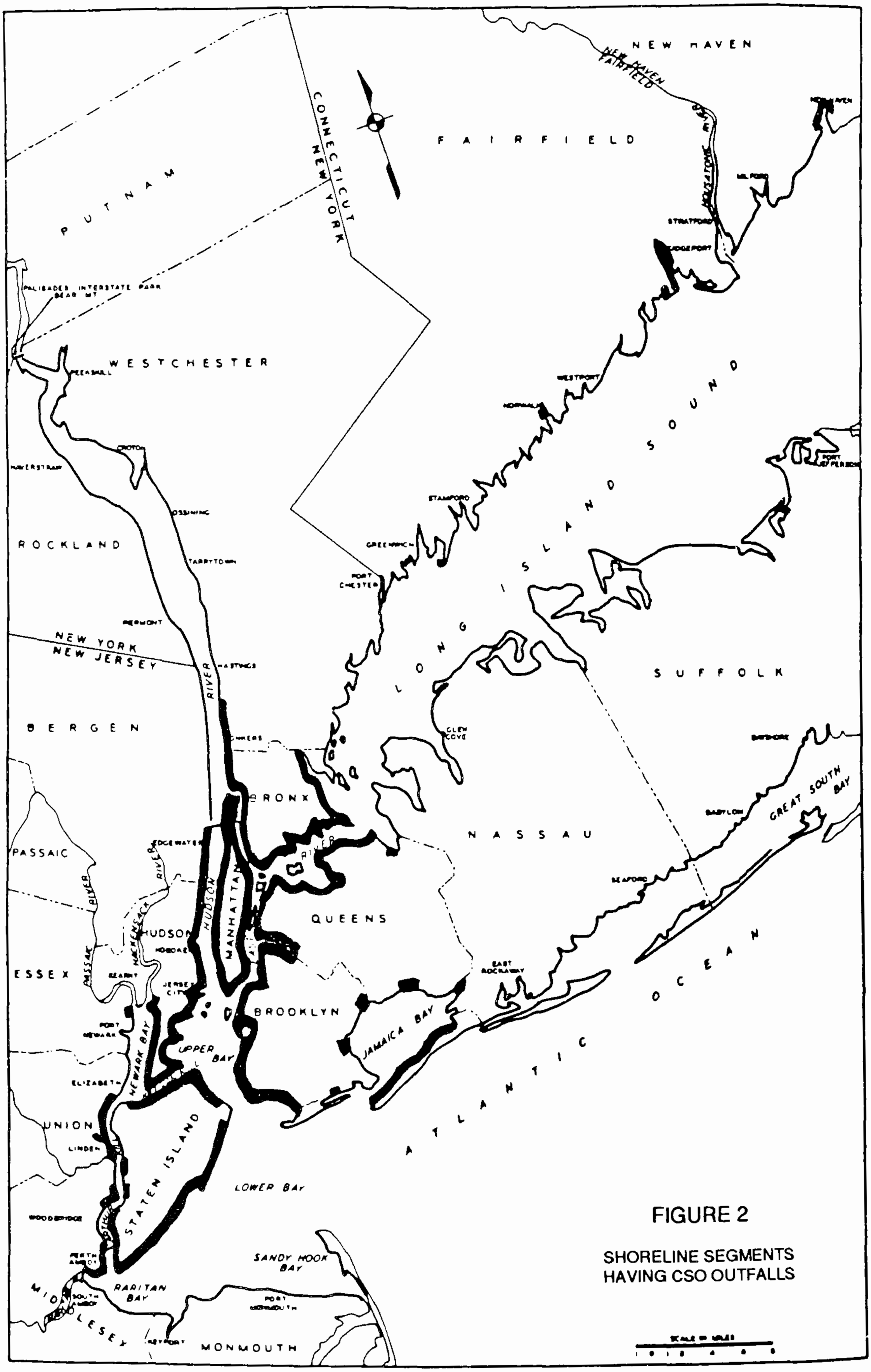


FIGURE 2

SHORELINE SEGMENTS HAVING CSO OUTFALLS

Characteristics of Floatables

Floatables are solid waste materials and natural debris that remain buoyant at the water surface; unlike microbial contamination, they are visible to the eye. Composed of general trash, medical items, and natural debris (kelp, wood), floatables are aesthetically unpleasing and sometimes detrimental to marine life. When not combined with sewage, they pose more of a public safety concern (broken glass, sharp objects) than a public health concern. However, the heightened media coverage of beach washups in 1987 and 1988 focused on syringes because of the association with AIDS.

During the past few years there has been an increase in the collection of quantifiable data on floatables. Figure 3 shows the amount of floatable material removed from the Flow Balancing Method (FBM) prototype being tested on two CSOs in Brooklyn's 26th Ward service area. The quantity of floatables appears to be directly related to rainfall (HydroQual, 1989).

The pathways of floatable pollution interconnect wastewater treatment and solid waste disposal operations at marine transfer stations and landfills. Most wastewater solids are removed by bar racks, screens, and skimmers early in primary treatment and disposed of in landfills. But inadequate equipment and/or improper operational procedures at landfills and marine transfer stations can cause floatables to reenter the water.

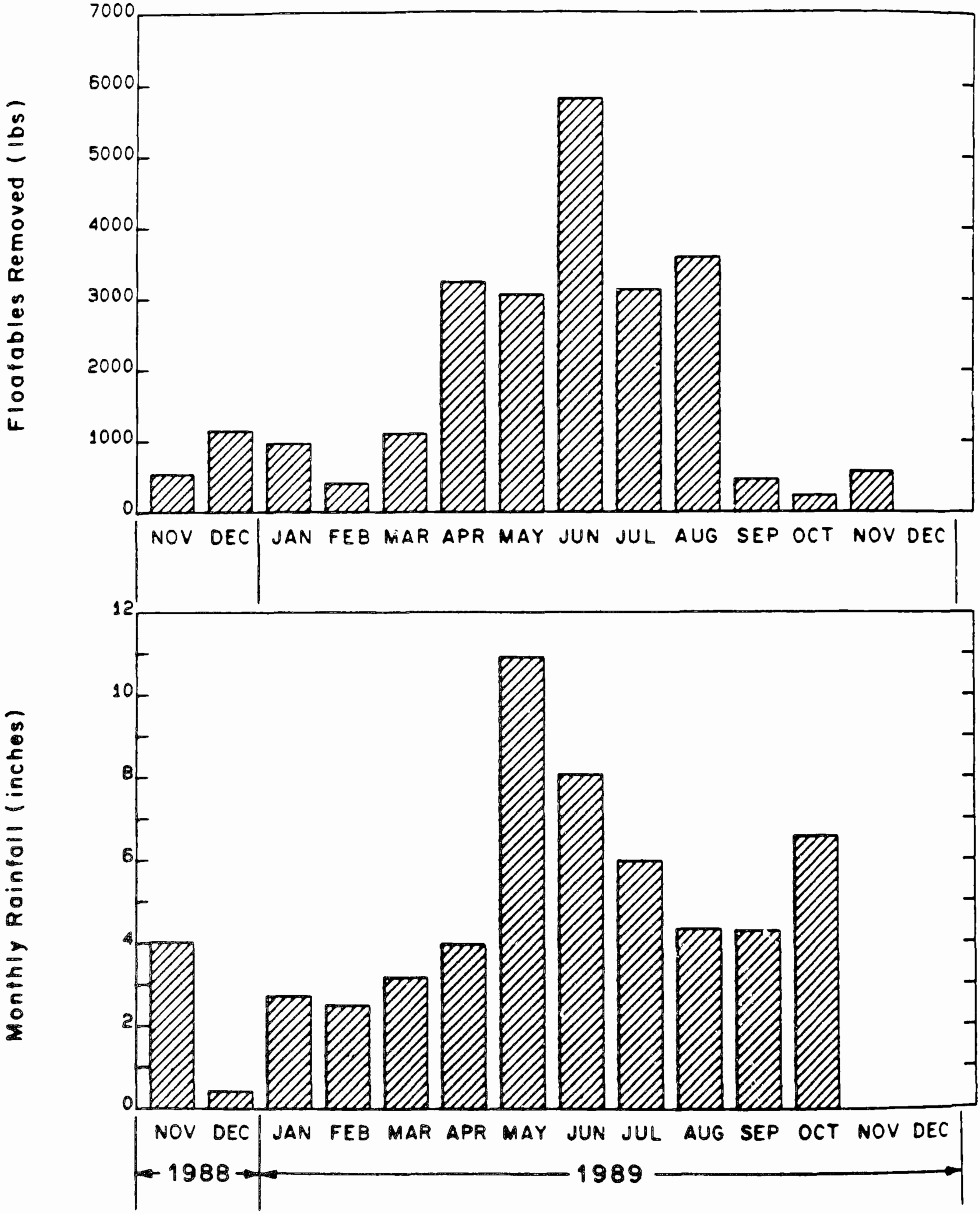
Much evidence also indicates that floatables are generally found close to their sources. A 1989 study (HydroQual, 1989) comparing the amounts of floatables in the open water with those on the beach showed more glass, metal, styrofoam, paper, and medical items (syringes) at the beach (Figure 4). This was probably because the pathways from the nearby CSO sources to the beaches did not intersect the open-water monitoring transects. In addition to the transport of floatables via water, glass, cans, styrofoam, and paper were probably also left by beachgoers. It is believed that most of the syringes found on Connecticut's beaches were left behind by drug users, not washed up from the water (CDEP/CDHS, 1989). Nearly 90% of the material captured in the open water was plastic, generally fragmented and weathered so that it "swims" just below the water surface.

Beaches on Staten Island and Brooklyn experience heavy impacts of floatable debris, probably from the Fresh Kills Landfill (NYSDEC, 1988). Because illegal dumping is episodic, poorly monitored, and seldom documented, the percentage it contributes to the floatables present in our coastal waters is unknown.

CSO and Treatment Plant Coliform Loads

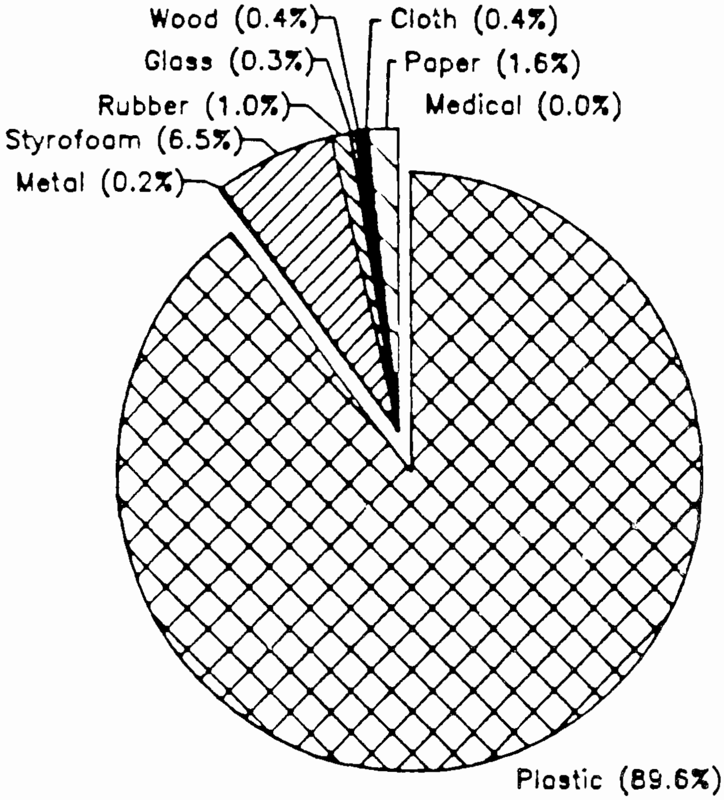
The fecal coliform loads discharged in the treated effluent of New York City's 14 WPCPs are estimated in Table 1. Fecal coliform loads discharged by CSOs in each plant's service area are estimated for an average rain of 0.39 in. in 6.67 hrs (O'Brien & Gere, 1986).

FIGURE 3

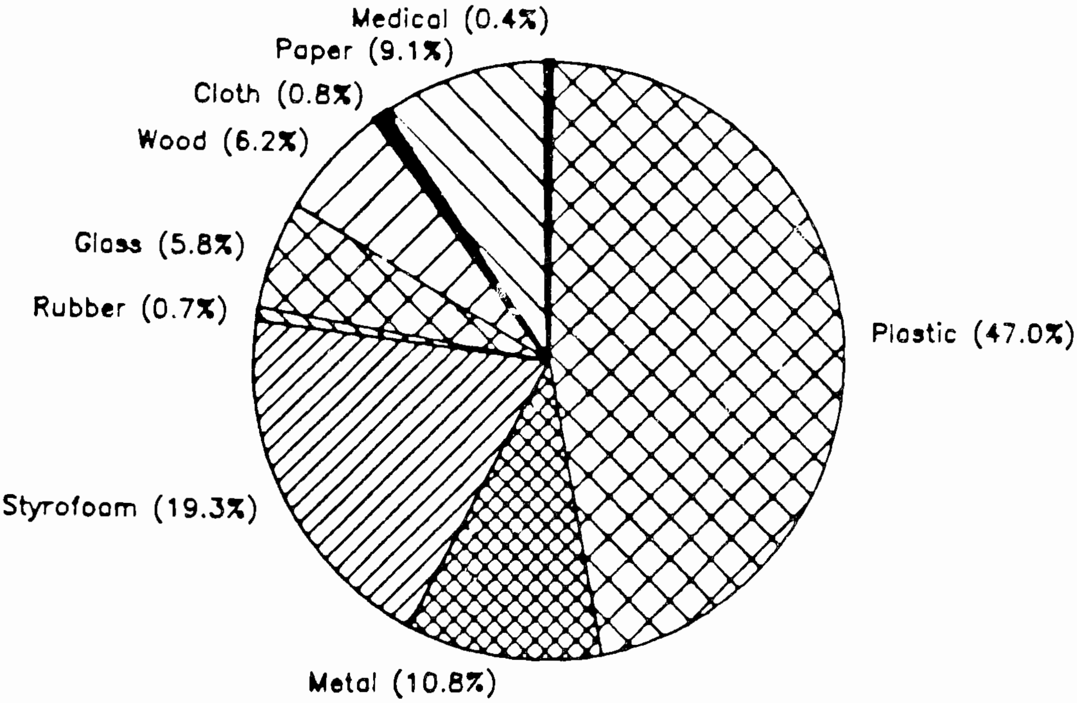


NYCDEP 26th Ward Regulators 2 and 2A CSO Floatables

FIGURE 4



Open Water Trawling
Captured Material Distribution



Beach Monitoring
Captured Material Distribution

HydroQual, Inc.

TABLE 1

TABLE 1. COMPARISON OF NEW YORK CITY WPCPs AND CSO FECAL COLIFORM LOADS

	WPCP 1989 Average[1]			CSO for Average Rain Storm[2]		
Plant	Avg Flow MGD	Avg Fecal Coliform counts/100mL	Avg Load counts/day	Combined Sewer Overflow MG[3]	Fecal Coliform 1E06/100mL	Load counts
Wards Island	315	17	2.01E+11	40.2	2.0	3.04E+15
North River	177	43	2.90E+11	17.3	2.5	1.63E+15
Hunts Point	156	12	7.02E+10	70.7	1.4	3.74E+15
26th Ward	63	8	1.98E+10	14.7	7.8	4.33E+15
Coney Island	101	13	4.75E+10	31.8	6.5	7.81E+15
Owls Head	110	24	9.93E+10	54.2	2.5	5.12E+15
Newtown Creek	344	41	5.36E+11	78.3	1.4	4.14E+15
Red Hook	45	14	2.35E+10	16.0	2.5	1.51E+15
Jamaica	101	11	4.19E+10	74.9	3.9	1.10E+16
Tallman Island	65	12	2.83E+10	39.5	2.0	2.99E+15
Bowery Bay	157	12	7.25E+10	60.9	3.2	7.37E+15
Rockaway	27	7	7.30E+09	18.2	2.5	1.72E+15
Oakwood Beach	36	29	3.87E+10	0.0		
Port Richmond	43	6	9.75E+09	39.3	6.7	9.95E+15
Total			1.49E+12			6.44E+16

[1]Source: NYCDEP Discharge Monitoring Reports.

[2]Source: O'Brien and Gere 1986.

[3]Corresponds to 0.39 inches of rain during a 6.67 hour storm.

The comparison shows that the total CSO load during an average storm is more than 10,000 times greater than the total treatment plant load. The annual total coliform load for a typical New York City WPCP service area, Hunts Point, was evaluated by modeling CSO discharges from 1957 through 1985 (Figure 5). The median yearly coliform load from CSOs is approximately 250 times greater than the Hunts Point WPCP effluent load, based on NYCDEP's 1989 flow data (NYCDEP, 1989) and LMS' 1988-1989 total coliform concentration data (LMS, 1989a).

CSO loadings are affected primarily by rainfall intensity and accumulation, which have certain expected return periods. The variation in coliform loadings from CSOs for a range of rainfalls is shown in Figure 6. The six-month storm produces a coliform load 20 times that of a storm with a five-day return period. These comparisons demonstrate that CSOs are the predominant source of coliforms and the magnitude of this load varies greatly depending on the rainstorm.

FATE OF PATHOGENS AND FLOATABLES

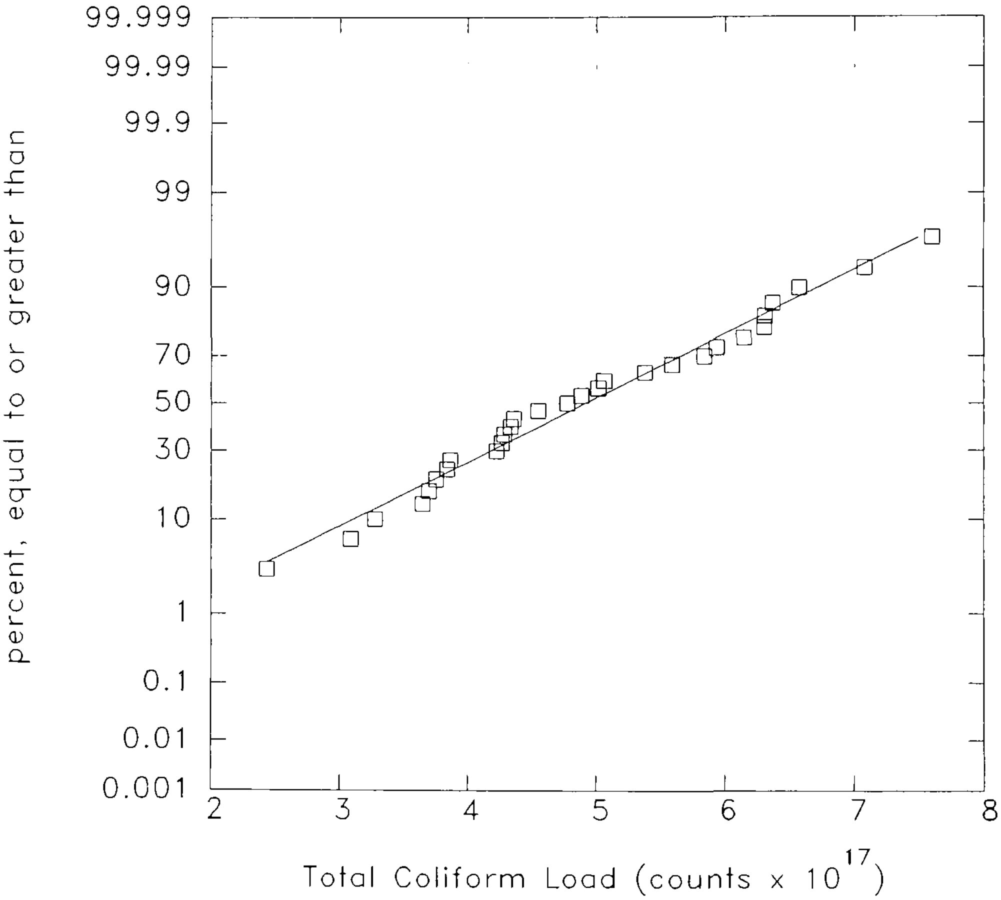
Ocean dynamics, estuarine transport, and meteorological conditions influence the survival of microbial organisms and the transport of floatables. The fate of pathogens is controlled primarily by two mechanisms: (1) transport/dilution and (2) degradation. The momentum of the waves and the wind in ocean waters and tidal flow within estuaries affects the movement and persistence of bacterial contamination. The degradation of pathogen indicators in water bodies is relatively fast and attributable to salinity, temperature, and sunlight.

East River Total Coliform Concentrations

The response of bacteriological levels to CSO discharges is evident in East River sampling data for a wet-weather survey (LMS, 1989b). The total precipitation of approximately 1 in. started at 0400 hrs and had a peak intensity of 0.30 in./hr, which corresponds to a return period of 25 days. The total coliform concentrations in the East and Harlem rivers observed prior to rainfall were well below NYSDEC criteria. The distributions of total coliform concentrations consistently show greater levels in the lower East River and lower levels near western Long Island Sound. Increased concentrations are evident in the data collected from 5 to 10 hrs after the onset of rain. Peak concentrations, which are approximately an order of magnitude greater than those prior to rainfall and at approximately half of the sampling stations exceed NYSDEC's monthly criteria, occur about half a day after rainfall. Coliform concentrations decrease during the next 1.5 days such that the concentrations measured three days after rainfall are nearly back to prerainfall levels. The impact of CSO discharges is also evident in other areas of the New York-New Jersey harbor. Hydrodynamic and time-

FIGURE 5

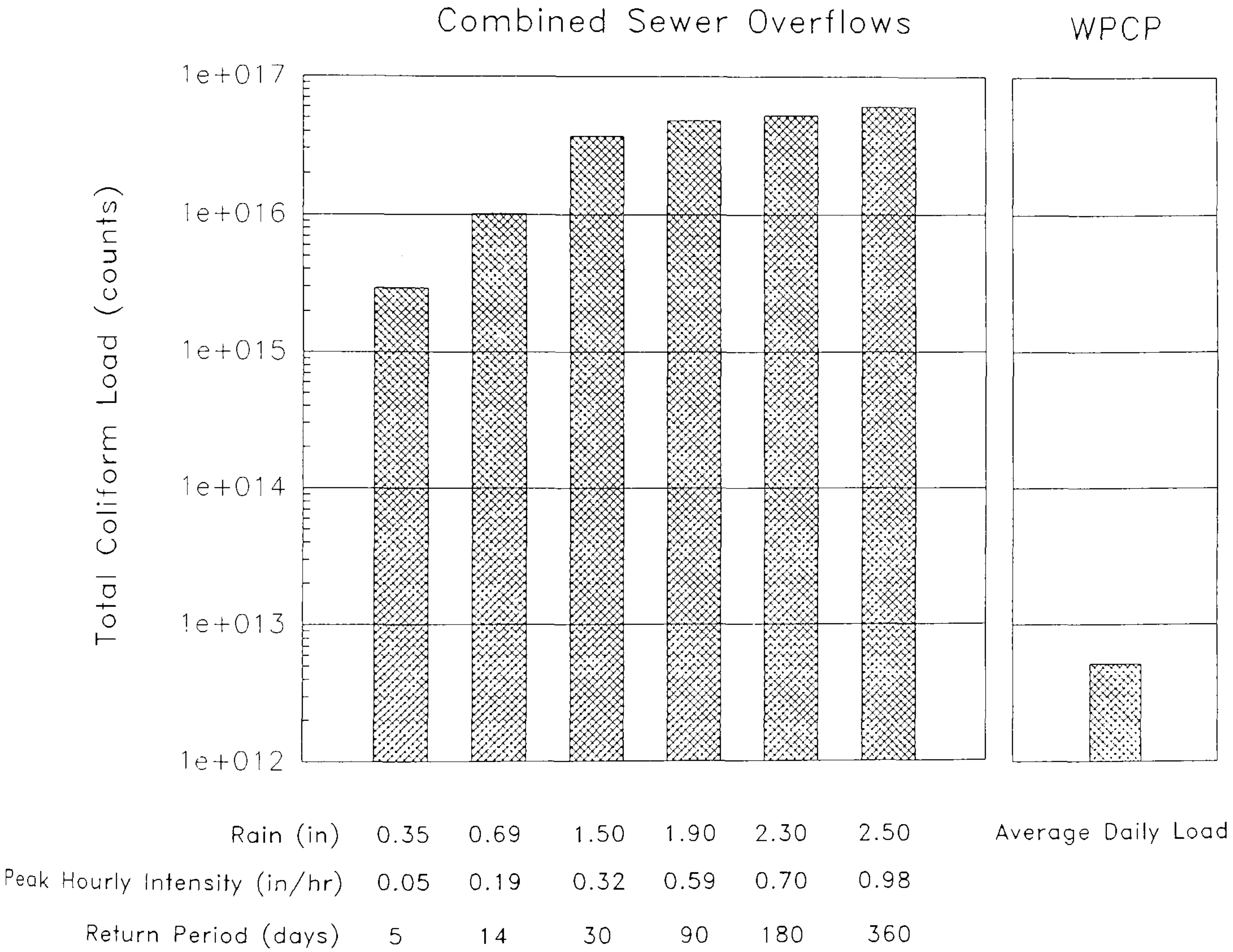
Hunts Point Service Area Combined Sewer Overflows (CSOs)
Total Yearly Coliform Load, 1957-1985



Note: WPCP Average Yearly Total Coliform Load = 1.9×10^{15} counts

FIGURE 6

Total Coliform Loadings From The Hunts Point WPCP Discharge and Loadings From Hunts Point Combined Sewer Overflows For A Range of Rain Events



variable water quality models are being applied to analyze the fate of pathogen indicators. For example, responses of the New York-New Jersey harbor to CSO discharges are being modeled as part of New York City's CSO abatement program.

Seasonal Nature of Floatables

Floatables are transient and seasonal (the largest impacts occur during the summer). They do not degrade readily and must be physically removed from the environment. If not removed, the spring tides associated with the new and the full moon will cause floatables to reenter the water as evidenced by EPA data on floatable material (EPA, 1989) removed from open waters (Figure 7). The generation of floatables into coastal waters is heightened during the summer season. Short-term meteorological events (freshwater inflow, heavy rains, and high-speed onshore winds) cause washups in the vicinity of the source loading.

Nevertheless, long distance transport is influenced by tidal currents and circulation in the Hudson-Raritan estuary. A high Hudson River freshwater inflow intensifies the Hudson-Raritan coastal plume that hugs the New Jersey shore. The plume carries with it a substantial floatable load. Dry spells followed by intense rains flush the urban area of debris and cause CSOs and high loadings on collection and treatment systems that may result in operational failures. Once in the Bight, these floatables are then subjected to the Bight's currents and winds. Wind seems to have the greatest significance on beach washups. It has been observed that strandings occur when one wind direction persists for an extended period of time. Depending on the direction, either New Jersey or Long Island beaches may be affected. In 1976 and 1988, strong south-southwesterly winds persisted in the Bight. As a result, Long Island was impacted greatly (Figure 8). By contrast, in 1987 climatological information shows that winds from the east-northeast prevailed (Figure 9). The Hudson-Raritan plume with its high floatable load stayed much closer to the New Jersey coast and beach washups occurred.

Floatables can exhibit much variability, however, making their fate difficult to determine. Current analytical techniques employ field measurements, drogue release and tracking, strandograms, and hindcasting. Models developed to simulate the transport of oil or sewage spills are being used to analyze the fate of floatables. During the EPA Floatables Action in 1989, three of the sightings of floatable slicks were communicated to USCG/NOAA. They monitored meteorological conditions, used their model to predict the fate (dispersion or landfall) of the debris slick, and reported their predictions in a timely manner.

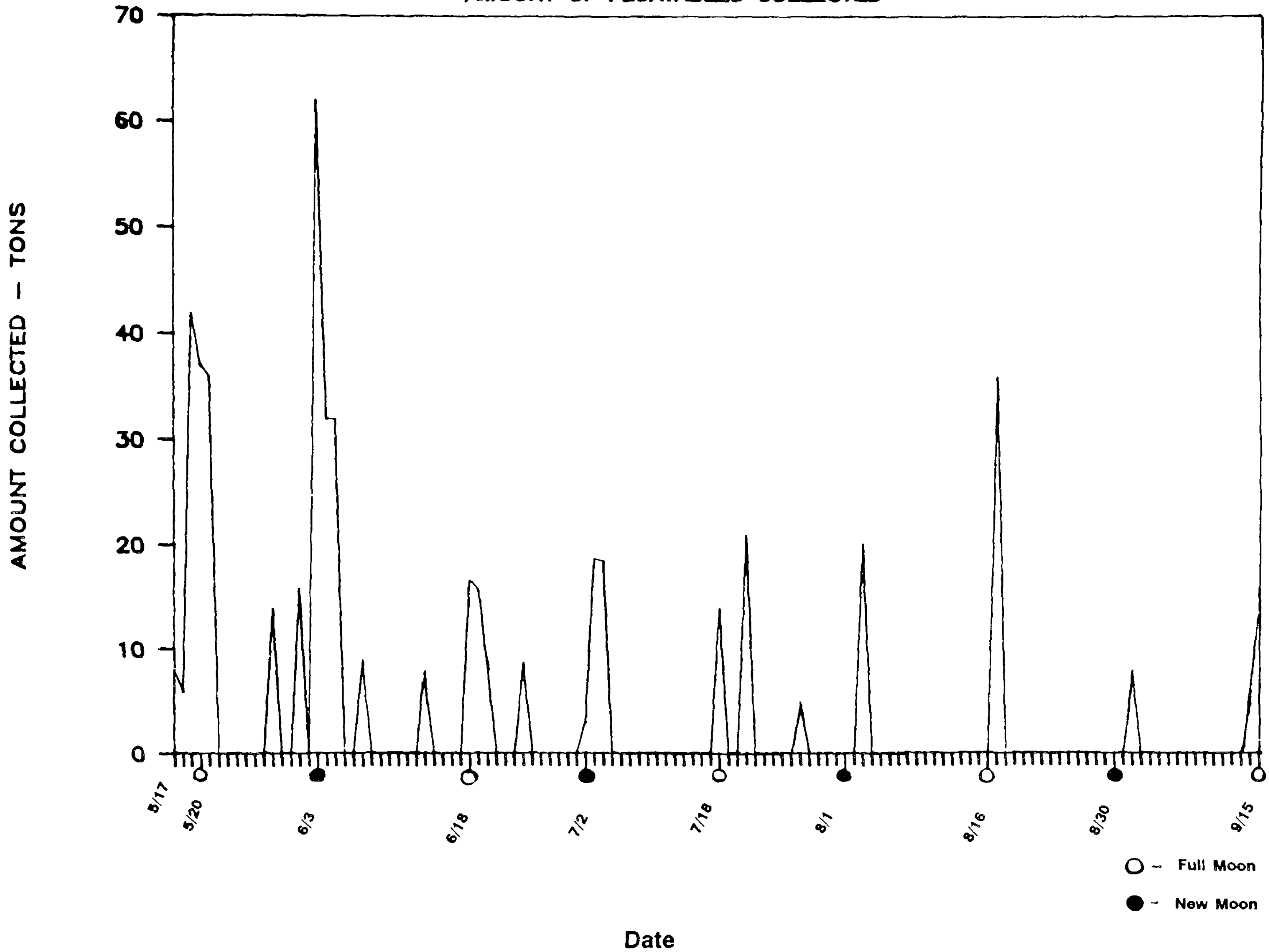
EXTENT OF CONTROL

As CSOs are probably the greatest single source of floatables and pathogens to our coastal waters, they are the focus of control strategies. EPA's strategy for CSOs directs the state to consider technology-based as well as water quality-based requirements. Because CSOs are covered generally by SPDES permits that prohibit the discharge of floatable material, a technology-based approach is appropriate. The tasks for a technology-based

FIGURE 7

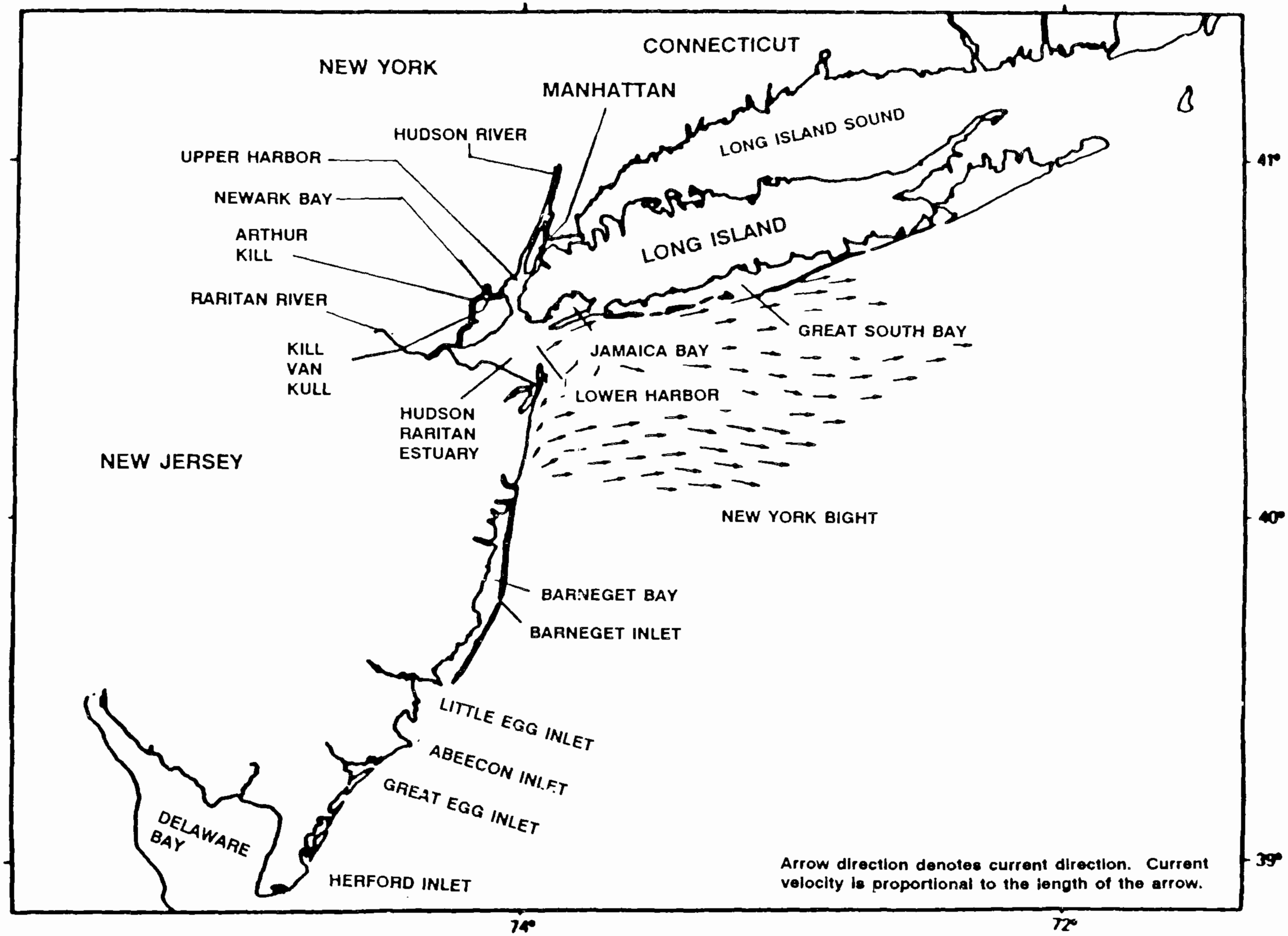
1989 Floatables Action Plan

AMOUNT OF FLOATABLES COLLECTED

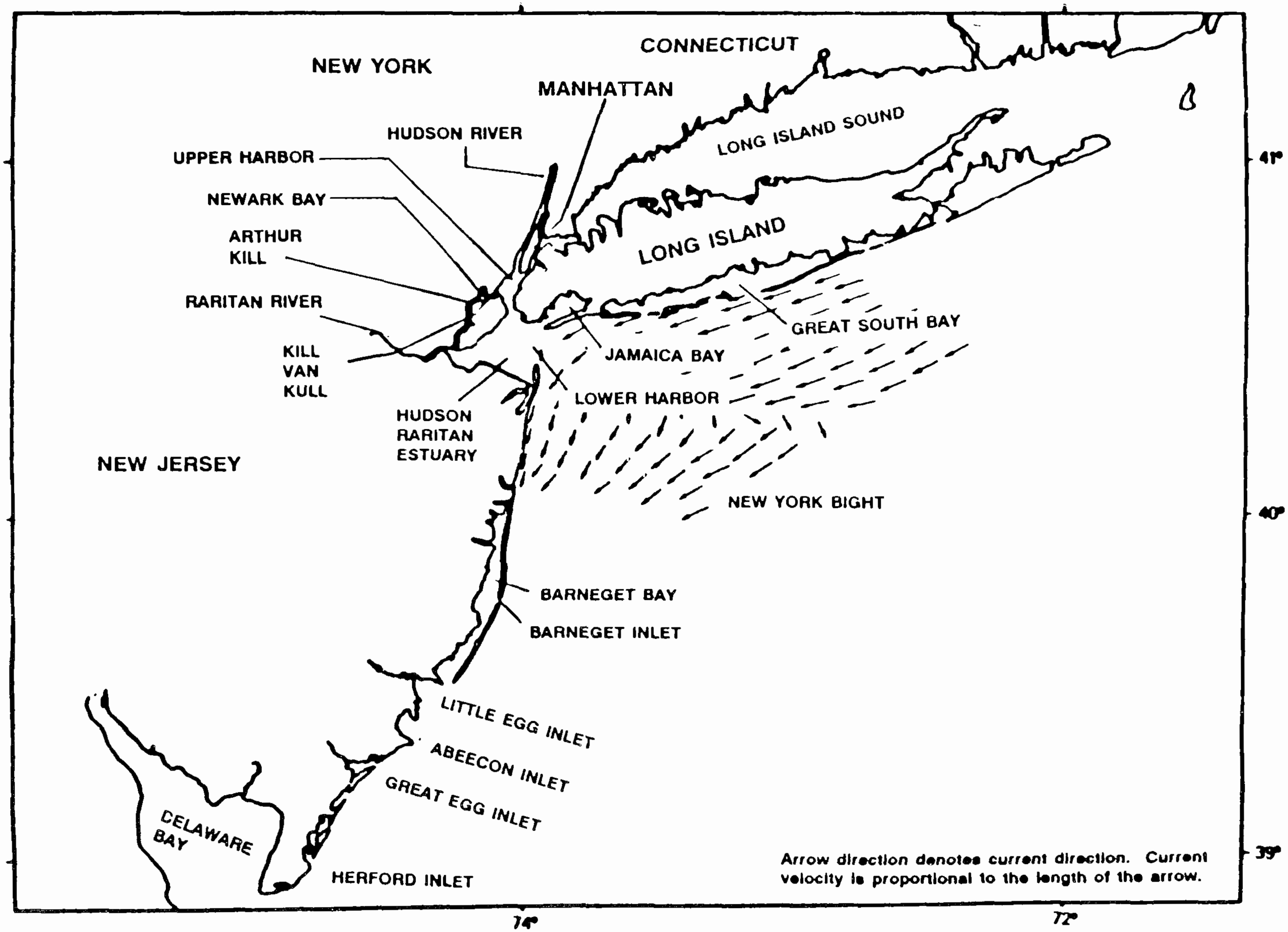


U.S. Environmental Protection Agency

FIGURE 8



WIND-DRIVEN CURRENTS IN THE NEW YORK BIGHT, SOUTHWESTERLY WINDS.



WIND-DRIVEN CURRENTS IN THE NEW YORK BIGHT, NORTHEASTERLY WINDS.

approach focus on the land aspects of the CSO problem; the water quality-based approach goes beyond that to evaluate, in detail, the water quality response to CSO abatement alternatives (Figure 10).

The control of other discharge sources of floatables and pathogens (storm water, for example) necessitates an analytical framework similar to that described for CSOs.

Technology-Based Control

A clear understanding of the combined sewer system is attained by collecting and compiling available data, measuring the flow and pollutant loadings, and using these data to model the CSO discharges. Designing removal facilities for floatables (e.g., swirl concentrators) necessitates the selection of a reasonable rainfall condition, such as the maximum hourly rainfall that occurs once every three, six, or 12 months, to evaluate the hydraulic design. Cost-effectiveness, land availability, and economic considerations also have to be considered in selecting the targeted level of control.

Water Quality-Based Control

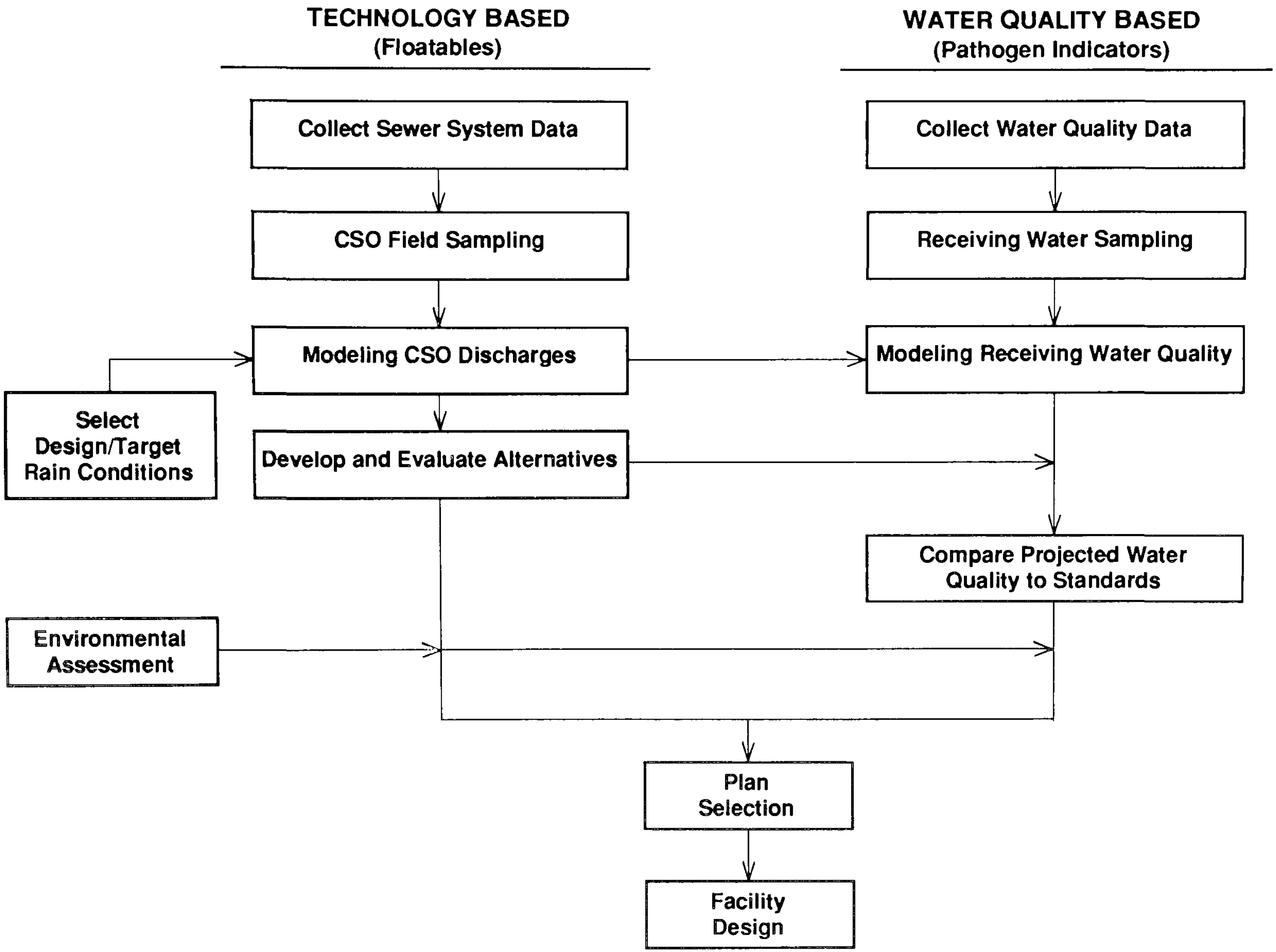
New York, New Jersey, and Connecticut have numerical criteria for bacteriological parameters in their water quality standards. These criteria are generally specified as a statistical term (geometric mean, median) for a monthly time period. In addition, numerical criteria for the other water quality constituents, such as dissolved oxygen, may be contravened because of CSO discharges. Substandard DO concentrations are commonly found in the upper tributaries to the Sound-Habor-Bight system. Technical evaluation of the extent of control necessary to comply with bacteriological as well as other standards requires these additional tasks:

- Field sampling, measurement, and laboratory analyses of receiving waters
- Modeling of receiving waterbody response
- Projections of reduction in bacteriological loading for design storms (or a continuous period of rain events) that will achieve compliance with applicable standards

This water quality-based approach is exemplified by New York City's CSO Facility Planning projects, which include extensive field sampling to provide synoptic data for model validation. The extent of CSO control is analyzed by first identifying areas of poor water quality, where water quality standards are not being met. These are found typically in the upstream portions of tributaries, such as Flushing Creek, Paedegart Basin, and Gowanus Canal, where there are relatively large CSO outfalls.

The reductions in pollutant loadings of coliforms, biochemical oxygen demand (BOD), and total suspended solids (TSS) are evaluated jointly for a range of control technologies

ALTERNATIVE APPROACHES TO ADDRESSING EXTENT OF CONTROL



e.g., in-line or off-line storage, swirl concentrator, disinfection). The improvements in coliform and dissolved oxygen concentrations that would result from these CSO reductions are projected and compared with the water quality standards. Combinations of the CSO abatement alternatives are developed by interfacing the water quality modeling with other tasks, including environmental assessment, design engineering, and public participation. How much control of pathogen indicators is needed to restore beneficial uses in the system is currently being evaluated in New York-New Jersey Harbor as part of New York City CSO abatement projects.

Beach Monitoring for Pathogen Indicators

The practices of the local county health departments in monitoring the bacteriological quality of beaches are geared to short-term periods. Because a 28-day period of data collection to evaluate compliance with standards would not allow fast enough action for health protection, routine monitoring data for periods of two to seven days are assessed regularly. If two or three consecutive samples at a beach exceed the monthly criterion, the beach may be closed if the cause is identifiable and justifies this action. These beach closure practices require that control of CSOs and other sources in the vicinity of beaches have a high level of assurance (i.e., backup systems). Nevertheless, the random nature of rainfall and associated pathogen loadings may result in a short-term beach closure even though monthly bacteriological criteria are being met.

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CITY OF NEW YORK CSO ABATEMENT PROGRAM CLEANING UP OUR COASTAL WATERS: AN UNFINISHED AGENDA

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The five boroughs of New York City are divided into fourteen (14) sewage treatment plant drainage areas. These 14 plants treat approximately 1.7 billion gallons of sewage every day. This sewage is conveyed to the plants through approximately 6,000 miles of sewers. Between 70% and 80% of these are combined sewers.

During dry weather, the combined sewers function as sanitary sewers, conveying all flows to the treatment plants. During wet weather, however, large volumes of rainfall runoff enter the system. If this water was conveyed to the treatment plants, it would exceed their hydraulic capacity. (The plants are designed to handle twice their average dry weather flow for limited periods.) To avoid flooding the plants, regulators are built into the combined sewers to act as relief valves. During and immediately after rainfall, the combined sewers continue to carry up to twice the average dry weather flow to the treatment plants, but above that level, the regulators shunt all additional flow to the nearest waterway. During these discharges, or combined sewer overflows (CSO), a portion of the sanitary sewage entering or already in the combined sewers will be discharged into the waterway along with storm water and debris washed from the streets.

There are more than 400 CSO's distributed along the City's shoreline. The smallest of these is 12 inches in diameter with a contributing drainage area of 2 or 3 city blocks. An example of one of the larger outfalls is at the head of Flushing Creek. It is a three barrel outfall, 10 feet high by 60 feet wide overall.

From the earliest times, Combined Sewer Overflows were recognized as a major source of pollution. During the 1950's, the City contracted for a series of studies leading to "The Elimination of Marginal Pollution" or CSO. These studies resulted in facility plans for approximately 25 CSO retention basins in Eastchester Bay, the Upper East River and Jamaica Bay. These basins would capture most overflows and return them to the treatment plants after the storm. Any storm overflow exceeding the capacity of the retention basin would be discharged after having a major portion of the sewage solids, and all of the floatables, removed through an approximate equivalent of primary treatment. Disinfection would also be performed on these excess flows where necessary to protect swimming waters.

A major construction program, called "The Auxiliary Water Pollution Control Program", was planned. The proposed CSO facility at Spring Creek on Jamaica Bay was designated as a prototype and was advanced first. The Spring Creek facility was opened in 1972 and resulted in significant water quality improvements. The facility has been operating since 1972 and has caused a dramatic improvement in the condition of Spring Creek.

The Federal Water Pollution Control Act of 1972 was, ironically, the main reason for the suspension of the Auxiliary Program after the completion of the Spring Creek facility. This law provided unprecedented funding for pollution control but gave priority to the elimination of raw discharges and the achievement of secondary treatment at new and existing treatment plants. New York City's treatment plant needs were so great that no resources were available for CSO control. This delay, however, was beneficial because subsequent studies and developments in CSO control pointed the way toward more cost-effective solutions.

From 1975 through 1977 the City conducted a harborwide water quality study funded by a Federal Grant under Section 208 of the Water Pollution Control Act Amendments of 1972. This study included development of a water quality computer model and monitoring of combined sewer overflows. Initial results showed that, on a steady-state basis, the effect of CSO's on the dissolved oxygen (D.O.) levels of most of the "open water" parts of the harbor complex were insignificant. Notable exceptions were the narrow creeks, canals and backwaters of certain bays, where CSO's could result in contravention of water quality standards, at least on an intermittent basis.

Consequently, a separate study was made of these confined water bodies, grouped generically under the title: "Tributaries". Unlike the "open waters", several of these tributaries were found to be extremely oxygen deficient, resulting in septic conditions and offensive odors.

In summary, the 208 Study found that, although a large amount of CSO abatement was needed in the tributaries, a greatly reduced amount of treatment was necessary for CSO's discharging into open waters. Predicated on these findings, the Department of Environmental Protection formulated its first CSO Abatement Program. It consisted of Facility Planning Projects for those Tributaries which the 208 Study had indicated were severely impaired by CSO's. Some of these were Flushing Bay, Paerdegat Basin, and Newtown Creek.

New York State DEC was not satisfied with the City's approach to CSO Abatement. They took the opportunity of the 1982 issuance of SPDES Permits to require that the City conduct a City-Wide program for the abatement of CSO's that cause contravention of water quality standards.

The DEP, with DEC's approval, began the development of this program through a two-phased approach. The first phase, generally identified as "CSO Problem Assessment", was completed in 1986. It consisted of:

1. Identification and characterization of CSO's.
2. Assessment of CSO's effect on water quality (from existing data and past studies, but with updated mathematical modelling).
3. Development of a Phase II work plan.

While the results of the 208 studies were generally confirmed, the impacts of CSO's on water quality were assessed in greater detail for individual reaches of the harbor. The Phase II Work Plan recommended that the harbor complex be divided into four areas for detailed Facility Planning. The current CSO Abatement Program consists of eight project areas which are a combination of the City-Wide Program and the original Tributary Program. Together they cover all the waters of the Harbor Complex. They are:

Area-Wide	Tributaries
East River	Flushing Bay
Jamaica Bay	Paerdegat Basin
Inner Harbor	Newtown Creek
Outer Harbor	Jamaica Tribs

In December, 1989, we presented our recommended plans for Flushing Bay and Paerdegat Basin at Public Hearings. I will use those projects to illustrate the engineering efforts which are undertaken and the magnitude of the construction program which will be required.

Paerdegat Basin is a narrow body of water, stretching approximately one mile from its head to its mouth at Jamaica Bay. There are three large CSO's which discharge at its head. During Facility Planning, a large amount of data was acquired through field investigations. CSO flows and loads were measured along with their resulting impact on water quality. Analysis of this data revealed that water quality in the Basin generally meets State Standards, with the exception of a relatively small area at the head of the Basin, where a CSO mound continuously depresses oxygen levels. After a significant rainfall, however, the situation changes considerably. Dissolved oxygen and coliform violations occur and persist, in varying degrees, for approximately three days. The Basin then returns to its dry-weather condition. This generally conforms to the findings of the 208 Study and the City-Wide CSO Study regarding water quality in Tributary Water Bodies.

All of the data collected is used to calibrate computer models of the sewer system and the water body. Utilizing these models, we can evaluate the impact of various rainfall events and the effectiveness of different abatement strategies. Alternatives are evaluated and ranked according to the following criteria:

- o Ability to meet water quality standards
- o Public acceptance
- o Cost Effectiveness

Evaluation of alternatives resulted in a recommended plan with several components. Regulator modifications would maximize flow to the treatment plant. Dredging the CSO mound would eliminate the oxygen demand at the lead of the Basin. However, the principal component of the plan is the achievement of 50 million gallons of CSO retention. This would consist of 20 million gallons of in-line sewer storage and the construction of a 30 million gallon retention facility. This facility will be constructed entirely underground with the exception of headworks and odor control buildings and a small outfall structure. The surface over the facility (approximately five acres) can be returned to community use.

Implementation of the recommended plan will result in a 75% reduction in pollutant loading to the Basin. This will permit achievement of State Water Quality Standards for Coliform throughout the Basin at all times. Dissolved Oxygen Standards will be met with the exception of the head of the Basin which may experience a minor violation approximately 10% of the time.

The capital cost of the recommended plan is $135 million. Design and construction schedules, along with appropriate environmental reviews, would place the facility on-line in 1995.

From the Paerdegat Basin Project, we can see the direction in which the Department's CSO Program is moving. For the largest CSO's discharging into the headwaters of tributaries, where a high level of abatement is required, storage at or near the point of discharge, combined with treatment of existing plants, is the preferred technology. The prime factor in this preference is the capacity of the present treatment plants and intercepting sewers. Over $2 billion of City, State and Federal funds are invested in these facilities, which are capable of handling far more than their present dry weather flow. In general, the screens, headworks and primary tanks can handle two times the secondary treatment design flow. This excess primary effluent may be bypassed around the secondary tanks, and recombined with secondary effluent for disinfection and discharge.

For storm flows which exceed the system storage capacity, the CSO Abatement Facilities will operate as primary treatment plants, with screening, solids and floatables removal, and disinfection where necessary.

For the smaller CSO's, it now appears that floatables and settleables removal will be necessary at most locations, with aggregation and/or elimination of outfalls where feasible. For discharges affecting bathing or shellfishing waters, disinfection may also be necessary.

With more than 400 outfalls for which retention will not be required, this will require a major construction commitment. Our Flushing Bay Project illustrates this point.

There are 15 CSO's discharging to Flushing Bay and Creek. One of these, at the head of the Creek, contributes approximately 60% of the pollutant load to the Bay. For that outfall a 40 million gallon underground retention facility is proposed. This facility, in conjunction with other measures, will permit the achievement of State Water Quality Standards. However, the remaining outfalls will continue to discharge floatable materials during rain events.

Various alternatives were considered for floatables captures. These included:

- Screening
- Swirl Concentrator
- Hydrodynamic Concentrator
- Helical Bend Concentrator
- Primary Settling Tank
- In-Channel Horizontal Rotating Screen
- Floating Boom
- Source Load Reduction

After extensive investigation, it was decided that Swirl Concentrators provided the best combination of floatable and settleable removal characteristics in conjunction with operational simplicity and maintainability. The device consists of a circular channel in which rotary motion of the combined sewage flow is induced by the kinetic energy of the incoming flow. Heavier particles settle rapidly to the bottom and are discharged through a foul sewer outlet to the treatment facility. "Clean flow" discharges over a circular weir and proceeds to the outfall. Floatable material is retained by baffles and discharged through the foul sewer outlet when the swirl drains after the storm.

The facility plan recommends the elimination or consolidation of overflows where feasible and the construction of seven Swirl Concentrator Facilities. One of these will be advanced immediately as a prototype and all facilities will be on-line by 1996. The total capital cost of our Flushing Bay facilities, retention and floatables, is approximately $300 million.

The City has committed $1.5 billion to be spent over the next 10 years for CSO abatement facilities. This is predicated on the construction of 10 to 12 retention facilities throughout the City. By the year 2000, these facilities are expected to be on-line and water quality violations will no longer occur as a result of rainfall events. However, the control of floatables will take us into the next century and cost as much as 2 to 3 billion dollars more.

Toward that end, the City has initiated a City-Wide Floatables Study. This project will assess all possible sources of floatables, their transmission routes and ultimate destinations. Armed with this information, we will be able to prioritize our resources toward the abatement of those sources which have the greatest impact. Only through the massive commitment of municipal resources and the efforts of all members of the public can our waters be returned to useful productivity.

CLEANING UP OUR COASTAL WATERS:

AN UNFINISHED AGENDA

ADDRESSING THE PATHOGENS AND FLOATABLES PROBLEMS:

A REGULATORY PERSPECTIVE

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March 13, 1990

In addressing the issue, it is important to take a moment to reflect on the underlying theme of this conference. An unfinished Agenda. We should not, in our enthusiasm to finish the job we've all dedicated our professional careers to, forget where we've been, and where we are. Let's quickly dispel the idea that things have never been so bad and that the water just keeps getting worse and worse.

We tend to look back at the past with a sense of nostalgia. Ever since the disastrous state of our environment was brought to the public attention in the late 60's and early 70's, we have looked upon the pre-chemical, pre-industrial eras as if people wandered around their cities in pristine, pollution-free nirvanas. The truth is that they did not.

The first New York City Authorization for a common sewer took place in 1695, almost three hundred years ago. By 1910 New York City alone was discharging over 600 million gallons of raw, untreated sewage into the harbor every day. All along the Atlantic Coastline communities discharged vast quantities of raw sewage, and frequently disposed of garbage, directly into the ocean.

That's 1910. We tend to think of it as a golden, charming era. Ty Cobb was playing ball in Detroit; Harry Houdini was escaping from cages, chains, trunks and handcuffs all over the country; Halley's Comet was passing by. But - on a more mundane level, in the same year, The Metropolitan Sewage Commission of New York was reporting that "practically all the waters within 15 miles of Manhattan Island are decidedly polluted". .... "the waters are incapable of supporting fish life...the waters in many of the smaller rivers and inner tributaries of the harbor are now so heavily charged with sewage that the waters in many of these places is black, and effervesce with foul gasses. ...no attempt is made to purify the sewage."

The same report went on to discuss the outrageous garbage wash-ups --- not of the summers of 1987 and 1988, but the summer of 1906. I quote: "Inspections of the sea in all directions to a distance of about 35 miles from the Narrows showed the presence of fields of many acres of garbage...of that portion of the garbage which was carried to shore, the most offensive elements were dead and decomposing animals, such as dogs, cats, rats, and fowls...a great many people put on their clothes and left the water in disgust after a few minutes, as it was so full of vegetables and grease. One woman decided to leave after a dead dog came in contact with her face."

The report goes on to talk about the adverse impacts òn shellfish, statistics on typhoid from poisoned oysters, gastroenteritis, cholera, and so on.

Dumping of garbage into the ocean was finally made illegal in 1936, but it was not until eighteen years ago that this nation launched an ambitious effort to really clean up and restore the country's waters --- waters that had been neglected and abused for over 200 years.

Today all wastewater treatment plants in this area are at secondary treatment or are on schedule to do so. And we have essentially eliminated discharge of raw sewage during dry weather periods;

Then, what are the problems of today? Despite the great strides I have attempted to bring to mind, there is clearly a long way to go towards finishing our ultimate agenda.

Our ocean beaches continue to be plagued by problems. While most of these problems are no longer continuous, the problems associated with rainfall and high tides in an area which has a dense population, a combined sewer system, and at times questionable street cleaning practices cause significant use impairments.
What then, can and are the regulatory agencies doing about it?

Let's start with floatables:

The summers of 87 and 88 were marred by significant wash-up of floating debris on the New Jersey and New York ocean beaches. A problem, which had been considered by Regulatory Agencies as merely aesthetic, and not all that significant was envisioned very differently by the public. People stayed away from the ocean in droves. Not only did they not swim, they did not fish and did not eat the fish. Supermarkets displayed signs that fish being sold was not caught in local waters. The presence of a small number of hyperdermic needles as part of the flotsam coupled with public concern over contracting AIDS had proven enough to cause a severe reaction by the public, one which at times approached hysteria.

In an attempt to get a better handle on the problem EPA embarked upon an investigation of floatables accumulation in the New York/New Jersey Harbor complex. Our scientists mapped the estuaries and shorelines that were most heavily impacted. We looked at possible sources as well as the dynamics of floatables. We found that floatables pollution takes two distinct forms, dispersed quantities of free-floating garbage and wood, and floating slicks of concentrated garbage and sewage, which occasionally wash ashore and force beach closings.

We found that debris slicks may occur after a rainstorm event that results in overflows of combined sewers and discharge of stormwater from storm sewers. Then again, we also found that slicks can form through "resuspension" of floatables that have already washed up on our shorelines. This normally occurs when the high lunar tides from a full or new moon, succeed in refloating or resuspending floatable materials on shorelines and carrying them out where they concentrate in slicks. Finally, we found that the largest debris slicks form as a result of resuspension and a storm event occurring at the same time.

With this information, EPA then formed an Interagency Workgroup of local, state and Federal agencies (August 1988) to develop a strategy which would be responsive to the floatables problem by mitigating as much of the adverse impact as possible. A Summer 1989 Floatables Action Plan was developed, adopted and implemented during the period of May 15 through September 15, 1989. The plan consisted of four key elements: surveillance, regular cleanups (moon-tides and rain events), nonroutine cleanups and a communications network to facilitate coordinated use of available resources. Agencies involved in implementing the plan were the New Jersey Department of Environmental Protection (NJDEP), New York City Department of Sanitation (NYDOS), New York State Department of Environmental Conservation (NYSDEC), U.S. Army Corps of Engineers (USACE), U.S. Coast Guard (USCG) and U.S. Environmental Protection Agency (EPA).

We had also determined that most floatable debris that impact the shorelines of New Jersey and New York originate in the New York/New Jersey Harbor. Large slicks had been primarily observed from Governor's Island to the Narrows, and in the Arthur Kill. Therefore, the surveillance plan concentrated on detecting slicks of floatable materials within the Harbor where it could be collected easily.

An integral part of the plan was the regular removal of debris from the harbor at established key locations. These locations were the Narrows and the outflow of the Arthur Kill into the Lower Harbor. The USACE removed the debris with their drift vessels utilizing specially designed nets paid for by NYSDEC and NJDEP. NYDOS supplied a barge at its Gravesend Bay Marine Transfer Station to transport the collected debris to the Fresh Kills Landfill for disposal. Debris removal routinely occurred during daylight hours on the day before, day of, and day after the full and new moon high tides. Also the USACE conducted debris removal at the two locations following significant storm events that caused overflow of combined sewage.

An additional aspect of the plan focused on the capture of debris slicks that were spotted at other points within New York/New Jersey Harbor. The USACE vessels and a fishing cooperative (vessels under contract with NJDEP) were available to conduct debris removal operations. Collection activities were only possible landward of the Sandy Hook-Rockaway transect.

For slicks that were observed beyond the Sandy Hook-Rockaway Point transect, a NOAA/USCG model was used to predict potential impact areas. The state floatables coordinators were informed of the potential slick wash-ups and notified the local authorities accordingly.

To administer the plan, a communication network was established for reported sightings of floatables. An EPA floatables coordinator functioned as the center of the reporting network and coordinated debris removal activities. All agencies involved in the surveillance and debris removal operations were available 24 hours/day through the use of hotline numbers and paging systems.

Additionally, the State of New Jersey implemented a program known as "Operation Clean Shores" to remove floatable debris from approximately 45 miles of shoreline from south of the George Washington Bridge to Highlands, New Jersey. This program, which utilized minimum security prisoners, NJDEP personnel and assistance from local municipalities was funded through a two million dollar grant under the Sewage Infrastructure Improvement Act. The cleanup was originally scheduled to be conducted from March through May but was extended through September 1989.
Also, the States of New Jersey and New York developed guidelines and held sessions to educate beach operators on beach cleanup operations, how to handle medical waste, how to dispose of it, and who to notify.

The spring and summer of 1989 was a period of record breaking rainfall with average monthly rainfalls over twice the norm. These heavy rains resulted in combined sewer overflows and stormwater discharges of floatable debris as well as a significant resuspension of debris off the shorelines as high waters and flood conditions scoured debris from banks of rivers and streams. Slicks were observed in the harbor complex after practically every rainfall event.

Despite all the rainfall the region received, only two stretches of <u>ocean</u> beaches along the Long Island and New Jersey shorelines were closed during the bathing season as a result of floating debris washing ashore.

The reduction in the beach closures can be partially attributed to the Floatables Action Plan. During the period from May 15 to September 15, the USACE collected approximately 543.7 tons of debris of which 461.2 tons was captured on floatable days. The collected material, as estimated by the USACE, contained (on a volume basis) approximately ninety percent wood and ten percent other floatable materials (plastics, paper products, tires, grasses, reeds, etc.).

While USACE was performing debris removal from the Upper Harbor, the New Jersey Commercial Fishermans Association under contract to NJDEP was being utilized to conduct activities in Raritan Bay. The NJCFA began their operations on June 18 and continued through Labor Day. During this period approximately 165 barrels (55 gallons capacity each) of household trash and 30 cubic yards of wood was netted. Also, to further eliminate the potential source of floating debris, NJDEP implemented its Operation Clean Shores program. Through September 15, this program was responsible for removing approximately 3,000 tons of debris from 28 miles of New Jersey Shorelines.

Despite the efforts to collect marine debris within the harbor, syringes continued to be found during the summer season on the ocean beaches along the New Jersey shoreline (Sandy Hook to Cape May), the south shore of Long Island (East Rockaway Inlet to Montauk Point), and New York City beaches (Coney Island, Manhattan Beach and the Rockaways). The New York City Beaches reported a dramatic decrease from 943 in 1988 to 434 syringes in 1989. The reported number of syringes found on the south shore of Long Island decreased slightly from 110 to 75. The reported number of syringes found along the New Jersey shoreline increased from approximately 60 to over 300. Two events accounted for 45% syringes. The additional increase may be indicative of better recording mechanisms.

The Floatables Action Plan played an integral role in preventing a repeat of the large number of beach closures which occurred during the Summers of 1987 and 1988, and keeping the beaches clean of floating debris. Other programs that were instituted this past year: New Jersey Operation Clean Shores the States of New Jersey and New York efforts to educate beach operators on the handling/reporting of floatables debris, and medical waste tracking, also significantly contributed to a successful summer. These programs are all stopgap measures until such time that long term solutions can be instituted to correct the sources of the problem. The Floatables Action Plan will be continued on a limited basis during the winter months (surveillance and cleanups following new and full moon high tides, and significant rainfall events) and will be reinstituted for the summer of 1990.

As a means of further supporting this effort, and in recognition of the success experienced this past summer, EPA will shortly be awarding $2,200,000 to the City of New York as grant aid for the purchase of two skimmer vessels. It is expected that these vessels will be available for use during the summer of 1991.

This is but one of many short-term efforts towards control of floatables and pathogens that EPA is involved in. Other assistance type activities include previous grants to New Jersey municipalities for repair of regulators and appurtenances to insure maximum capture of flow, demonstration studies of netting type devices for retrofitting of overflow points, an attempt to significantly improve the quality of stormwater discharges through implementation of Best Management Practices within the Village of Mamaroneck, and funding of the Flow-Balancing in-stream treatment techniques currently being demonstrated within the City of New York.

I believe that all the preceding is very positive, however, it shows but one side of EPA, that of helper, researcher, and doer. The other side of EPA is atleast equally as important, that is the function of regulator, overseer and ultimately enforcer.

In recognition of the significance and timeliness of the Combined Sewer Overflow problem in areas such as ours EPA has recently formalized a strategy for dealing with means of mitigating problems associated with combined sewers. The policy is written around three basic objectives:

1. ensuring that discharges occur only as a result of wet weather,

2. establishing minimum technology treatment requirements for discharges and assuring compliance with them and,

3. minimizing water quality impacts from these wet weather discharges

The states have recently submitted strategies for accomplishing these objectives in a finite timeframe. EPA is in the process of reviewing them.

The last item I would like to address is enforcement.

Enforcement of violations, especially those which create use impairments, albeit temporarily, will be swift, tough and predictable. We will look more than ever to the regulated public to ensure that ample checks exist to prevent "unforeseen events" from happening before they occur. Cases where negligence is apparent will be prosecuted to the full extent of the law. We will certainly raise even higher the hurdles placed before the regulated public before a violation will be excused.

While no one of the above items is the solution to the problems that still beset our waters we are hopeful that together they will lay the ground work and provide the structure for our path towards finishing our agenda (for pathogen and floatables problems in the Region).

THE POSITIVE IMPACT OF YEAR-ROUND DISINFECTION: A REGIONAL PERSPECTIVE

Presented by

Howard Golub
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at the conference

CLEANING UP OUR COASTAL WATERS: AN UNFINISHED AGENDA

Manhattan College
Riverdale, New York
March 12 - 14, 1990

THE POSITIVE IMPACT OF YEAR-ROUND DISINFECTION: A REGIONAL PERSPECTIVE

The Interstate Sanitation Commission is a water and air pollution control agency of the States of New York, New Jersey and Connecticut formed in 1936. In water pollution, the Commission has regulatory and enforcement powers and water quality and effluent regulations that apply within the Interstate Sanitation District.

The Commission's Water Quality Regulations adopted in 1977 contained maximum coliform limitations for treated sewage discharges. However, these limitations applied only when the disinfection of effluents was required by another regulatory agency with appropriate jurisdiction. As a result, disinfection practices in the Interstate Sanitation District were not uniform. The State of New Jersey required year-round disinfection for discharges into Raritan Bay but allowed seasonal disinfection elsewhere -- from April 15th through October 15th. In New York, year-round disinfection was required for private facilities, for most POTWs discharging to Long Island Sound and for the Oakwood Beach treatment plant in New York City; others disinfected seasonally from May 15th through September 15th. Connecticut required year-round disinfection by all plants discharging into Long Island Sound. Consequently, the applicability of the Commission's coliform limitations and the disinfection status of sewage discharges into the region's waters varied.

In 1983, the Commissioner of the New Jersey Department of Environmental Protection requested that the ISC look into the matter of maintaining shellfish beds, especially in Raritan Bay, in condition to allow shellfish harvesting throughout the year. Many beds otherwise suitable for shellfishing were closed during the cold weather months when some of the sewage treatment plants in the area were not disinfecting their effluents.

ISC's examination of the situation included public hearings at which the proponents and opponents put their views and evidence on the record. There was evidence and arguments presented on both sides of the issue. Some contended that extending year-round disinfection requirements to all plants in the region would not suffice to open shellfish beds because other sources of coliform contamination were too great to allow the waters to be brought within safe coliform limits for shellfish harvesting. Others contended that year-round disinfection would be an efficacious measure, both for its effect on shellfishing and as a general health measure. The case for neither side was incontrovertible. A Hearing Officers' Report was prepared to aid the ISC Commissioners. After months of consideration, the Commission amended its Water Quality Regulations in September, 1984 to require the Commission's coliform requirements to be met on a year-round basis, effective July 1, 1986.

Since being implemented, year-round disinfection has shown positive results. In the Atlantic Ocean off The Rockaways, the

New York State Department of Environmental Conservation extended the season in 1987 for 16,000 acres of shellfish beds for direct harvesting, and in 1988 all seasonal restrictions were removed. In 1989, the New Jersey Department of Environmental Protection removed the seasonal restriction for 13,000 acres in Raritan and Sandy Hook Bays for depuration harvesting. At the request of the New York State Department of Environmental Conservation, the Commission is presently sampling the New York portion of Raritan Bay for coliform criteria for shellfishing. In an evaluation of pre- and post-year-round disinfection data for coliforms at sewage treatment plants, the Commission found greater compliance after the year-round disinfection requirement was implemented.

The results to date are encouraging, however more remains to be done. The Commission is looking into the issue of disinfection for combined and storm sewers and will work with the states and the U.S. EPA to to achieve compatibility throughout the area.

ADDRESSING THE PATHOGENS AND FLOATABLES PROBLEM: AN AFFECTED COMMUNITY'S VIEWPOINT

Paul J. Noto, Mayor
Village of Mamaroneck

Floatable debris is a result of several factors, among them, storm drains and combined sewer overflows which is a discharge of material in the sewer system that seep into the groundwater and runs into the streams and rivers that empty into the Mamaroneck Harbor. Untreated wastewater from sewage treatment plants during large storm events, and volumes of waste material which is dumped daily into the oceans from commercial shipping fleets throughout the world often find its way into the Long Island Sound and local waterways. Floatable debris can also enter the water through mishandling of solid waste that is floating on barges for transport to landfills.

The impact of floatable debris and pathogens on a waterfront municipality is multi-faceted. Primarily, the first indication of problems are the beach closings that occur when the bacteria contamination reaches a level that is deemed unsafe for recreational swimming. Once the beach closings become frequent enough, there is a general decline in park attendance, a reduction in demands for maritime industries that usually go with waterfront communities, a perception that property values decline and a general concern over the public health that permeates all of the decision-making within the municipality. There is a general feeling that the quality of life in the community is eroding since most people who live there were attracted to the community because of its maritime character.

Beachgoers themselves can add to the problem by littering, not only on beaches, but near any coastal waterway. Boaters contribute by throwing trash overboard and discharging sanitary waste directly into Long Island Sound.

Municipalities can develop programs to address, not only the impact of floatables and pathogens, but the causes as well. The Village of Mamaroneck has been very aggressive in addressing the floatable problem and we have done so by developing a program that is a multi-dimensional approach to the problem.

The most direct program a community can develop and one that attacks the problem at its source is a sewer maintenance program. Unfortunately, most municipal sewer lines were constructed in the 1930's and are in the process of a gradual but steady deterioration. This deterioration creates sewer leakage which forces raw sewage into the groundwater, and the resulting runoff runs into the nearest waterway. The sewer maintenance program we developed includes televising the lines in the municipality, locating the cracks in deteriorating lines and repairing them, and installing new lines when necessary. This is a very expensive but necessary endeavor that every municipality must undertake. The Village of Mamaroneck with a population of 18,000 and an annual budget of $12 million will be spending approximately a million dollars a year on sewer maintenance and replacement for at least the next ten years. Unfortunately, this program is a gradual one and cannot address all the sewer problems within a municipality in one given year, but this type of program, along with a continuing maintenance program will help address problems in smaller areas.

Part and parcel with this type of program is a regional approach that requires all neighboring municipalities to do the same. The Village of Mamaroneck is one municipality at the bottom of a watershed and given the geographic locale, the Village is in a drainage system of approximately 23 miles. Therefore, it is absolutely essential that other communities in the watershed coordinate their maintenance programs so that the problems are addressed on a much larger scale.

In addition, Mamaroneck undertook a program to eliminate inflow/infiltration which is the flow of stormwater into the sewer lines which causes combined sewer overflows. During large storm events, most sewer systems are ill equipped to handle the large amounts of stormwater that run into the sewer system which causes overflows that seep into the groundwater and the runoff, which contains large amounts of bacteria, runs directly into the harbor and the Sound. The Village undertook to clean and televise 12,000 feet of sanitary sewer pipe and to disconnect and repair catch basins and manhole frames that were improperly connected to our sanitary sewer. By reducing this inflow/infiltration, communities can take a giant step towards reducing the floatables and the pathogens.

A contributing cause of inflow/infiltration is illegal stormwater connections that connect stormwater gutters to sewer lines. To address this problem, we undertook, in cooperation with the County of Westchester, a smoke testing program whereby homeowners were tested through a smoke test to determine if in fact their stormwater runoff was properly connected to the storm drains and not into the sewer lines. Unfortunately, many people purchased homes unaware of the fact that their storm runoff systems could be a contributing factor to the combined sewer overflows. This program, combined with public education, and enforcement measures, is potentially a very successful one. Unfortunately, it does require a large commitment of time and resources since every street must be tested and, of course, once the improper connections are discovered, enforcement measures must be undertaken. Obviously, this is not always a popular solution, however, a necessary one.

Additional municipal efforts should include repairing catch basins and enacting animal waste laws which are very difficult to enforce, yet create a necessary standard of behavior for the general public.

Another element of the local program must include controls on local development. We have learned through the Long Island Sound Study and other studies that, in fact, uncontrolled development can contribute to water pollution. Part of any municipal site plan review process must be adequate controls on development to make sure that Best Management Practices are utilized, stormwater discharge is strictly regulated, that the runoff is kept to a minimum and that all environmental impacts on developments are fully explored and addressed. Every community needs development to maintain the vitality of its economy and maintain a strong tax base. This does not mean the community should have no development but simply that all development should be carefully evaluated with a thorough environmental review. In New York most developments now fall under the SEQRA process which mandates a complete environmental review by the appropriate municipal board.

Any successful local effort to help clean up the Long Island Sound relies heavily on public education. The Village of Mamaroneck has been very aggressive in generating as much information as possible for the public so that everyone is aware of the problems of Long Island Sound and how each individual can contribute to keeping it cleaner. We are particularly proud of our award winning Sammy Terry Program, copy attached, which was created by our Village Engineer in which a cartoon character, Sammy Terry, was created as an enforcement agent to help educate people about illegal stormwater connections, and to enforce the law against these improper connections. This program was undertaken in cooperation with our local schools and our local scout troops. The young people became involved by going throughout the community and helping with the investigations. This was all done in conjunction with Archie Comics which is created and produced in Mamaroneck, New York. The program was a success and we continue to use Sammy Terry. It was so successful that the County of Westchester has taken advantage of the program and will be using it county wide. This is important for several reasons, besides the fact that it does provide a measure of entertainment, it relies heavily on the interest of young people. Since we believe that the Long Island Sound is in danger and we wish to preserve it for future generations, involving young people at this level is very important and very helpful because they become sensitized to the need to take individual responsibility for helping to keep Long Island Sound clean.

An additional component of public education, includes a program for local officials to speak to as many public forums as possible: League of Women Voters, the Women's Club, the service clubs, etc. where local officials can explain the problem, can explain what is being done to solve the problem and to encourage people to participate on an individual basis in the overall cleanup. That includes encouraging people not to use fertilizer, to check for improper stormwater connections, to recycle when necessary and to be cognizant of every individual's overall responsiblity to the Long Island Sound.

It is equally important that a locality establish a good relationship with the local media to help offset the negative public relations input of the beach closings each summer, and also to generate good public relations relative to your cleanup efforts, and to involve the community into making every effort to clean up Long Island Sound.

Since a municipality cannot solve this problem on its own, it is imperative that an organized lobbying effort be undertaken by the community, primarily in conjunction with other neighboring communities. We in Mamaroneck were very successful in obtaining County funding for an independent study of the pollution in Mamaroneck Harbor and in obtaining the smoke testing crew from the County to smoke test, not only in Mamaroneck, but County wide. We were instrumental in getting our former Congressman Joseph DioGuardi to form the Long Island Sound Congressional Caucus which has provided strong federal support for the overall cleanup of the Long Island Sound. Through our lobbying efforts, we were able to obtain a $500,000 Environmental Protection Agency Action Plan Project for Mamaroneck Harbor which is still underway. Additionally, it is important to get the public to help you lobby other officials. A municipality can be particularly effective, due to its strong personal relationship with its constituents in getting them to lobby federal, state and county officials directly which will help keep these legislators responsive to the need for a solution to the problem.

In addition to this kind of effort, a community should form a regional organization that will help bolster their lobbying efforts. We formed the Mamaroneck Sewer District Task Force, which is a group of Mayors and Supervisors within the Mamaroneck Sewer District of about seven communities, where we coordinate our efforts. We are implementing some of the recommendations made from other levels of government and we are simply keeping each other informed so that our efforts to help clean up the

Sound are coordinated and comprehensive. As I indicated before, since the problem is a regional one, it will require regional solutions and intermunicipal cooperation to solve.

With regards to the anticipated regulatory requirements, it is unclear exactly what these requirements may fully entail. However, I think they are useful since we are well on our way to developing a regional approach, some of these requirements can be very helpful in forcing recalcitrant muncipalities to address this problem in a forthright manner. Unfortunately, many communities without beaches or without waterfronts view these problems as a low priority. These regulatory requirements can be very helpful. More importantly, we will require money to help implement them and we will require assistance and to provide additional public education since it is important that the public be made fully aware of these requirements so that they are not surprised when they are confronted with an additional regulatory burden.

There is a great deal that a municipality can do. However, no matter how much any one municipality does, it will not be enough unless all communities participate in an overall effort to help clean up the Long Island Sound. We are very proud of our record and our local initiatives in this area and we hope that by sharing our ideas, we can get other communities to participate as well on a sound wide basis.


HI! I'M Archie® AND I'D LIKE TO INTRODUCE YOU TO INSPECTOR SAMMY TERRY®!
INSPECTION NOTES
JOE EDWARDS & LES ZAKARIN
© 1988 ARCHIE COMIC PUB. INC
© 1988 LES ZAKARIN
HE'S AN ENVIRONMENTAL AND SANITARY EXPERT AND IS HERE TO HELP US SOLVE SOME OF OUR PROBLEMS. HE'LL BE IN TOUCH WITH YOU SOON.
PLEASE, HELP HIM TO HELP US!


ARCHIE AND INSPECTOR SAMMY TERRY (IN)
"THE RIGHT CONNECTIONS"
BOY! THIS IS SOME DOWNPOUR!
BUMP
ARCHIE, I'M SORRY! I DIDN'T SEE YOU! I'M UPSET BECAUSE THIS RAIN CAN ADD TO THE POLLUTION OF MAMARONECK HARBOR AND LONG ISLAND SOUND!
WHOA! WHAT KIND OF LOGIC IS THAT, INSPECTOR SAMMY TERRY? I THOUGHT RAIN WASHES AWAY POLLUTION AND MAKES EVERYTHING CLEAN!
NOT ALWAYS! MAMARONECK IS HAVING A PROBLEM WITH ITS SEWERAGE SYSTEM BEING OVERLOADED! THE RAIN IS CONTRIBUTING TO THIS OVERLOADING!
YES! AND THE BOY SCOUTS ARE HELPING INSPECTOR TERRY FIND SOME OF THE CAUSES!
I DON'T UNDERSTAND, INSPECTOR TERRY, HOW CAN RAIN OVERLOAD THE SEWERAGE SYSTEM?
SEE THAT ROOF LEADER? IF IT IS CONNECTED DIRECTLY INTO THE VILLAGE SEWER LINE, THE RAINWATER GOES TO THE MAMARONECK TREATMENT PLANT ALONG WITH THE SEWAGE!
2


THIS OVERLOADS THE SYSTEM! THE PLANT DOESN'T WORK AS WELL AS IT SHOULD AND THE WASTEWATER IS NOT TREATED PROPERLY! THIS ENDS UP IN MAMARONECK HARBOR AND LONG ISLAND SOUND!
GET THE PICTURE NOW, ARCHIE?
MMM... WHO WOULD HAVE THOUGHT A SIMPLE RAIN-STORM COULD CREATE SUCH A PROBLEM!
GEE! I'M GLAD YOU'RE HERE, INSPECTOR! I'M SURE MOST OF THE PEOPLE AREN'T AWARE OF THIS PROBLEM! THIS COULD BE ONE OF THE REASONS THEY'VE HAD TO CLOSE OUR BEACHES OVER THE YEARS!
: SIGH : ... YES, AND IT'S NO FUN IN THE SUMMER IF THE BEACHES ARE CLOSED!
BEACH CLOSED
HELP!
GASP
NOW I SEE WHAT YOU TWO MEAN! BUT WHAT CAN THE PEOPLE DO TO HELP TO REDUCE THIS PROBLEM?
"MMM... CAN YOU IMAGINE HOW TOUGH IT IS FOR FISH TO LIVE IN POLLUTED WATER!"
NO STORMWATER WANTED
3

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WORKSHOP SESSIONS ON THE PRIMARY FACTORS CAUSING USE IMPAIRMENTS AND OTHER ADVERSE ECOSYSTEM IMPACTS

TOXICS

TOXIC INPUTS AND FATE IN THE NEW YORK NEW JERSEY HARBOR, BIGHT, AND LONG ISLAND SOUND

by James A. Mueller[(1)]

INTRODUCTION

In developing plans for the improvement of the coastal waters in the New York metropolitan area, quantification of pollutant inputs is an essential part of evaluating the impact of management alternatives. Ultimately, the fate of pollutant inputs and attendant adverse impacts on water use must be related to specific sources so that effective engineering and management actions can be implemented. A number of studies have been conducted in the last 15 years on the inputs and fate of pollutants in the metropolitan area coastal waters. This paper summarizes results of these studies for the toxic inputs of heavy metals and organics, mainly PCB, as well as suspended solids to which many of the toxics are adsorbed. The fate of the PCB inputs to the coastal waters over the past 30 years with projected future impacts on the fishery is summarized from a recent study conducted at Manhattan College. To a lesser extent the fate of the other contaminants is considered in transporting the pollutants from the harbor to the bight waters.

SOURCES

In the most recent study conducted on the New York Harbor and Bight, HydroQual, 1989, the following eight sources of pollutant inputs are considered.

1. Wastewater. This includes point source discharges from municipal and industrial sources. The majority of the sources receive treatment, most of it secondary, prior to discharge with a small amount of raw sewage still being phased out.

2. Barge Dumping. This input includes a number of sources. Wastewater sludges are collected from the above treatment plants and dumped in the ocean 106 miles off the coast. Dredge material from the harbor and coastal waters, construction debris, and acid wastes are dumped closer inland while chemical waste dumps have been phased out.

3. Atmospheric Deposition. Pollutants carried offshore are deposited in coastal waters during both wet and dry weather. Dry deposition occurs from gas transfer and settling of particulates while wet deposition occurs durin rain, snow and fog.

4. Runoff. In urban areas, surface runoff occurring from rain events carries surface pollutants to coastal waters from separate storm sewers or from combined sewers. The latter, referred to as combined sewer overflow, CSO, contains a combination of surface runoff and untreated sanitary sewage. In non-urban areas, runoff consists of street, agricultural, and forest runoff. The major volume of this runoff is from the streams and rivers draining upstream areas and referred to as gauged runoff.

5. Sediment Flux. This source is an estimate of the pollutants which are resuspended or diffuse into overlying coastal waters. Some amount of this material originates from other sources resulting in a degree of double counting with some overassessment of inputs.

6. Landfill Leachate. Rainfall percolates through landfills and becomes contaminated with pollutants which are transferred to the groundwater or discharged from the site as leachate to surface waters.

7. Accidental Spills. This source includes spills of fuels and other petroleum hydrocarbons as well as toxic organics into coastal waters.

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(1) Professor, Environmental Engineering & Science Graduate Program, Manhattan College, Riverdale, NY, presented at the *Cleaning Up Our Coastal Waters: An Unfinished Agenda* Conference, Manhattan College, March 12-14, 1990.

8. Groundwater Inflow. Groundwater flow into coastal waters may transport pollutants not trapped in the soil layers. Its impact has been shown to be insignificant, Mueller et al., 1976, and will not be considered further.

LOCATION

Three geographical areas are considered for the various sources:

1. New York New Jersey Harbor also called the Transect zone because of the pollutant transport to the bight at the Rockaway Sandy Hook transect.
2. New York Bight, the ocean area from Cape May, New Jersey to Montauk Point, Long Island.
3. Long Island Sound.

Figure 1 shows the above zones with the New York Bight further divided into two coastal zones and a direct discharge zone. Figure 2 further delineates the Long Island Sound drainage area with associated USGS drainage areas.

NEW YORK NEW JERSEY HARBOR (TRANSECT ZONE)

The dominating feature of the transect zone is the Hudson River which drains 34,600 km^2 providing the major freshwater flow in the area. The population of the entire zone is about 15 million with 13 million in the New York New Jersey metropolitan area. There are 57 municipal and 16 industrial discharges downstream from the gauging stations on the Hudson River at Poughkeepsie, NY and on the various New Jersey Rivers as shown in Figure 3. There are a significant amount of CSO's in the zone as well as 92 landfills, Mueller et al., 1982.

NEW YORK BIGHT

The dominating feature of the New York Bight is the large water surface area, 35000 km^2, with 1800 km^2 considered the Apex directly outside the transect zone. A large net coastal circulation occurs from Northeast to Southwest. Figure 4 shows the 16 direct municipal wastewater discharges and 1 industrial discharge directly into near shore coastal waters in addition to the 6 municipal discharges into the bays. Figure 5 shows the locations of the 5 barge disposal sites within the bight proper, the 12 mile sewage sludge site now abandoned, as well as the two 106 mile sites for sewage sludge and chemi cal wastes outside the bight area.

LONG ISLAND SOUND

The Long Island Sound's dominant features are its large surface area of 3350 km^2 connected to the East River on the western end and the Atlantic Ocean in the East. The hydraulic exchanges between the East River and the Sound are not fully understood but would tend to govern the water quality in the area since no major rivers discharge to the western Sound. The Housatonic River is the major discharge in the central Sound with the Connecticut River the major discharge in the eastern Sound. Figure 6, the locations of the 15 municipal wastewater treatment plants, shows the majority of the flow to be discharged to the densely populated western end of the Sound. The four large NYC treatment plants, 12 to 15, are included in both the Long Island Sound and New York Harbor loads. In addition 24 industrial discharges are present, Figure 7, with the largest located in the central and far eastern end of the Sound.

MAGNITUDE AND TRENDS OF MASS LOADS

Pollutant mass loads are presented on an annual average basis for flow, suspended solids and the toxics. Year to year and seasonal changes in hydrology, meteorology and other factors can cause significant variations around tabulated estimates. In many cases, information on mass inputs is limited and loading rates are extrapolated from the best available data. In some instances, data is insufficient for developing estimates of load inputs.

NEW YORK NEW JERSEY HARBOR (TRANSECT ZONE)

Table 1 presents the magnitude of the toxic inputs to the harbor. The wastewater inputs are based on 1987 data and account for most of the treatment plant upgrading that occurred in the 1980's in the metropolitan area. The majority of these inputs come from municipal secondary treatment plants. Figure 8 shows the distribution of inputs by source. The total metals loads are summarized in this and subsequent loading figures to represent average source distributions of the major metals inputs, the tabulated data available for the specific metals.

For the total metals, inputs from wastewater, stormwater and tributaries are significant while most of the solids are contributed by the tributaries. While the above sources are also significant for the PCB's with the Hudson River contributing the majority due to the upper Hudson contaminated sediments, atmospheric inputs to harbor waters become as important as stormwater inputs. All atmospheric values are inputs only and do not consider losses of volatile components back to the atmosphere. The discussion on PCB fate later in the paper evaluates this situation. Toxics inputs from landfill leachates is insignificant for the metals and about 3% of total PCB inputs.

Table 2 shows the historical trends in the toxic wastewater inputs starting at 1970-74 for the solids and 1979-80 for the metals. By 1987 raw sewage inputs from New York City had markedly decreased due to new plant construction and completion of sewage interceptors. Separate industrial treatment plant inputs have also significantly decreased where they generally now represent less than 5% of the total wastewater inputs except for mercury where they represent about one third of the total. Figure 9 shows the marked decrease in solids inputs over this period to be paralleled by a decrease in total metals which represent 1.5% of the total wastewater solids discharged from treatment plants.

The heavy use of the harbor complex for shipping and the intensive concentration of industries in some areas subject the area to accidental spills as witnessed by the number of major spills of petroleum products in the Arthur Kill area in the early 1990's. In 1982, Mueller et Al performed a data gathering effort to document spills to the transect zone between 1974 and 1979 during which 1750 m^3 per year of fuel oil and hydrocarbon products were spilled into the harbor complex. Annual mass inputs of napthalene (51% of total inputs), toluene (3.3%), trichloroethylene (3.6%), and petroleum hydrocarbons (6% of oil and grease) were provided in this study.

The fate of the contaminants in the harbor waters is important to determine not only impacts in the harbor but also the quantity transferred to the New York Bight through the Rockaway Sandy Hook transect. Much of the suspended matter containing toxics settles to bottom, some of it ultimately removed during dredging operations to maintain navigation channels. Based on a mass balance analysis using settling rates, HydroQual, 1989, estimated that 60% of the solids and toxics were retained in harbor sediments due to the process of sedimentation. Typically sediments in near shore waters are more highly contaminated than in open bay waters due to settling. Since no biodegradation of the metals nor for the most part PCB occurs in the sediments, the impacts of the contaminated sediments on aquatic biota and the interchange of contaminants with overlying waters is required to evaluate environmental impacts.

NEW YORK BIGHT

Table 3 shows estimates of toxic inputs to bight waters with Fig 10 summarizing distributions. A range of estimates for suspended solids, copper, nickel and zinc is due to uncertainty in the amount settled in the harbor. For the solids, transfer coefficients (ratio of amount transferred into bight waters to amount of pollutant load into the harbor from all sources) varied from 0.004 to 1.0 while for the above three metals, from 0.4 to 0.7. This range of estimates is based on analysis of data from three techniques, a concentration gradient analysis, a net flux analysis, and a settling analysis, HydroQual, 1989. The remaining metals, organics and inorganics used a transfer coefficient of 0.4 assuming 60% settling in the harbor. For the total loads, average values of all range estimates were utilized.

Figure 10, summarizing the data in Table 3, shows the dredge spoils to be the major inputs of solids, the atmosphere and transect zone to be the major inputs of the metals while the atmosphere is the major input of PCB's. Although the sludge dumpsite is actually outside the bight proper it is included due to its proximity and is significant with respect to the total metals. Direct coastal zone inputs are insignificant for the total bight waters being less than 2% of the total inputs. When considering the bight apex, atmospheric inputs are much lower due to the smaller surface area, thus the greatest inputs are from the transect zone and dredge spoils as illustrated in Figure 11 for PCB.

The history of the barge dump volumes to the New York Bight, Figure 12, shows that volumes of acid and chemical wastes peaked from the late sixties to the late seventies but has now been discontinued. Dredging operations in the last 5 years are removing about one-third of the volume removed durin peak operations in the early seventies. The volume of sludge has been gradually increasing, with a sharp jump in 1980, as treatment plants continue to be upgraded producing more sludge. In total, 6 New Jersey, 14 New York City. 2 Nassau County and 1 Westchester County treatment plants dispose of sewage sludge at the dumpsite. Until early 1986, these plants used the 12 mile site. This was gradually phased out between March and December 1987. As of January 1 1988, all sewage sludge is disposed of at the 106 mile site with phase out of all sewage sludge ocean dumping mandated for the early 1990's. Although volume has increased in the past quarter century, loads have not always increased as shown in Table 4. Greater sludge digestion and destruction at the treatment plants is responsible for the solids decrease while the decrease for most metals may be related to reduced industry in the area, increased industrial recycling, and industrial pretreatment.

Table 5 compares the man-made and atmospheric inputs to the New York Bight to the inputs from the coastal advective transport due to the east to south, Montauk to Cape May circulation pattern, Hydroqual 1989. These coastal transport inputs are associated with background ocean pollutant concentrations, from discharges farther north, and with pollutants exiting from Long Island Sound. The information is quite tenuous since it is based on unverified coastal flow estimates from a hydrodynamic model and very limited ambient concentration data along the geographical limits from a 1988 EPA cruise. Although outputs from Cape May were generally greater than eastern inputs at Montauk, a mass balance considering sources could not be obtained. However it does indicate that the metal inputs from the inland sources are significant, especially when considering the bight apex where man-made inputs are 80 to 800% greater than background transport values.

LONG ISLAND SOUND

Table 6, the toxic inputs to Long Island Sound is based on data from the NCPDI study of Farrow et al., 1986, and atmospheric estimates of Stacey, 1990 modified by bight and harbor input data for metals and PCB's. Figure 13, the distribution of inputs, indicates that stormwater contributes the major solids inputs due to runoff from cropland and urban areas. For both total metals and PCB's tributaries in the central and eastern portions of the area contribute the greatest loads with atmosphere, wastewater and stormwater all significant. The magnitude of the toxics loads into the Long Island Sound is slightly less than half the magnitude of the toxics loads into the New York New Jersey Harbor.

The Long Island Sound 1988 annual report, EPA, 1988, indicates that sediment and mussel samples tend to be more contaminated with metals and toxic organics in the western portion near Throgs Neck than in the eastern areas. The PCB sediment data in the lower New York New Jersey harbor waters is also typically higher than existing at Throgs Neck presumably due to the Hudson River tributary source. A special study on tributylin (TBT) indicates that the highest concentrations in mussels were measured in site 2 at Mamaroneck in the proximity of a marina. This compound, highly toxic to some marine life in coastal waters, has been widely used in marine paint to prevent barnacles and algae from accumulating on marine hulls until 1988 when its use was severely restricted.

FATE OF PCB IN THE LOWER HUDSON ESTUARY

To evaluate the impact of the toxic loads on the coastal waters, a model of the fate and interactions of the contaminants with the sediment, atmosphere, and aquatic biota is required. A study of the PCB fate in the lower Hudson estuary below the Troy dam has recently been completed by Thomann et Al, 1989 and will be briefly summarized here.

The striped bass fishery in the Hudson River is presently closed because the PCB concentration is above the allowable USFDA level of 2 micrograms PCB per gram fish. Two management questions were considered by this study. "What can be done to open the striped bass fishery? What would be the effectiveness of upstream dredging of contaminated sediments on the lower fishery?"

Figure 15 shows the limits of the study area were from the Troy dam out to the Bight apex and out to the eastern end of Long Island Sound. The major upstream source of PCB's in the mid sixties and early 70's were from the GE discharges in the Hudson Falls Ft. Edward area. Prior to this time downstream loading from treatment plants and runoff were predominant as shown in Figure 16. The upstream load rapidly diminished in the late 70's to about the same order of the downstream inputs. In the early years from 1946 to 1974 when the PCB load was high, the flux of PCB was from the water column to the sediments in the lower estuary causing a buildup in sediment concentration. When the total load decreased in the mid 70's, the sediment flux was reversed with the sediment acting as a contaminant source to the water column.

To evaluate the fate of the PCB's in the estuary, a mathematical model was developed incorporating the circulation and flow patterns in the estuary with the sediment-water and water-air interactions as well as the food chain bioconcentration, excretion and accumulation processes. Since the various PCB homologs have differing partitioning coefficients, 7 PCB homologs were utilized in the model. Model calibration and verification was obtained with existing data. Figures 18 to 20 show the total PCB loadings over the 41 year period 1946-1987 to the Bight, 46 m ton, and Sound, 6 m ton, with the tri, tetra, and penta biphenyls comprising 80% of the load.

Figures 21 to 23 show the input and fate of the total PCBs and 2 homologs. Most (66%) of the PCB load to the estuary in this 41 year period has been volatilized to the atmosphere, 9% removed by dredging and 19% transported across the model boundaries. No biodegradation of the PCB is assumed in the model leaving only 5.7% stored in the system, primarily in the sediment. Volatilization is seen dominate all homologs, although progressively decreasing as one proceeds from the lower to upper homologs. This behavior is expected since higher homologs partition to solids more strongly becoming less available for volatilization. The fate mechanisms associated strongly with solids (dredging and storage) indicate lower contributions for the lower homologs and increasing contributions for the higher homologs. Boundary transport also appears to be significantly influenced by solids, since contributions increase with the higher homologs.

The model was used for projections of future striped bass PCB concentrations as shown in Figure 24 and 25. Under a "no action" alternative, 50% of the striped bass in the estuary are expected to be below 2 ug/gwet by 1992 with another 12 years required to get 50 % below 1 ug/gwet or 95% of the fish below 2 ug/gwet. If upstream dredging removes all PCB, the results are about the same as the "do nothing" alternative since mass inputs below Troy, NY to the Hudson estuary dominate loadings in recent years.

CONCLUSIONS

1. The quality of the existing toxics data base for the harbor, bight, sound coastal inputs is considered adequate for the metals for the wastewater runoff, and barge disposal sources. Other sources; atmospheric deposition, sediment flux, and coastal transport are considered poor to inadequate since they are based on little data or data extrapolated from other areas. Except for the sewage sludge source, the data base for other contaminants is also considered poor to inadequate. Quantification of the loads in this paper are best estimates requiring continual upgrading as better data bases are developed.

2. Fate models employing the physical, biological, and chemical interactions with the system hydraulics, such as that illustrated in this paper for the PCBs in the Hudson estuary, when properly calibrated and verified with field data provide a powerful tool to evaluate management decisions on use impairments.

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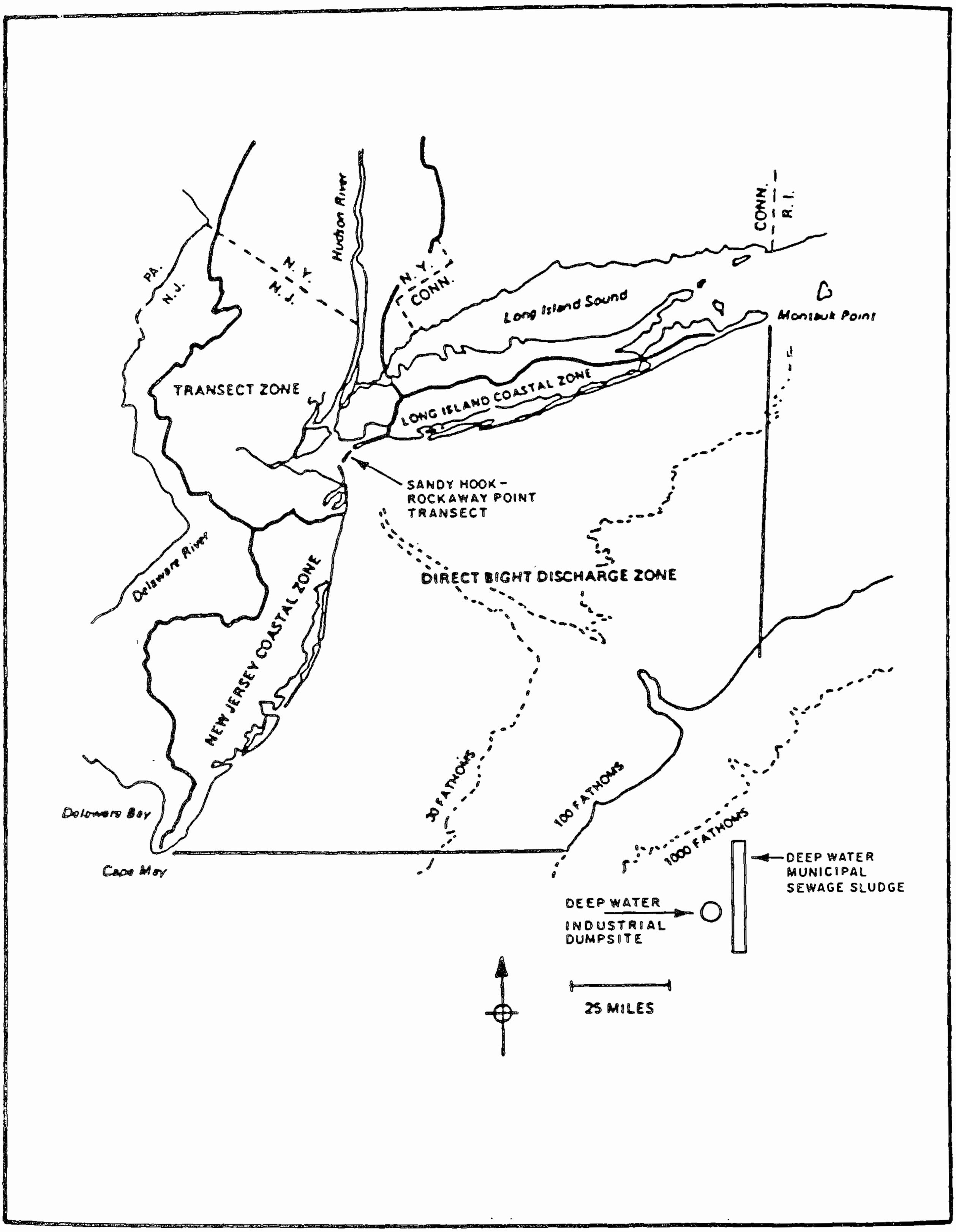


FIGURE 1. GEOGRAPHICAL ZONES IN THE NEW YORK BIGHT

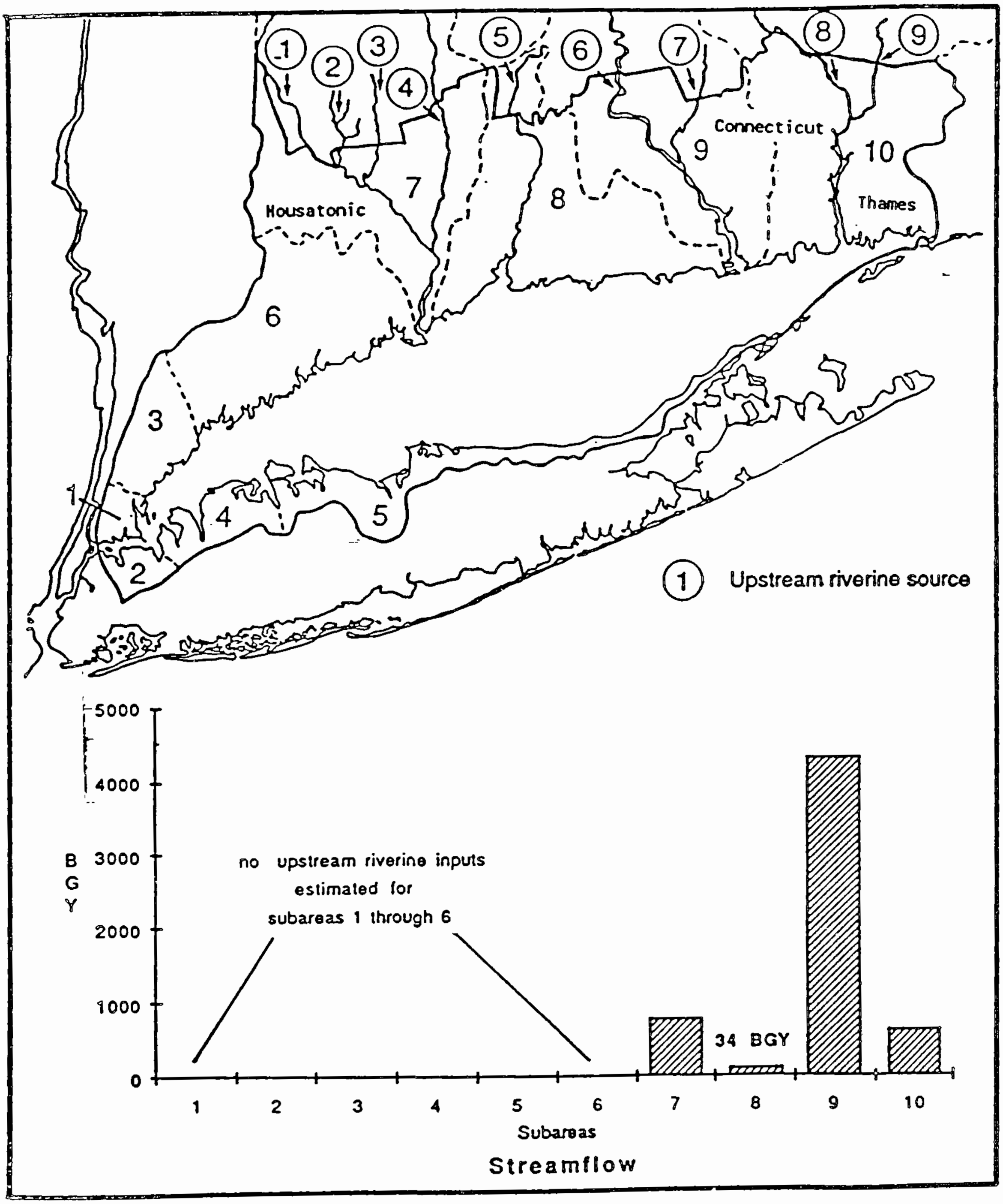


FIGURE 2. Long Island Sound Geographical Area Showing Annual Streamflow, circa 1982.

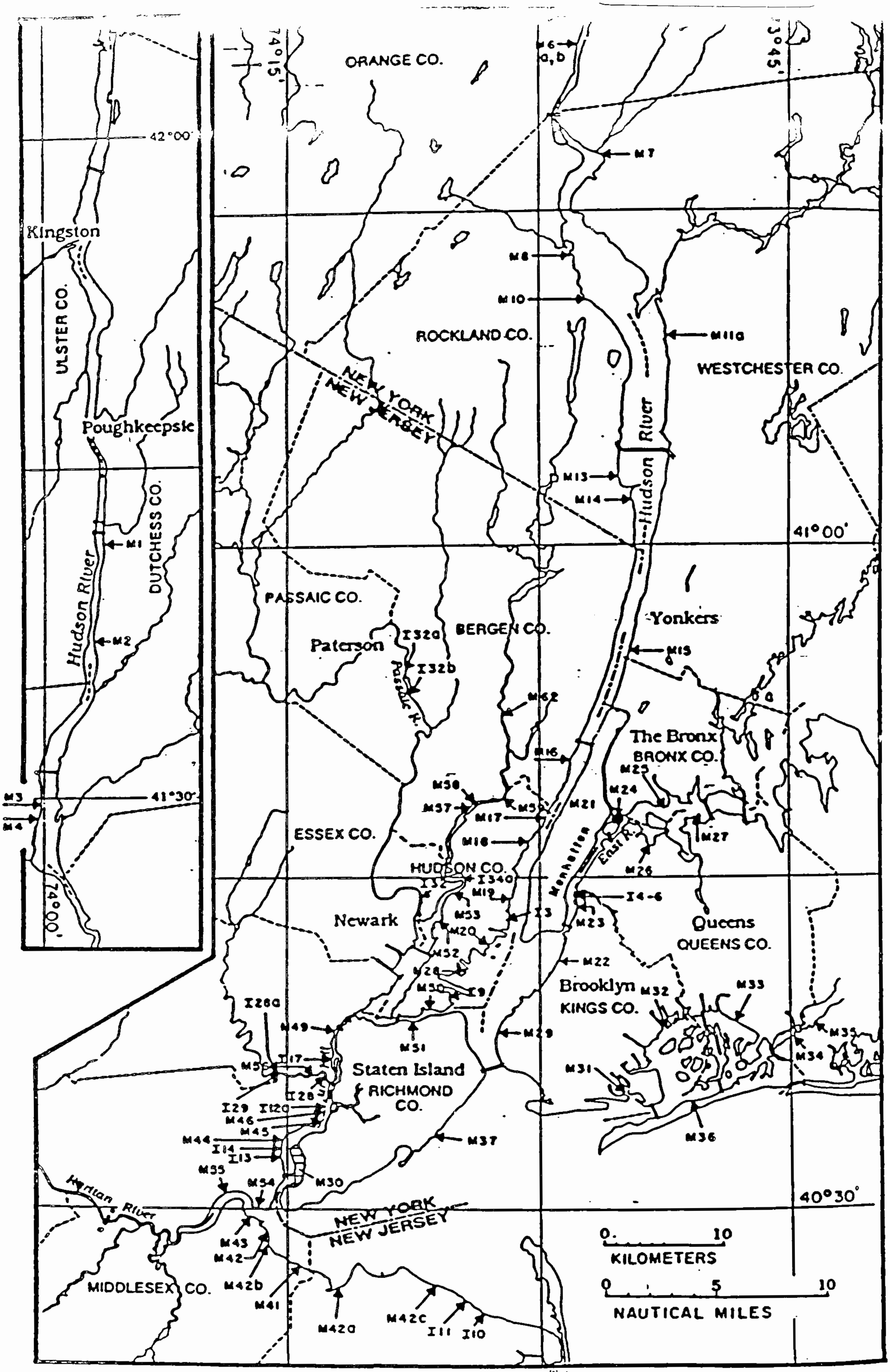


FIGURE 3 . TRANSECT ZONE WASTEWATER DISCHARGE LOCATIONS

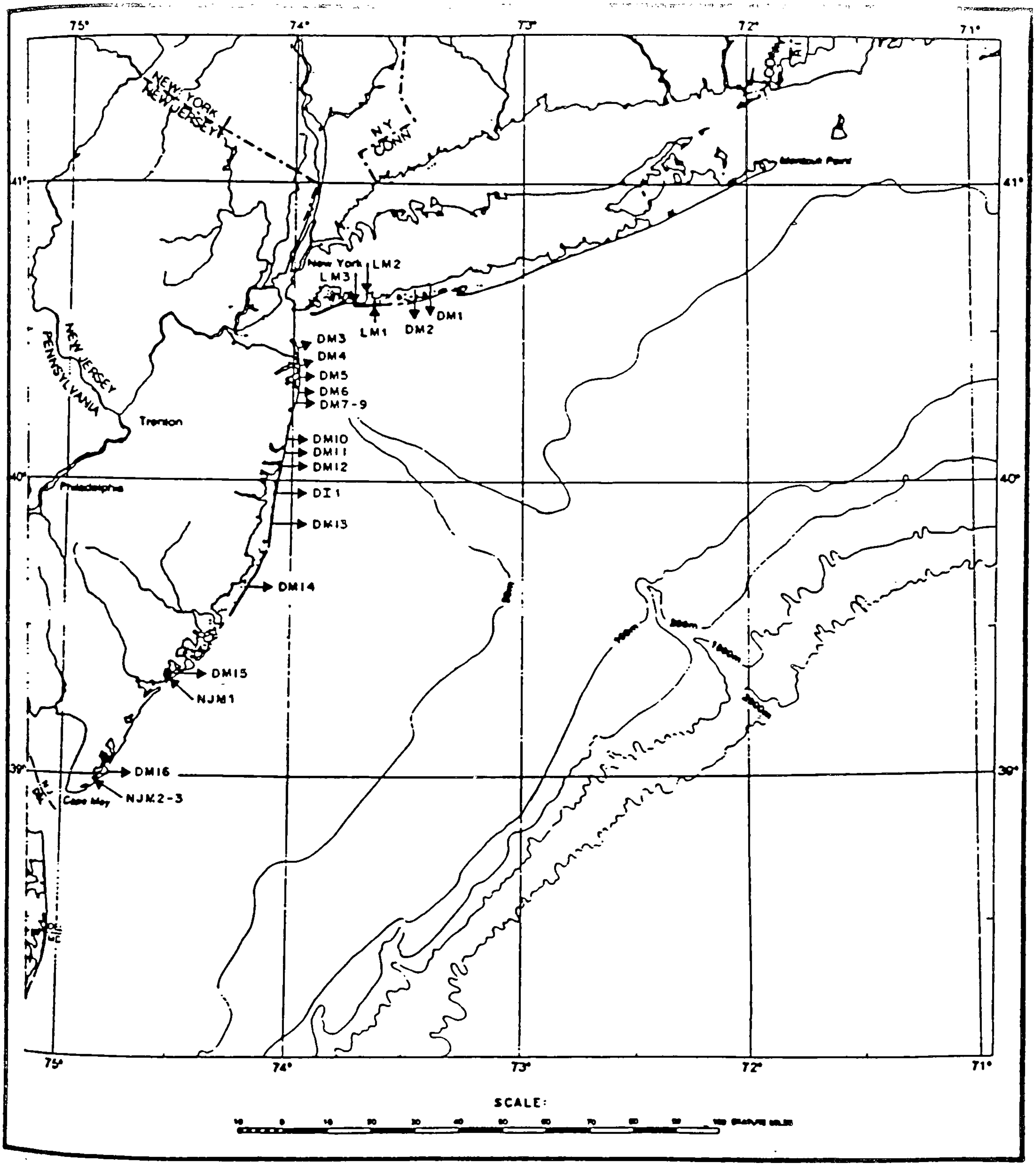


FIGURE 4 . LONG ISLAND AND NEW JERSEY COASTAL ZONE WASTEWATER DISCHARGE LOCATIONS

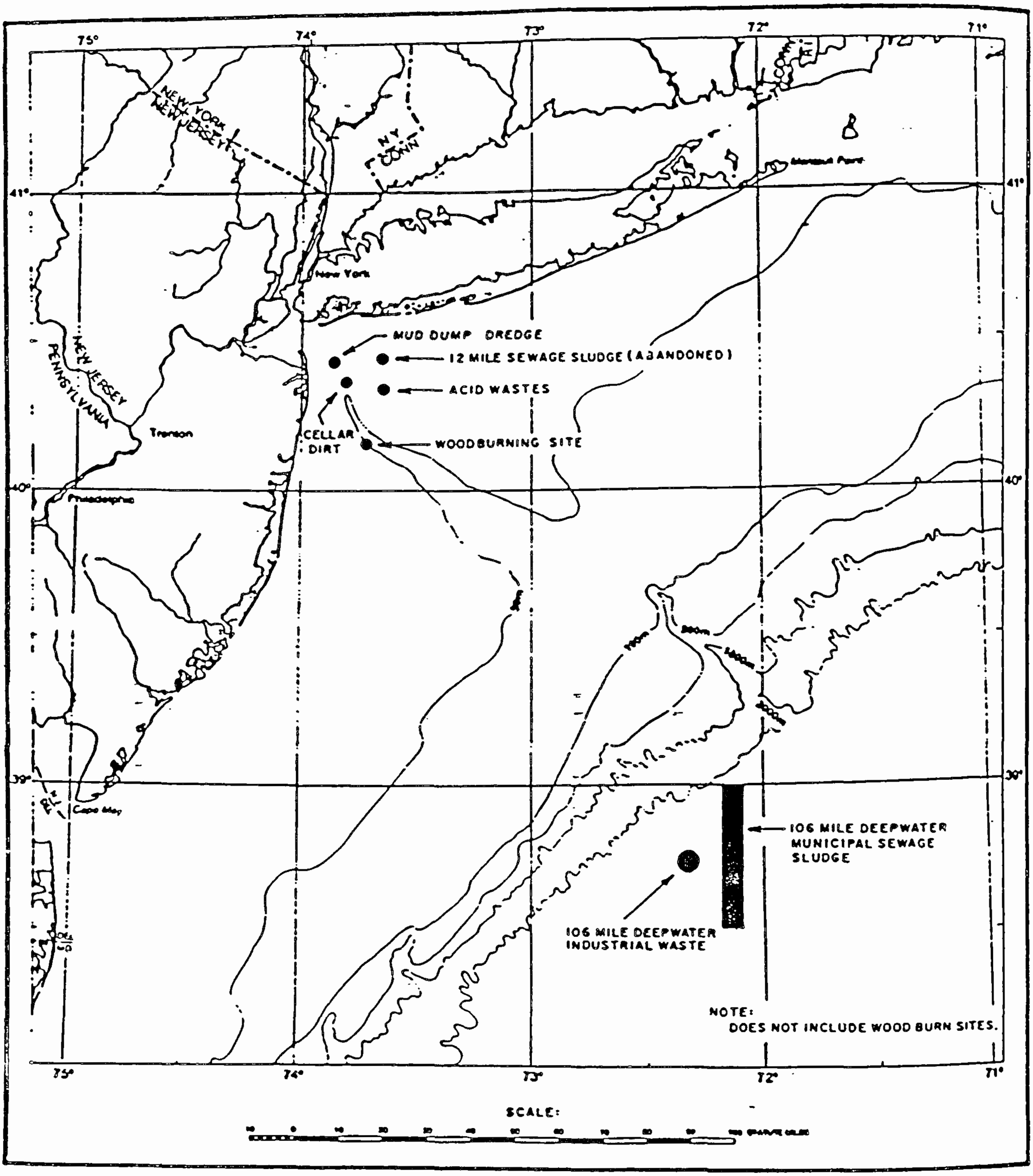


FIGURE 5. NEW YORK BIGHT DISPOSAL SITES

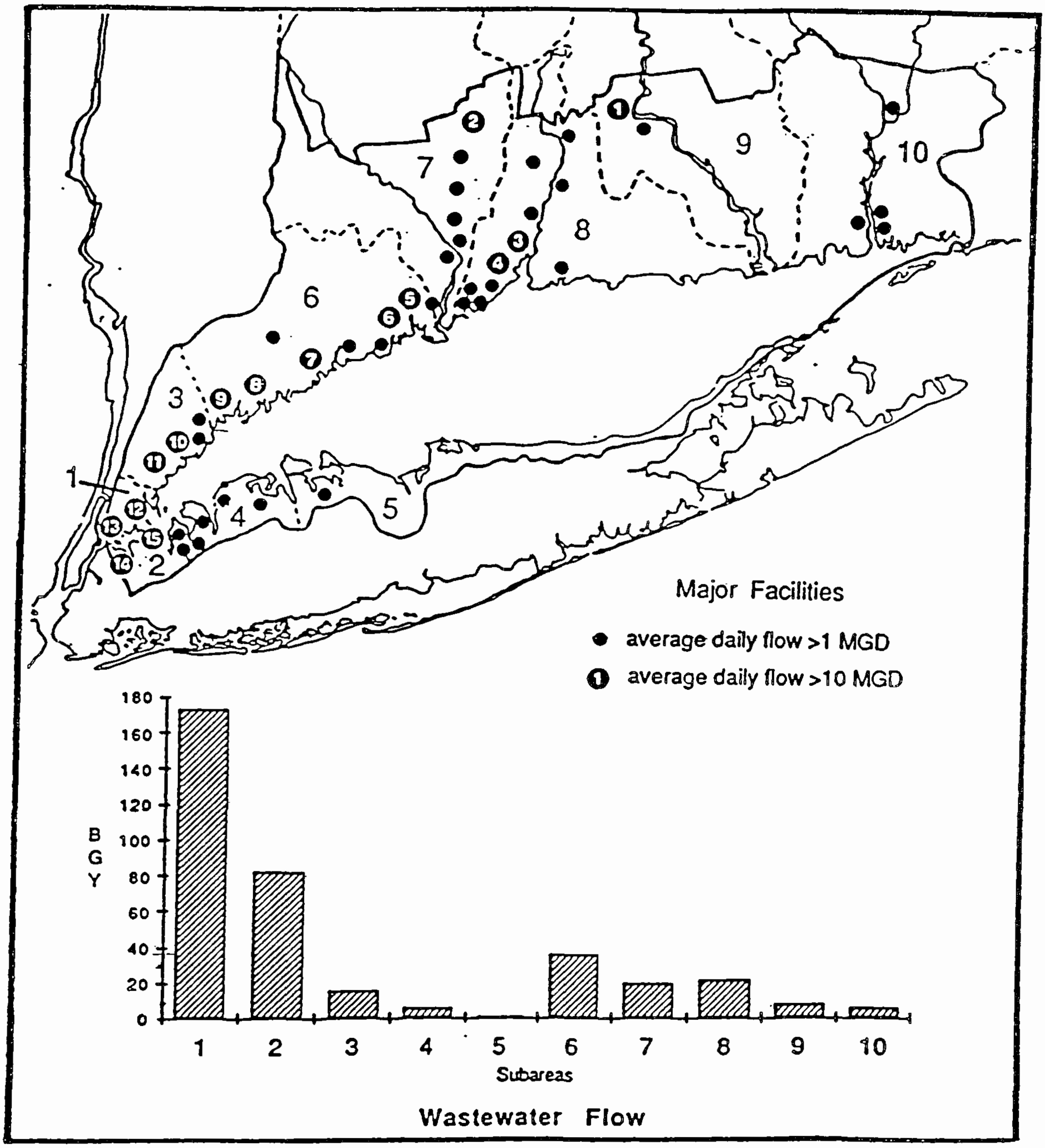


FIGURE 6. Annual Municipal Wastewater Treatment Plant Discharges by Subarea, circa 1982-84.

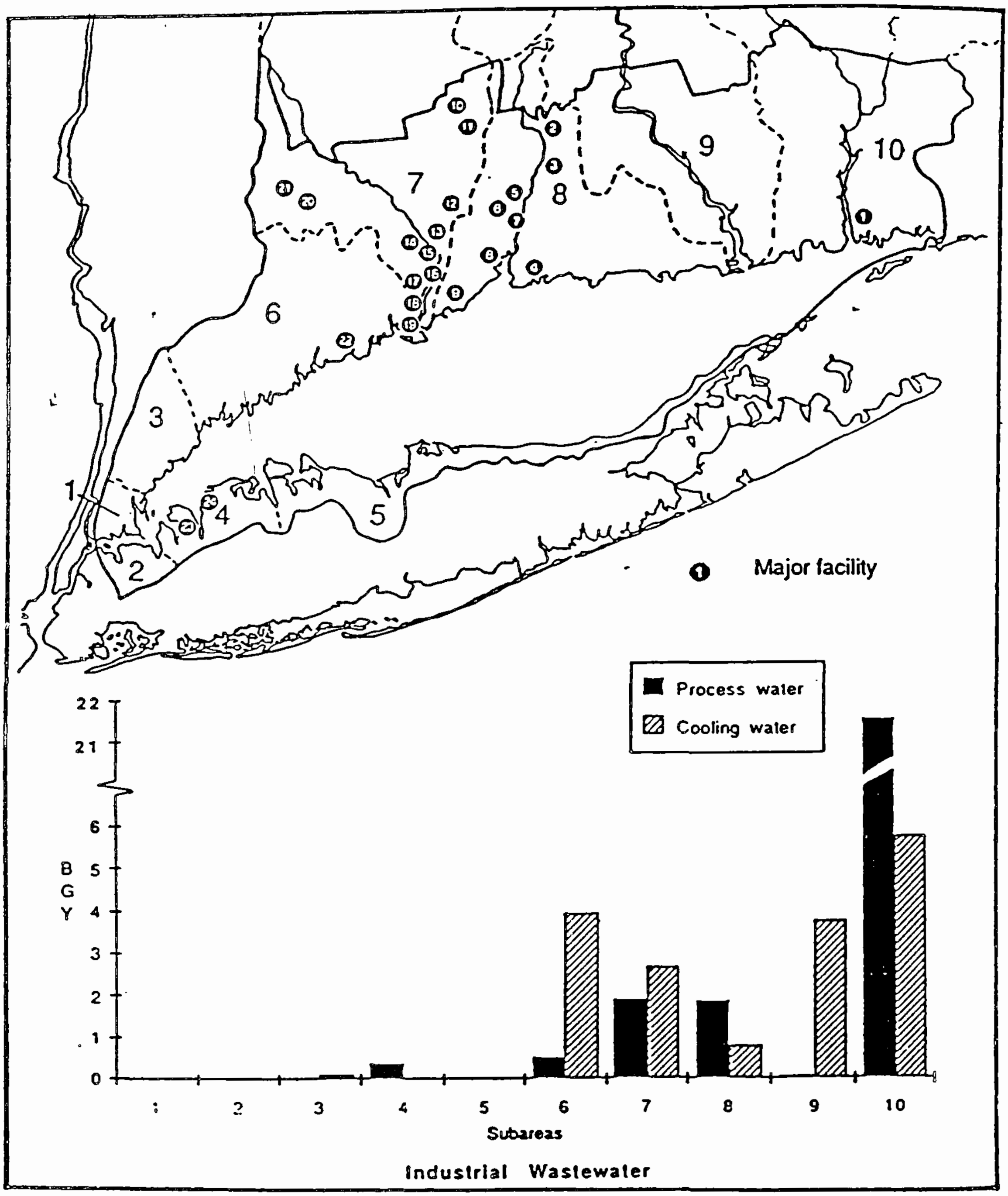


FIGURE 7. Annual Treated Process and Cooling Water Discharges from Direct Discharging Industrial Facilities by Subarea, circa 1982-84.

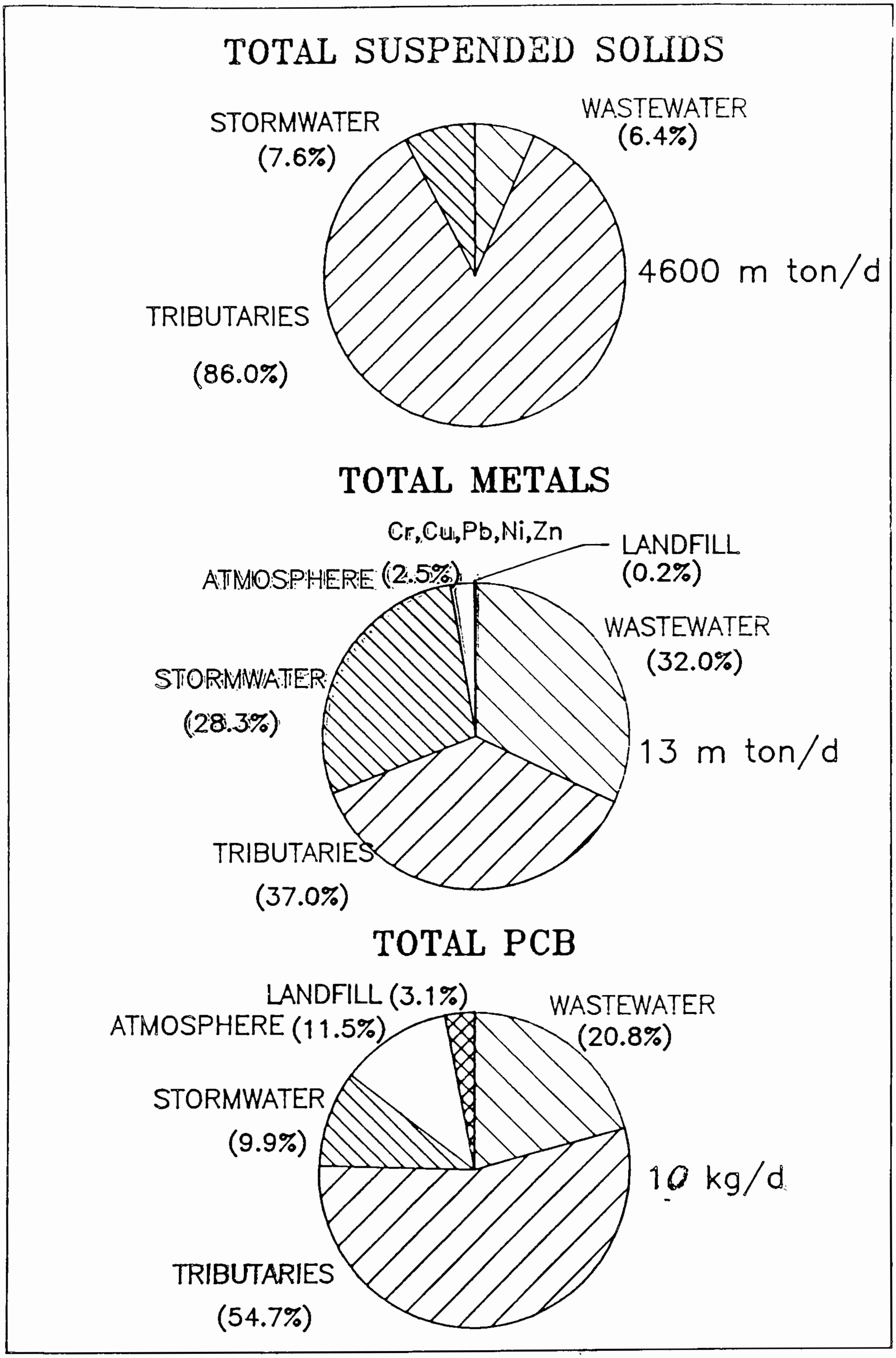


FIGURE 8. TOXIC INPUTS TO HARBOR

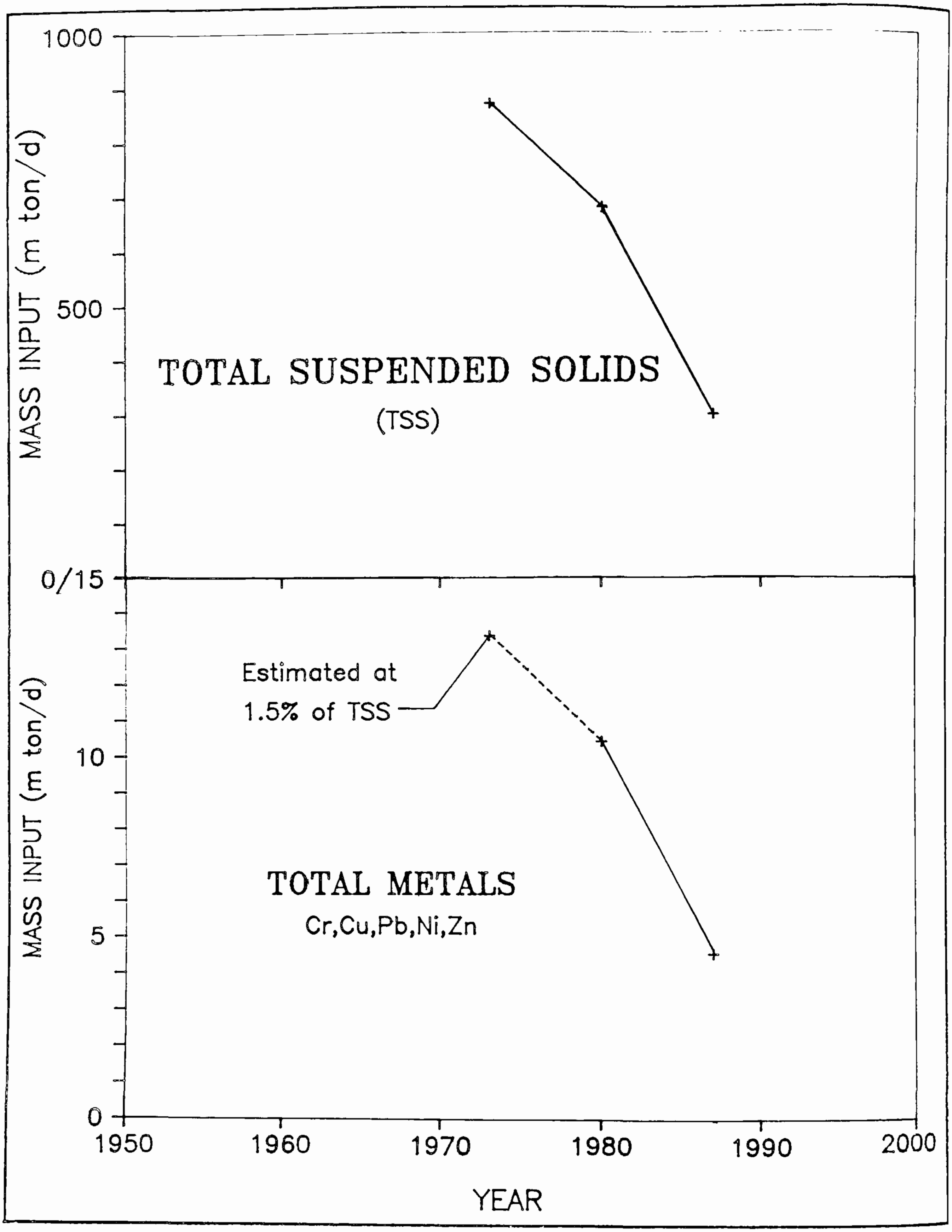


FIGURE 9. HISTORICAL WASTEWATER INPUTS TO HARBOR

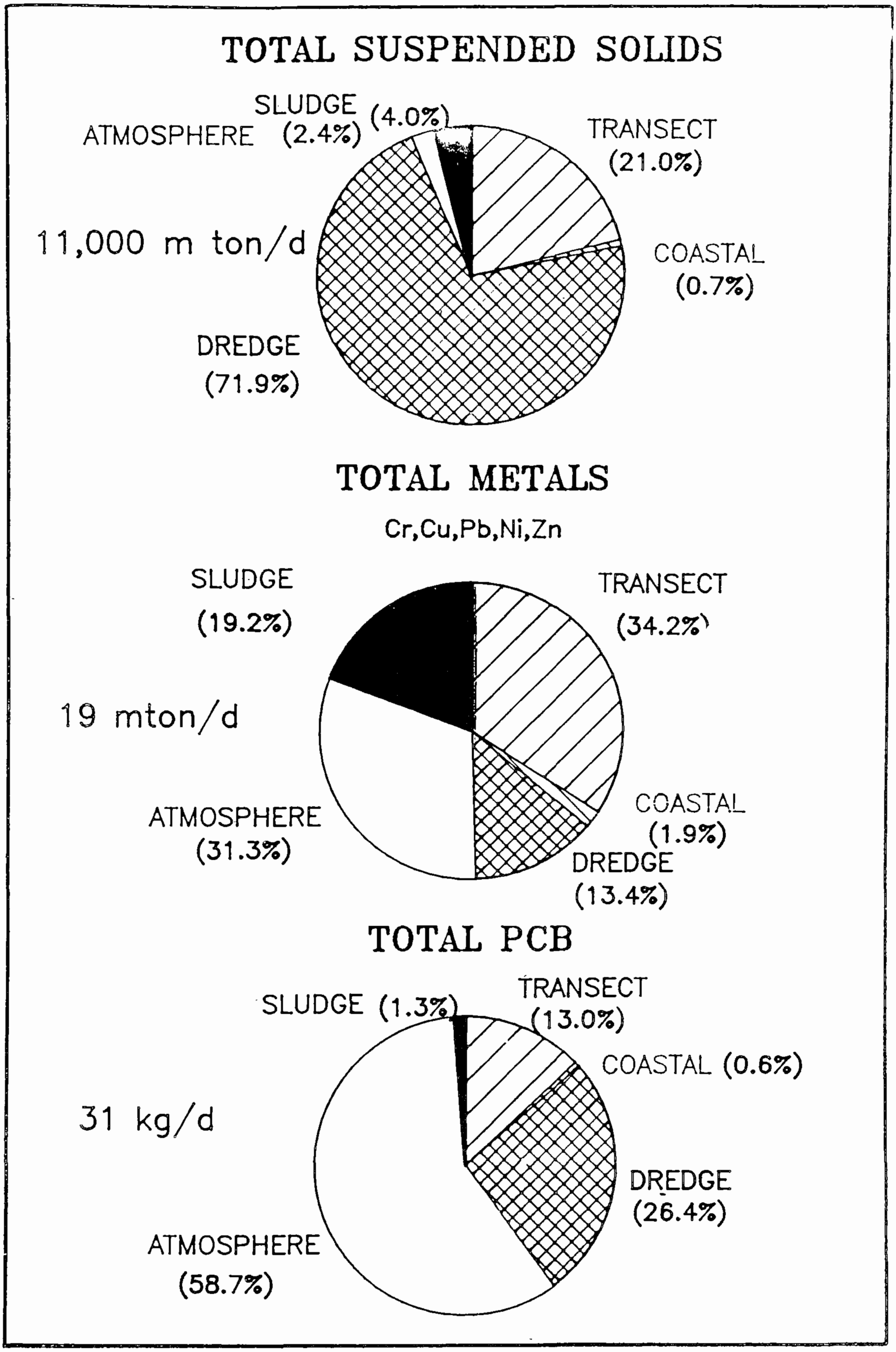


FIGURE 10. TOXIC INPUTS TO NEW YORK BIGHT

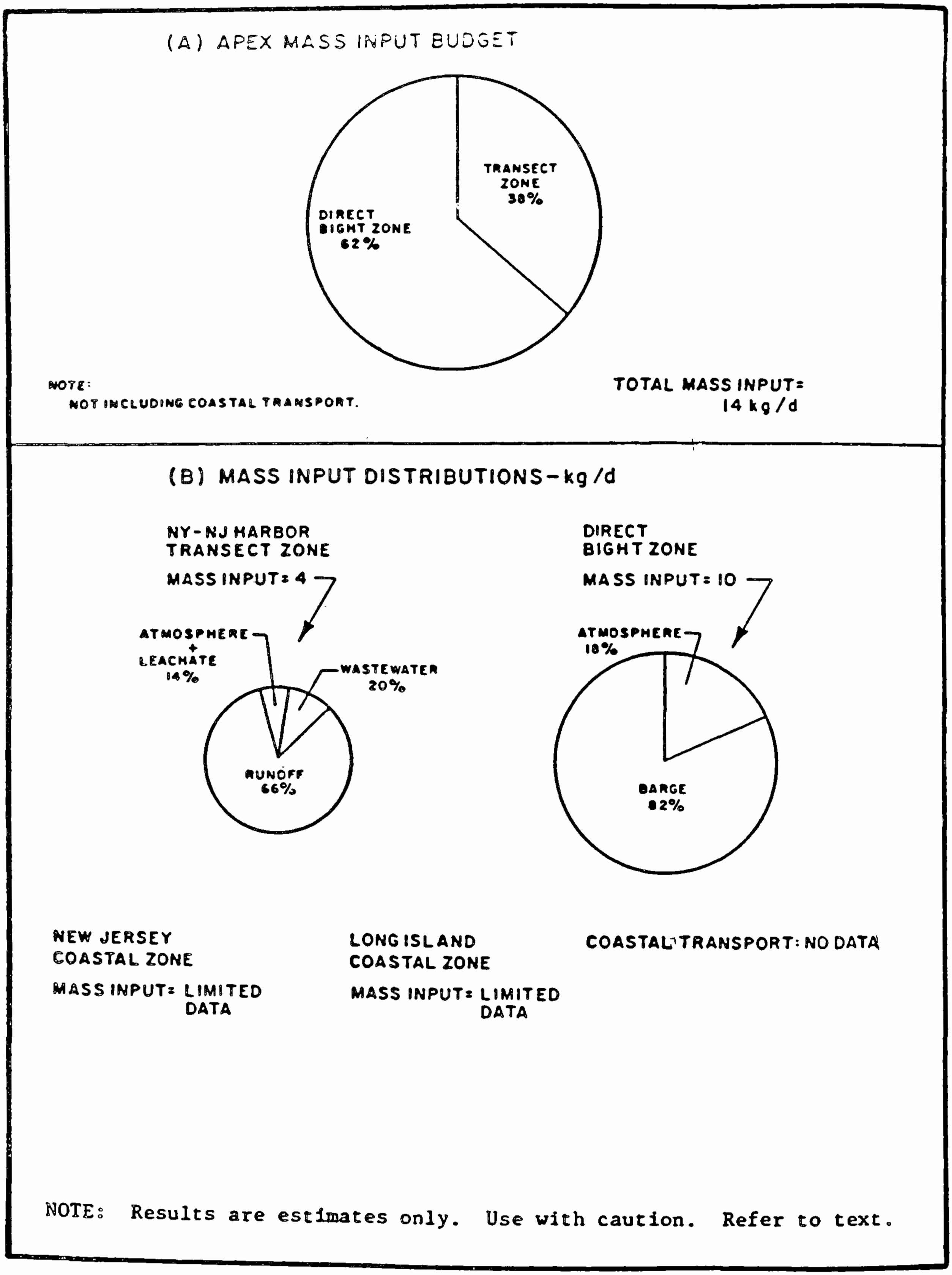


FIGURE 11. TOTAL PCB INPUTS TO NEW YORK BIGHT APEX

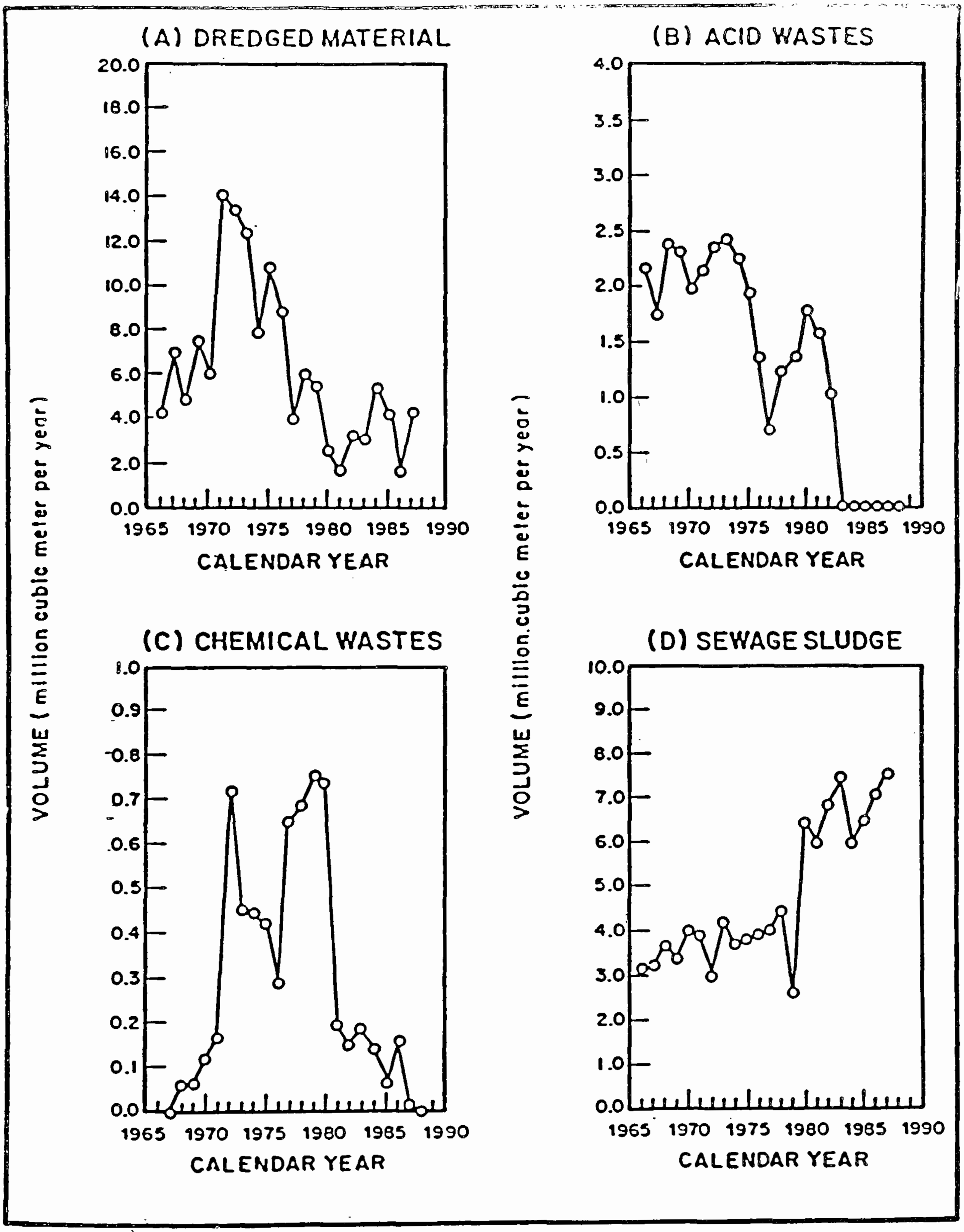


FIGURE 12. BARGE DUMPING TO NEW YORK BIGHT (1967 TO 1987)

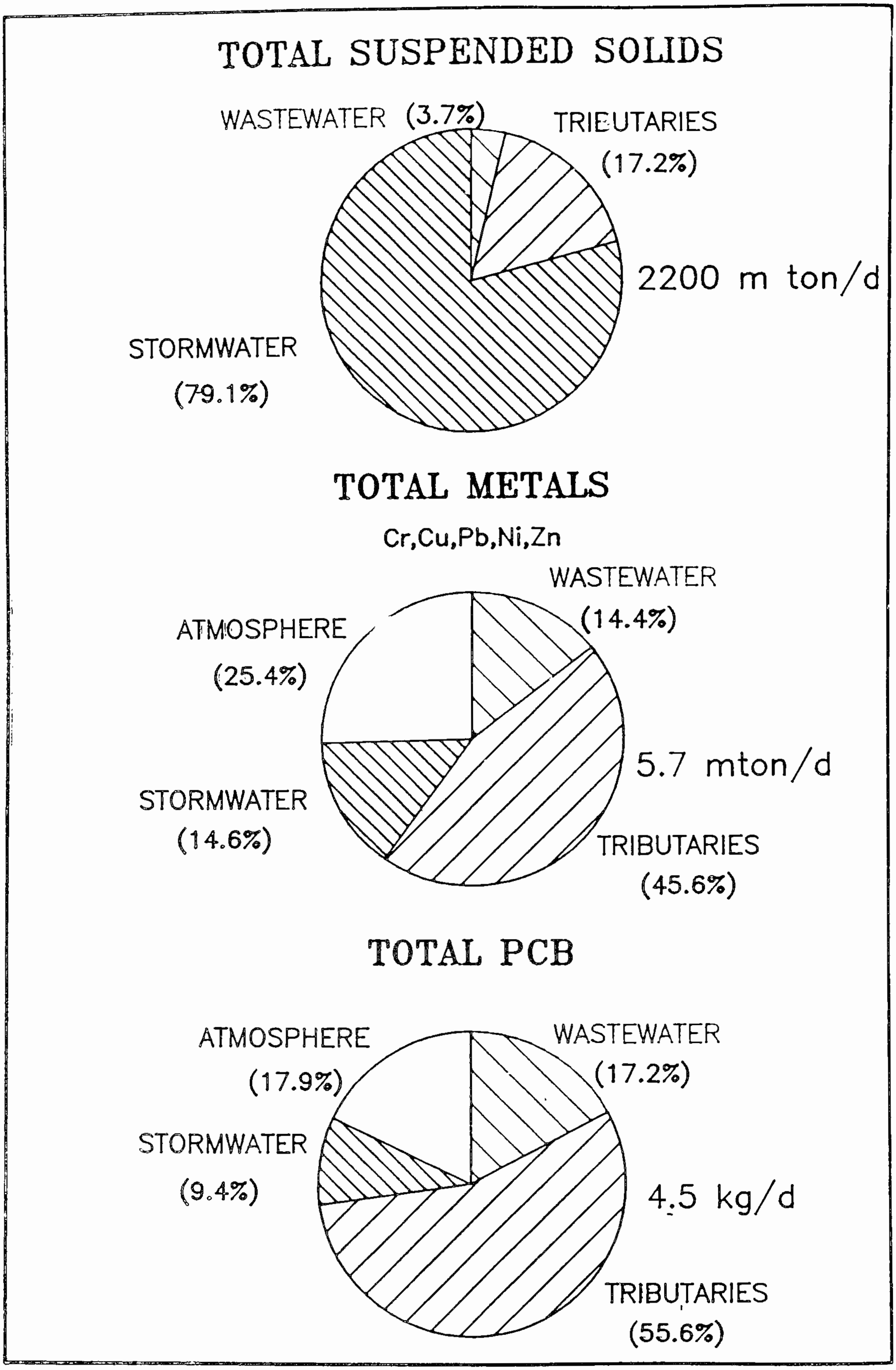


FIGURE 13. TOXIC INPUTS TO LONG ISLAND SOUND

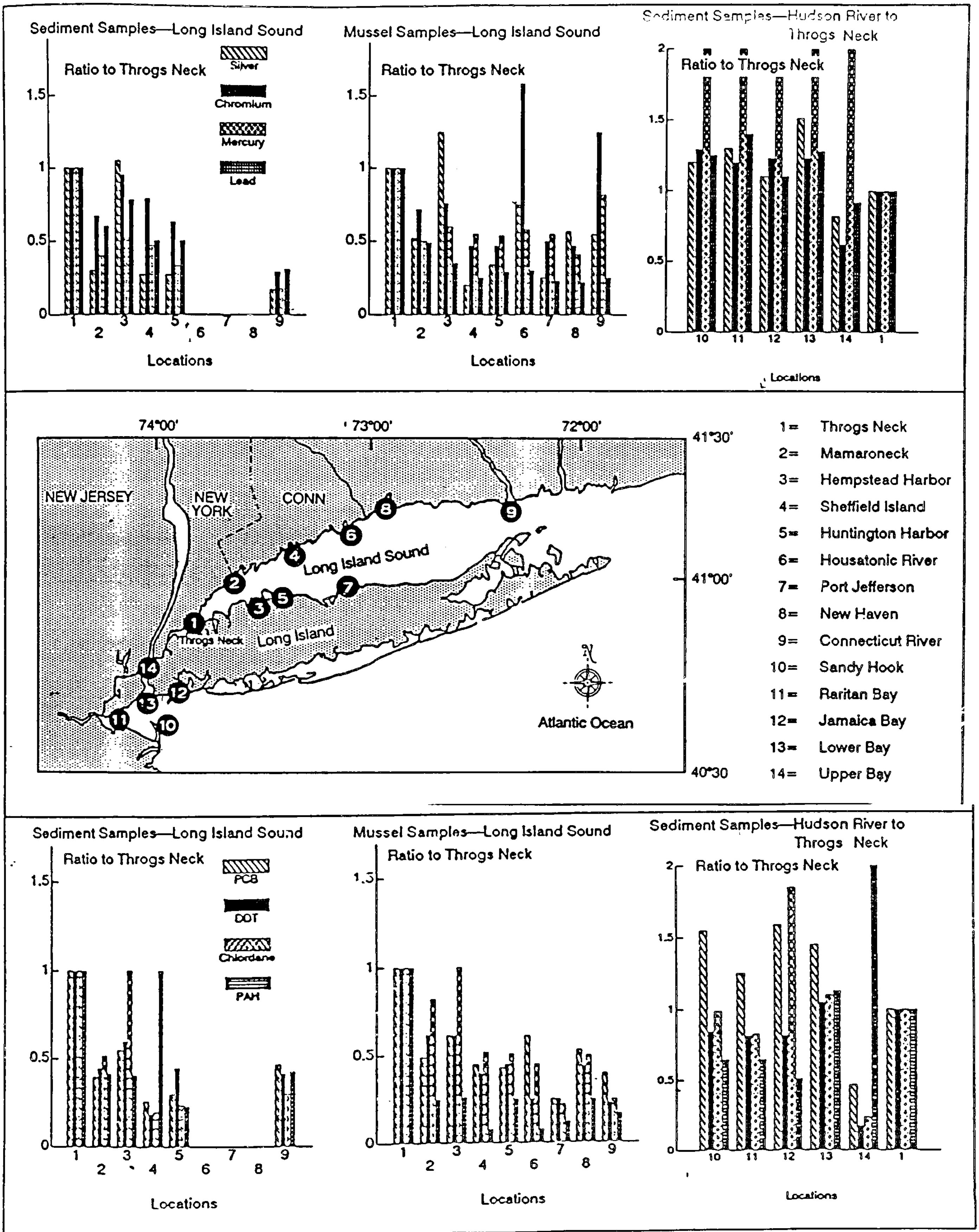


Figure 14. When the concentrations of some metals (top) and organic compounds (bottom) at sites in Long Island Sound and the Hudson-Raritan Estuary are compared to concentrations at Throgs Neck and a ratio is calculated, both mussels and sediment show a general western enhancement of contamination. (From Tom O'Connor, National Oceanic and Atmospheric Administration.)

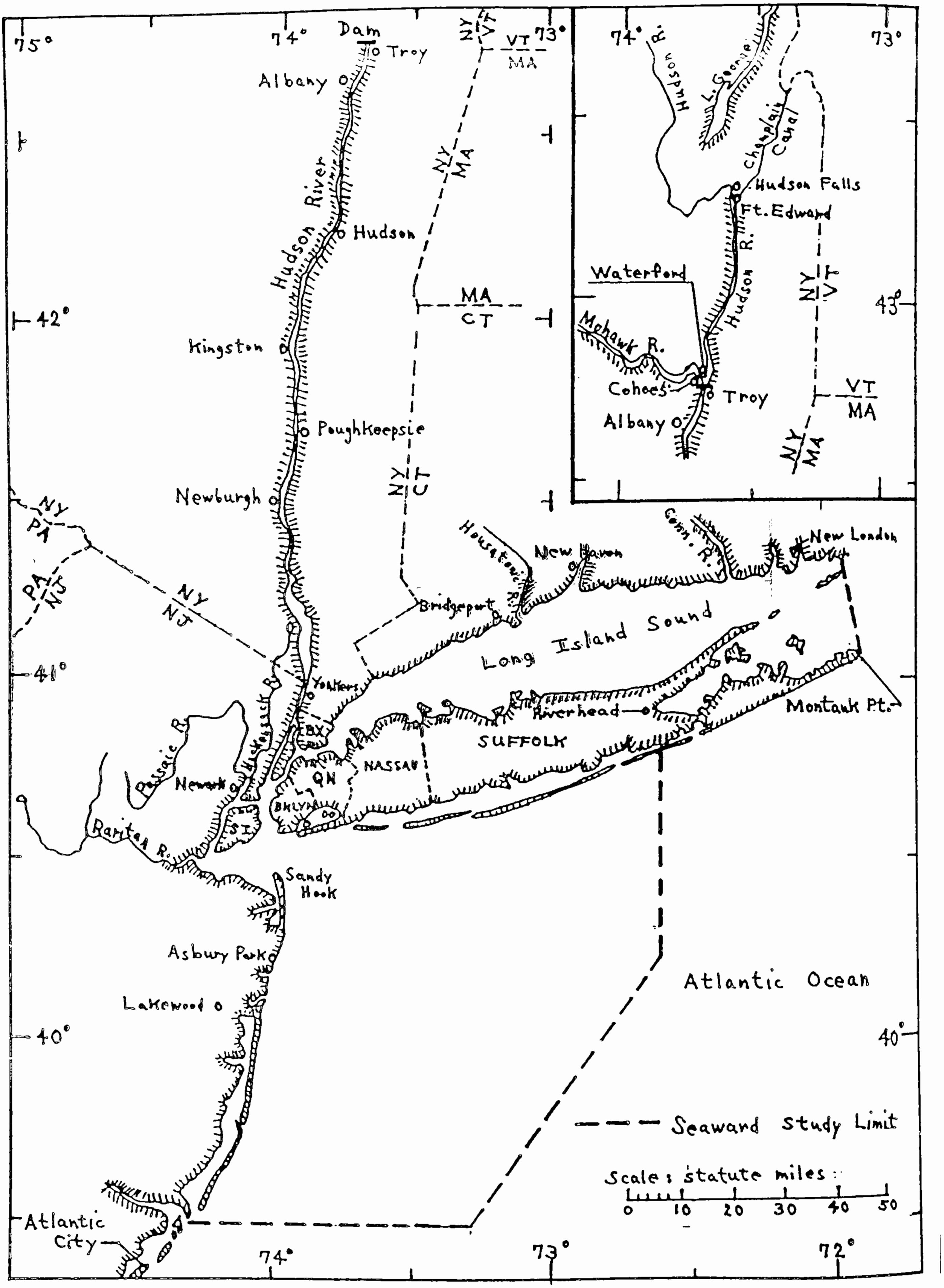


Figure 15. Limits of study area

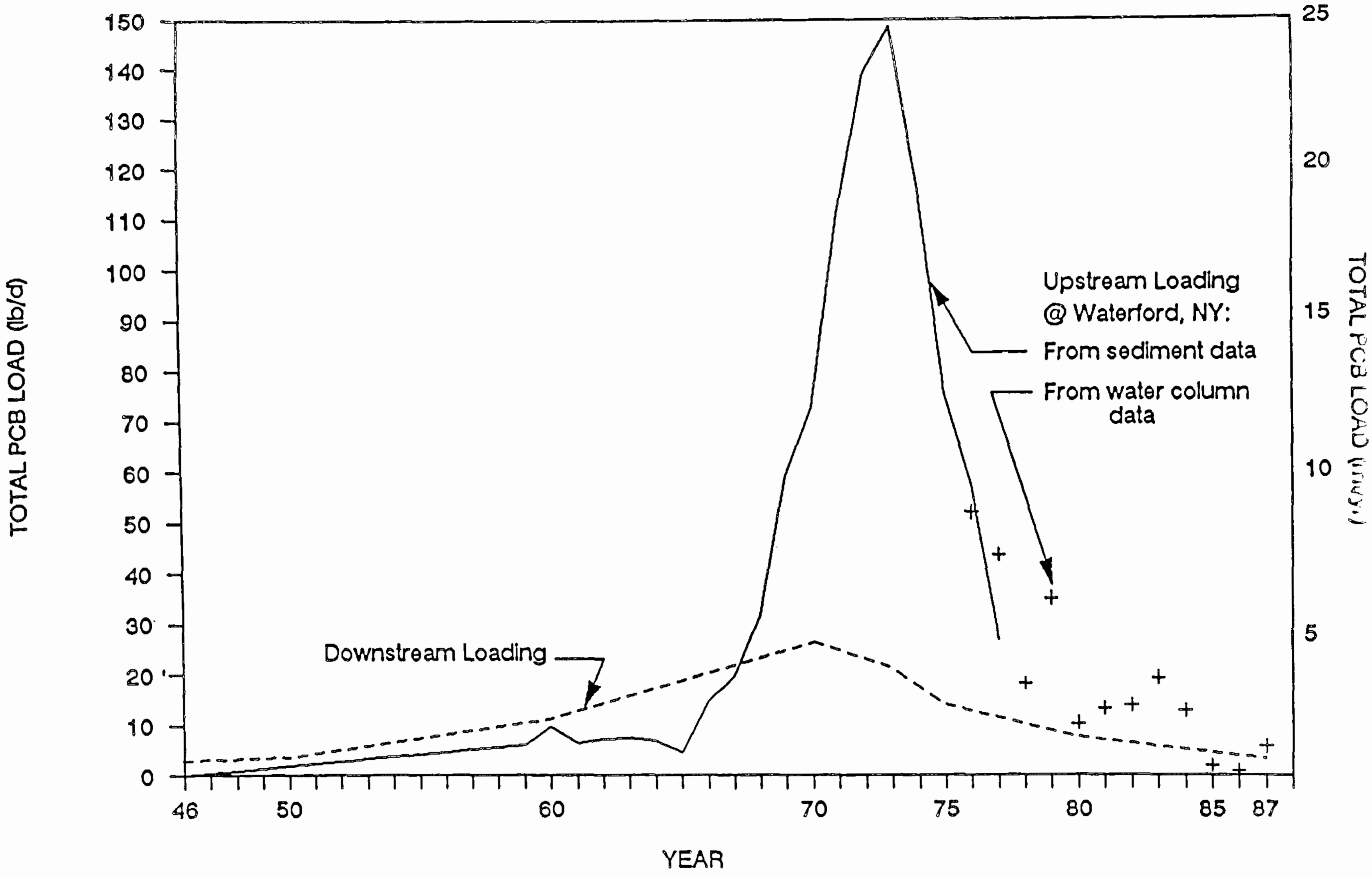


FIGURE 16. PCB Loading Rate to Lower Hudson from 1946 to 1987.

FIGURE 17. Annual Change in Sediment PCB Mass

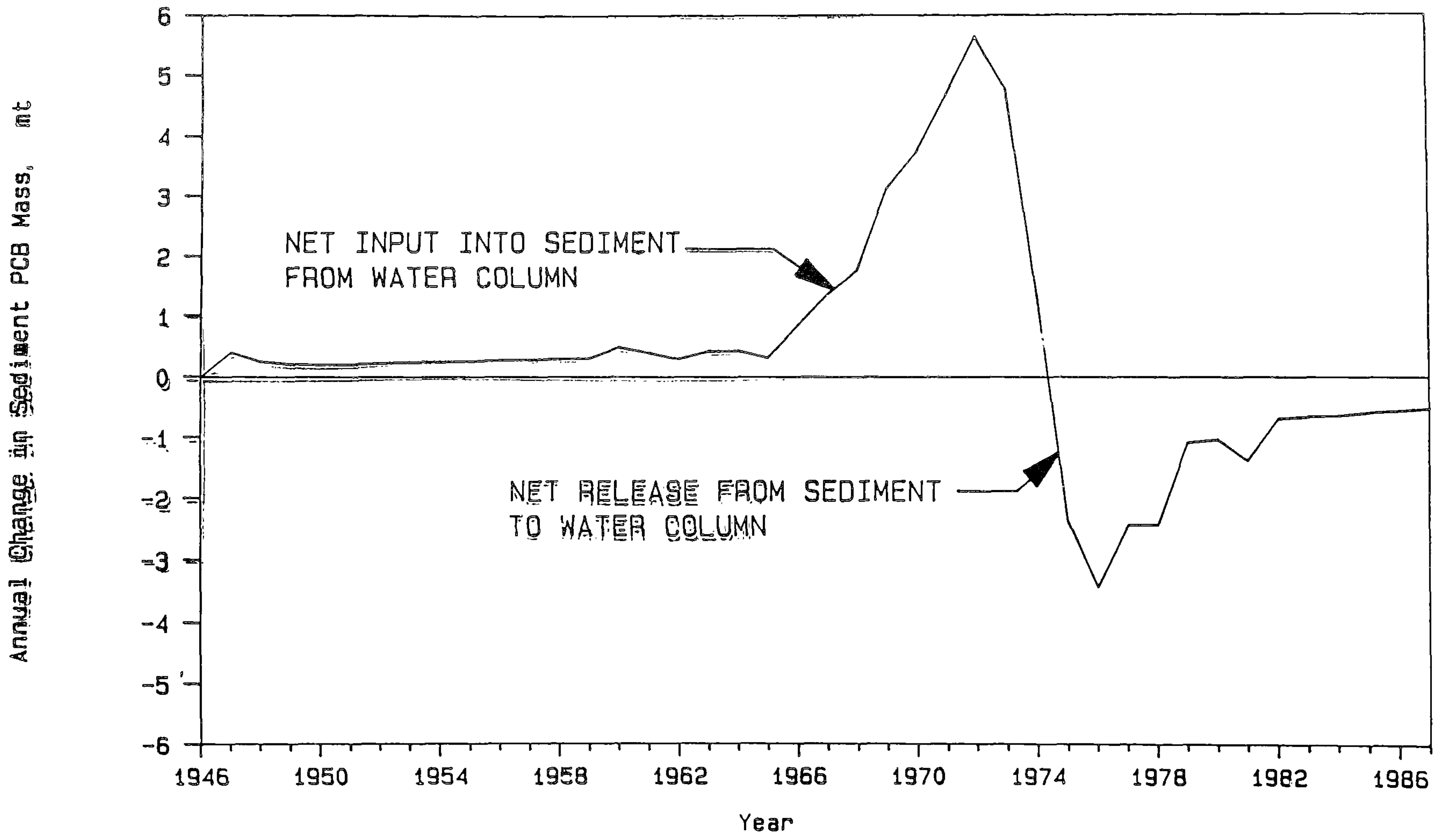


FIGURE 18. CUMULATIVE PCBLOADING TO NY BIGHT FROM HUDSON ESTUARY TOTAL MASS THROUGH 1987 - 46 METRIC TONS

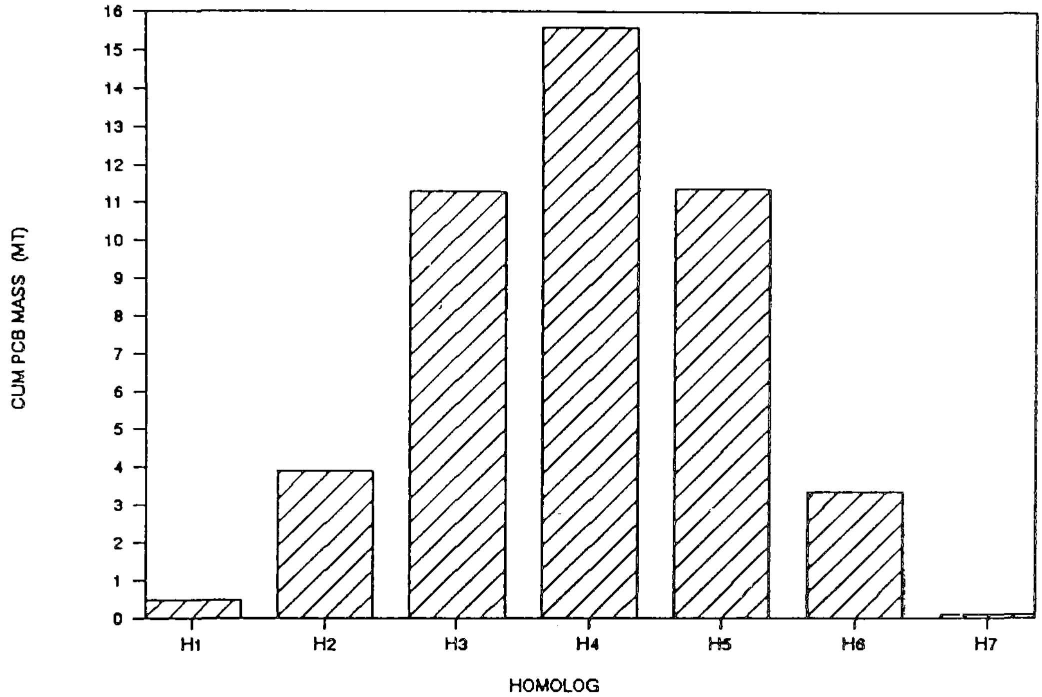


FIGURE 19. CUMULATIVE PCB LOADING TO LONG ISLAND SOUND FROM HUDSON ESTUARY TOTAL MASS THROUGH 1987 - 6 METRIC TONS

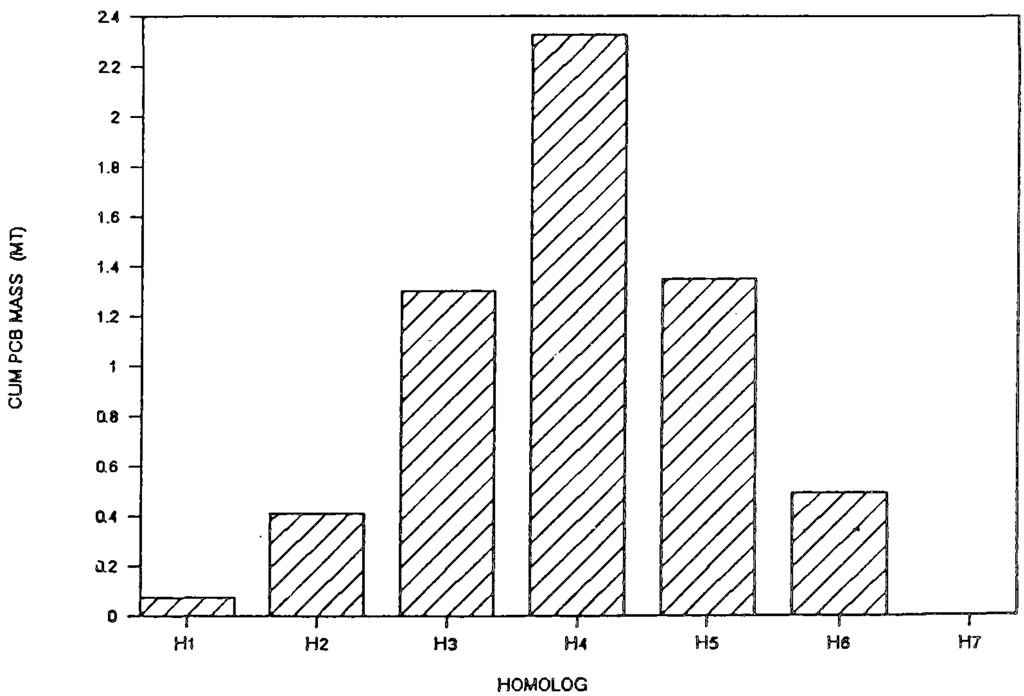


FIGURE 20. PCB FLUX TO NY BIGHT FROM HUDSON ESTUARY

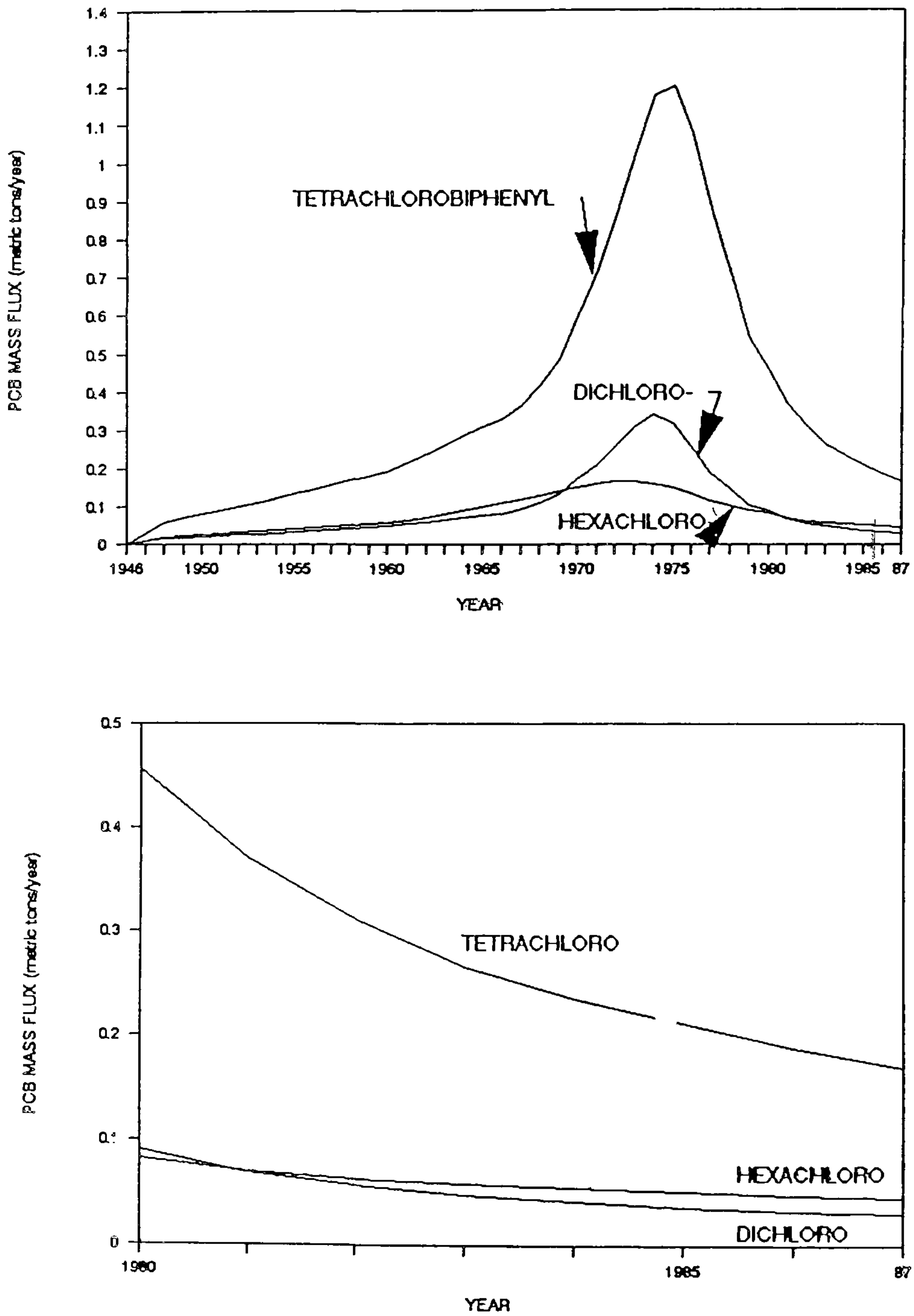
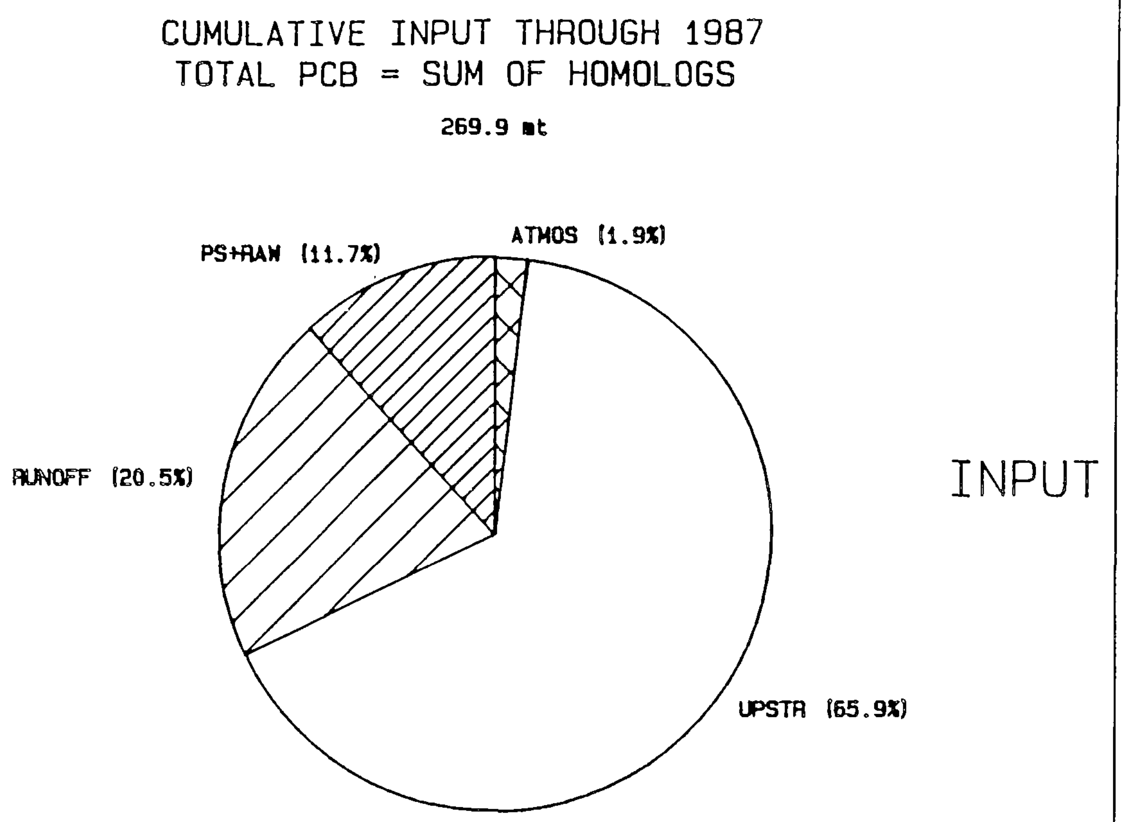


FIGURE 21. Total PCB Inputs and Fate



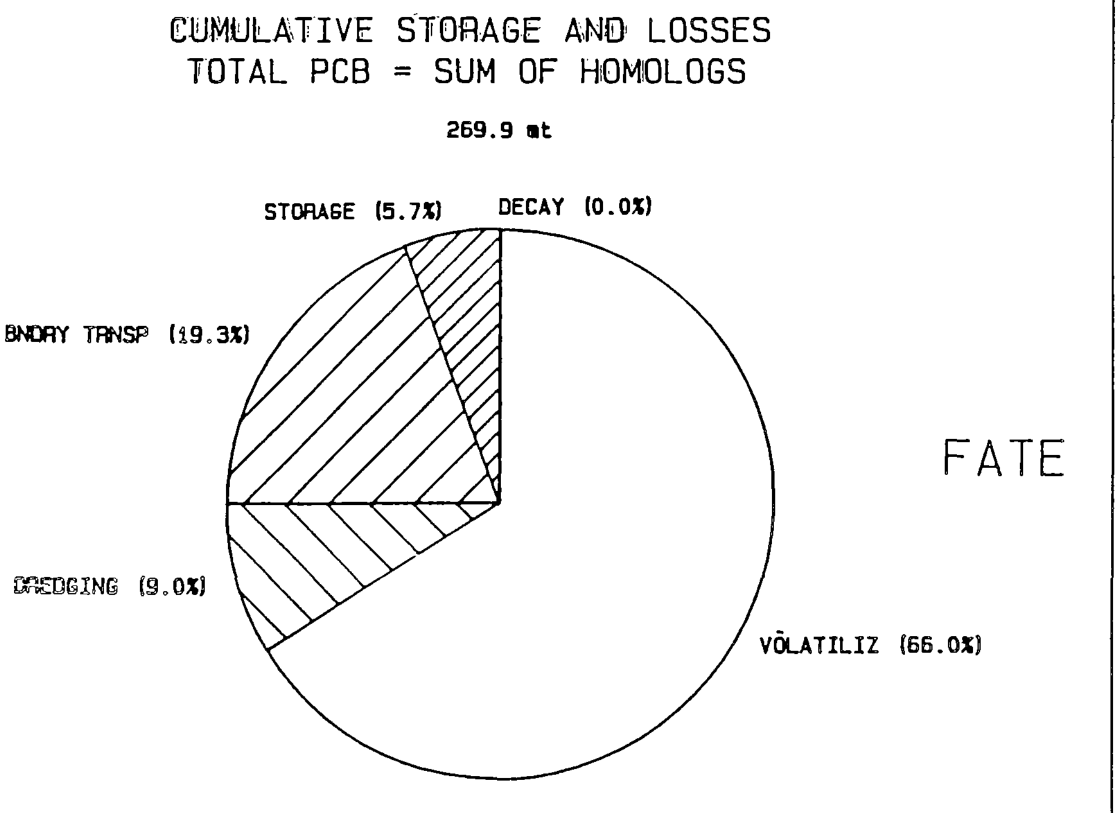


FIGURE 22. Dichlorobiphenyl inputs and fate

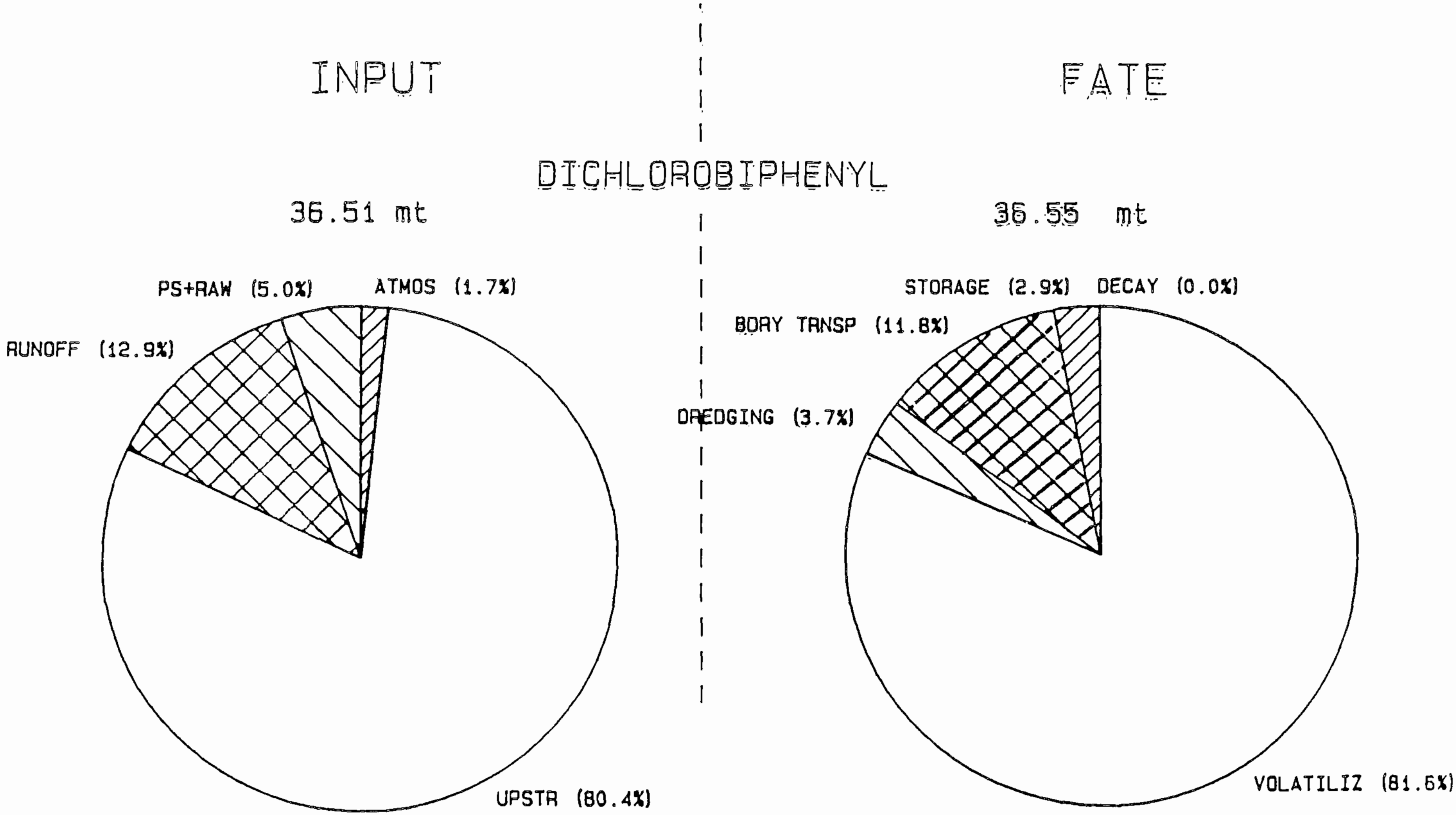
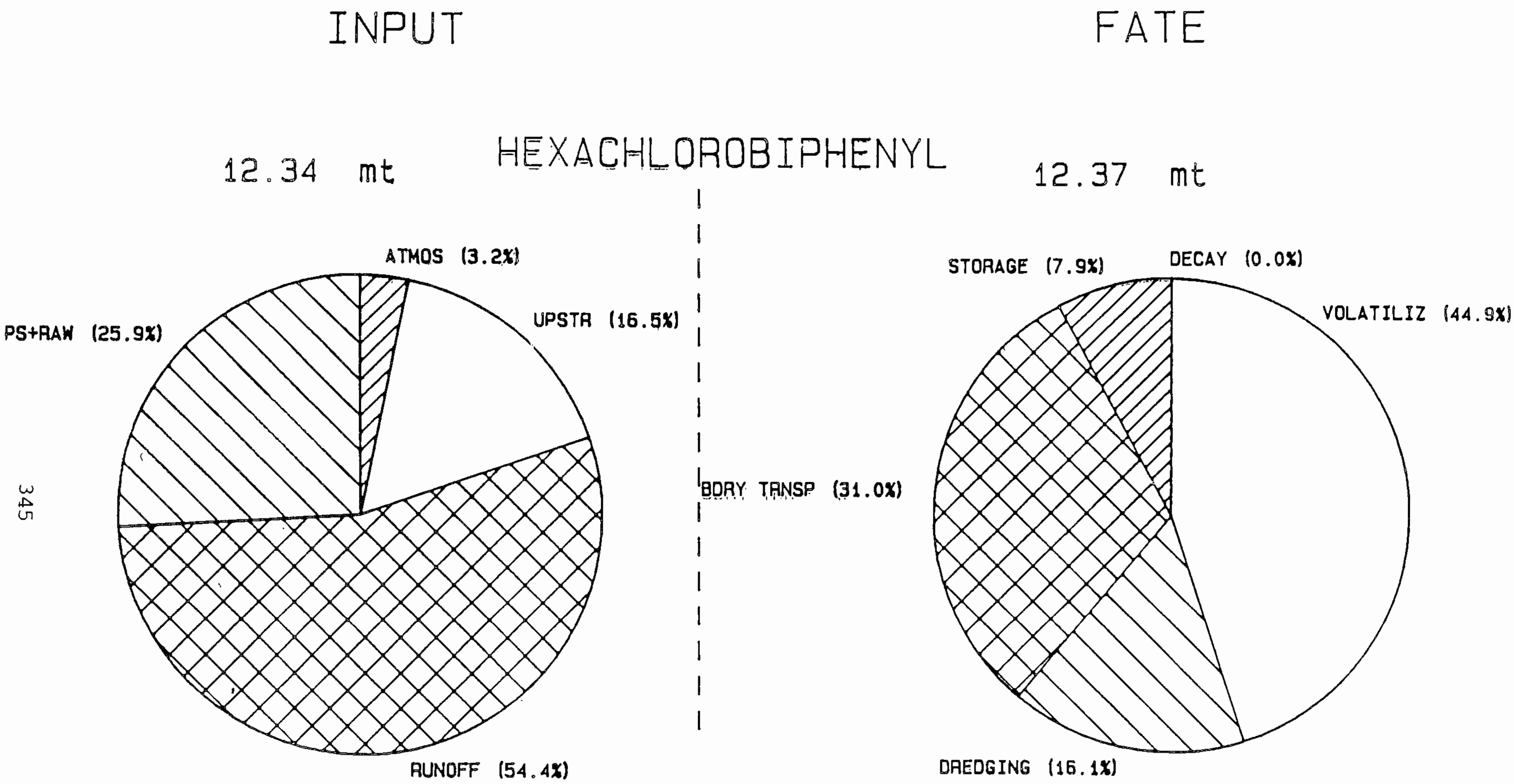


FIGURE 23. Hexachlorobiphenyl Inputs and Fate



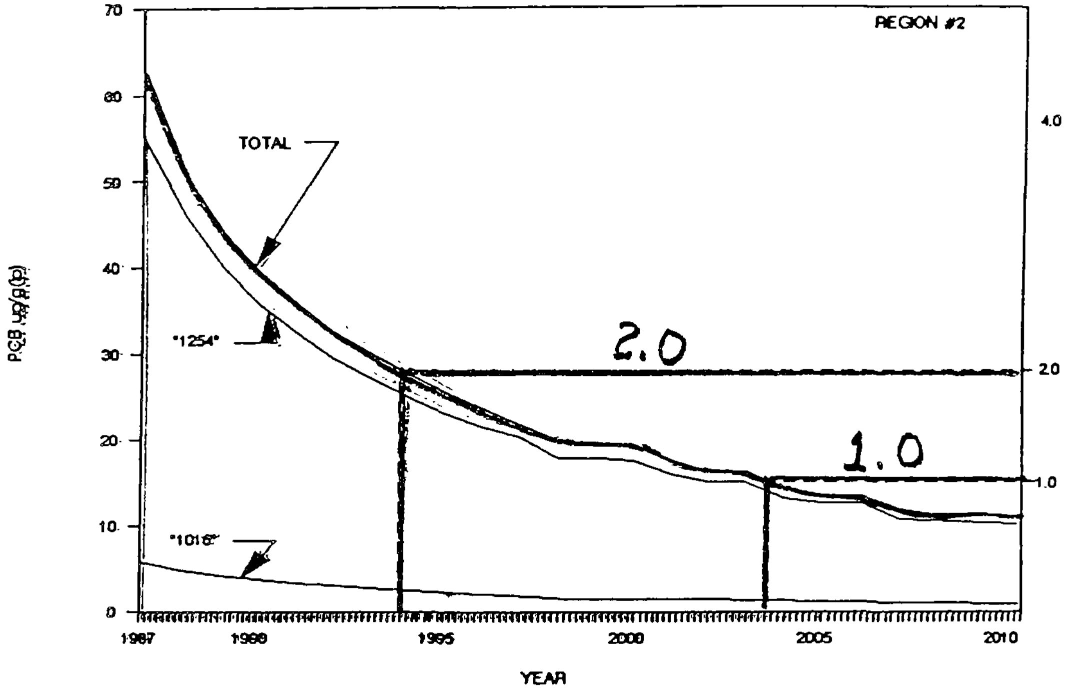


Figure 24. Simulated response of striped bass PCB concentration in Region #2 under the "No Action" alternative.

FIGURE 25. Estimated number of years to reach target percentiles in the striped bass of Region #2 under two alternatives.

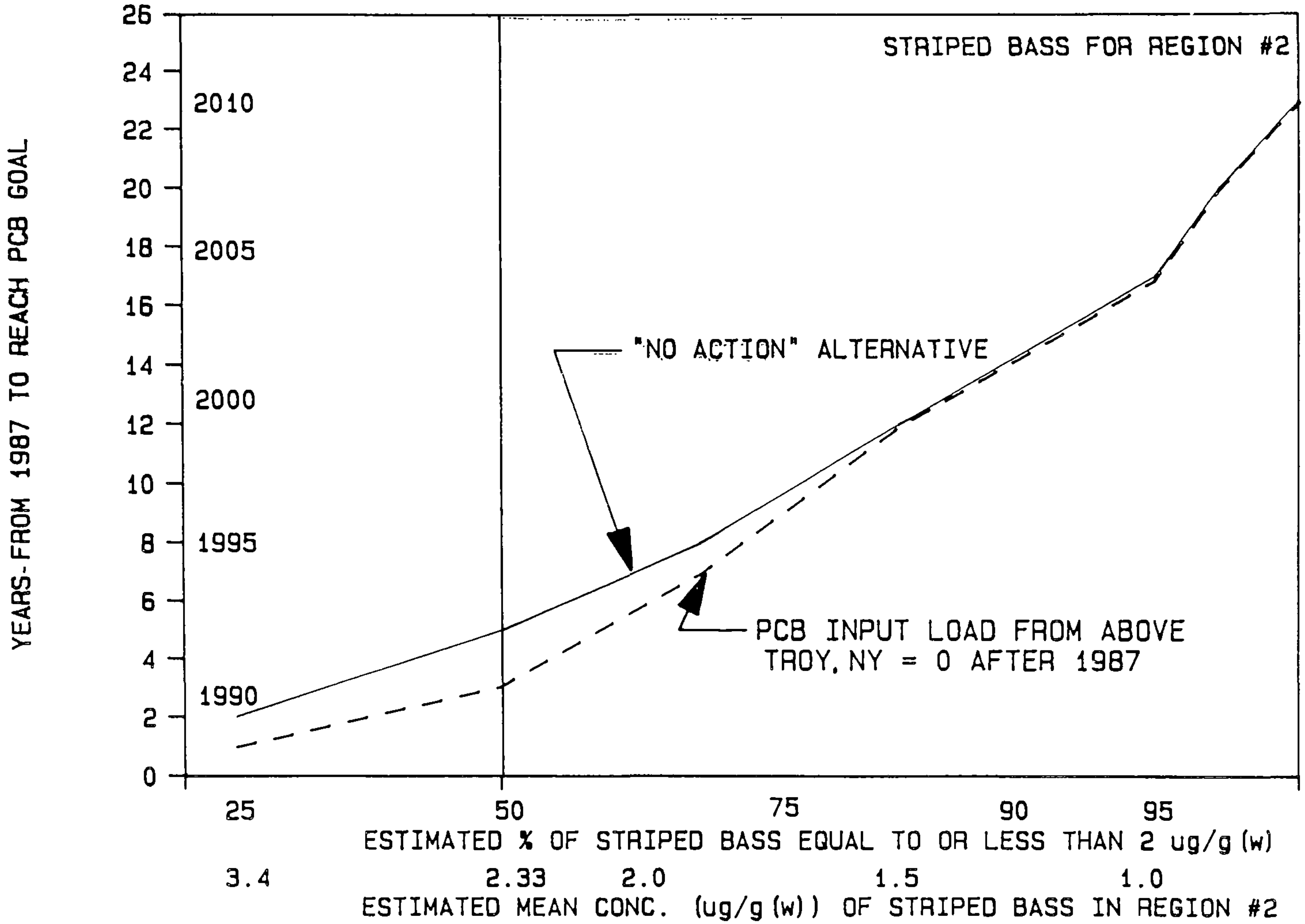


TABLE 1. TOTAL TOXIC INPUTS TO TRANSECT ZONE[a]					
Parameter	Wastewater[b]	Runoff[c]	Atmospheric Deposition[c]	Landfill Leachate[c]	Totals
Flow (mgd)	2572	19392			22000
Conventional					
TSS (m tons/d)	294	4280			4570
Toxic Pollutants	(kg/d)	(kg/d)	(kg/d)	(kg/d)	(kg/d)
Metals					
Arsenic	47		1.6	1.5	>50
Beryllium	9			0.1	>9
Cadmium	25	53-113	2	1	80-140
Chromium	315	1000	10	4	1330
Copper	1637	1620		6	3260
Lead	328	1630	100	7	2070
Mercury	15	7-37		0.2	20-50
Nickel	381	730	20	5	1140
Zinc	1515	3529	200	0.3	5240
Organic Toxics					
PCB Total	2	6-7	1.1	0-0.6	9-11
PAH Total	17	154	5-50		180-220
Inorganic Toxics					
Cyanide	368			2	>370

[a]Average daily values HydroQual, 1989
[b](1987)
[c](1979 through 1980), Mueller et al., 1982

TABLE 2. HISTORICAL TRENDS IN THE TRANSECT ZONE MASS INPUTS

Parameter	Raw (mgd)			Primary (mgd)			Secondary (mgd)			Industrial (mgd)			Total (mgd)		
	1970-74[a]	1979-80[b]	1987	1970-74[a]	1979-80[b]	1987	1970-74[a]	1979-80[b]	1987	1970-74[a]	1979-80[b]	1987	1970-74[a]	1979-80[b]	1987
Flow	480	342	18	663	410	436	1300	1870	2066	242	274	52	2685	2896	2572
Conventional	m ton/d			m ton/d			m ton/d			m ton/d			m ton/d		
TSS	258	141	7.6	358	318	82	209	241	198	52	8	6.4	870	680	294
Toxic Pollutants															
Metals	kg/d			kg/d			kg/d			kg/d			kg/d		
Arsenic	-	14	0.13	-	15	6.6	-	68	37	-	0.46	2.8	-	97	47
Beryllium	-	6	0.01	-	7.3	1.4	-	26	8	-	-	0	-	39	9
Cadmium	-	1.7	0.2	-	34	6	-	33	19	-	1.2	0.01	-	70	25
Chromium	-	54	3.4	-	651	73	-	314	237	-	1.7	0.58	-	1000	314
Copper	-	203	19	-	454	260	-	1100	1348	-	5.5	8.8	-	1800	1636
Lead	-	28	5	-	820	99	-	241	221	-	1	2.8	-	1100	328
Mercury	-	1.6	0.4	-	49	1	-	4.5	8	-	0.02	5.5	-	55	15
Nickel	-	58	3	-	470	65	-	404	306	-	2.3	7	-	930	381
Zinc	-	468	13	-	2330	248	-	2830	1240	-	19	14.3	-	5600	1515

[a]Mueller et al. (1976) for 1970 to 1974 data, Table 23
[b]Mueller et al. (1982) for 1979 to 1980 data, Table VI-13, Table VI-10

TABLE 3. SUMMARY OF POLLUTANT INPUTS TO NEW YORK BIGHT

Parameter	Transect Zone	New Jersey Coastal Zone	Long Island Coastal Zone	Direct Bight Zone	Deep-Water Dump Sites	Approximate Total[a]
Conventional						
TSS (m tons/d)	18-4574	11-93	14-31	8114	433	10918
Toxic Pollutants	(kg/d)	(kg/d)	(kg/d)	(kg/d)[b]	(kg/d)	(kg/d)
Metals						
Arsenic	>20	>1.15	>0.8	66	5	93
Beryllium	>4	>0.07	>0.06		0.3	4
Cadmium	32-56	3	2.8	37	24	111
Chromium	531	9	4.8	533	362	1440
Copper	1304-1631	60-66	25-26	1808	1354	4720
Lead	826	12	5.5	2535	433	3812
Mercury	9-21	0.5	0.6	9	2	27
Nickel	454-795	>10.3	>5.9-6.9	783	79	1503
Zinc	2098-3671	135-213	40-51	2628	1327	7059
Organic Pollutants						
PCB-Total	4	>0.05-0.14	>0.03-0.11	18.6-33.9	0.4	31
PAH-Total	70-88			435		514
Inorganic Pollutants						
Cyanide	>148	>14	>10.1			172

[a]Excludes coastal transport. ~~Refer to Section 3.5~~

[b]No estimate for sediment flux

Note: Estimates in this table are based on limited data and information in some cases and should be used with caution, Hydroqual, 1989.

TABLE 4. Comparison of 1973 and 1987 Sludge Loads to the New York Bight

	1973	1987
Vol, m^3/yr	4,281,760	7,578,162
Parameters	Total Load	Total Load
Conventional		
TSS m ton/day	450	433
Toxic Pollutants	kg/d	kg/d
Metals		
Arsenic	1500	4.7
Beryllium	0.3	0.3
Cadmium	44	24
Chromium	730	341
Copper	700	1354
Lead	720	431
Mercury	13	1.8
Nickel	120	78
Zinc	1800	1323
Organic Toxics		
PAH's		5.1
Dieldrin	-	0.05
Chlordane		1.47
DDT & metab.	-	0.20
Endrin	-	0.008
Heptachlor		0.008
H. Epoxide	-	0.023
Lindane	-	0.008
PCB-total	-	0.37

HydroQual, 1989

Table 5. Metal Inputs to New York Bight Proper and Apex Compared to COASTAL TRANSPORT Inputs

Metal	Montauk Transport (kg/d)	Bight Inputs as % of Montauk Transport	Apex Transport From East (kg/d)	Apex Inputs as % of Apex Transport
Cadmium	1,070	10	60	100
Copper	8,130	58	1,210	180
Lead	1,370	280	190	800
Mercury	120	23	3	800
Nickel	14,200	11	1,020	81
Zinc	9,140	77	1,800	220

TABLE 6. TOTAL INPUTS TO LONG ISLAND SOUND

Parameter	Wastewater(1)	Runoff	Atmospheric(2) Deposition	Total
Flow(MGD)	1160	16,900	-	18,100
Conventional				
TSS (m ton/d)	80	2,090		2,170
Toxic Pollutants	kg/d	kg/d	kg/d	kg/d
Metals				
Arsenic	9	76	7	92
Cadmium	39	72	10	120
Chromium	73	450	47	570
Copper	284	595	130	1010
Lead	63	550	340	950
Mercury	5	15		20
Zinc	404	1850	940	3190
Organic Toxics				
PCB - Total(3)	0.77	2.90	0.80	4.5

From Farrow et al., 1986 modified as follows:

(1) Metals data uses avg L.I. secondary concentrations for municipal wastewater except for As and Hg where NYC values were used.
(2) Using average values from Great Lakes estimates by Stacey, 1990 except As, Cr and Zn scaled up from Transect Zone values by surface area ratio
(3) From Thomann et al., 1989 deleting Newtown Creek from estimate.

TOXIC LEVELS IN WATER, SEDIMENT AND BIOTA, AND THEIR EFFECTS IN THE HUDSON-RARITAN ESTUARY, LONG ISLAND SOUND AND THE NEW YORK BIGHT

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ABSTRACT

A literature review provided information on the distribution of toxic contaminants in water, sediments and biota in three coastal systems in the New Jersey, New York and Connecticut area: The Hudson-Raritan estuary, the Long Island Sound and the New York bight. Particle-associated contaminants and their transport, dispersion and deposition are emphasized.

Disparities in data collection and analytical techniques make comparisons between data sets and systems difficult. In general, pollutant concentrations decrease with increasing distance offshore. Contaminant levels are highest in fine-grained particulates and concentrations are primarily controlled by particulate size and proximity to contaminant source.

Federal and state standards, criteria, and guidelines exist for regulating certain toxic contaminants in estuarine and coastal waters. There are no standards for contaminants in sediments. FDA can restrict the sale and consumption of fish if tissue levels exceed FDA established action levels for specific contaminants. Little information exists on the effects contaminants in these systems may have on biota. However, on-going research combining field and laboratory studies may contribute significantly to understanding toxic effects on biota.

Understanding distribution of toxics between these different systems is enhanced through the use of sediment geochemical tracers. These tracers (e.g. 137Cs, 7Be, DDT, PCBs, etc.) can provide an understanding of spatial and temporal distribution of contaminants. This information is critical for developing sound management strategies for these coastal waters and guiding continued research.

INTRODUCTION

Considerable information exists on the levels of toxics in three coastal systems in the New Jersey, New York and Connecticut areas: the Hudson-Raritan Estuary (HRE), the Long Island Sound (LIS) and the New York Bight (NYB). Less information exists on the effects these levels of toxics could have on human and ecological health. Limitations in our knowledge and in existing standards and criteria make regulation and management of toxic contaminants in these systems difficult. Sediment core data (e.g., radionuclides: 137Cs, 7Be; contaminants: lead [Pb], polychlorinated biphenyls [PCBs], DDT and its metabolites, chlordane) and an understanding of sediment dynamics are important tools for determining the selection and cost of clean-up actions as part of a management program (Bopp and Simpson, 1989). This paper summarizes selected data sets that report contaminant levels in water, particulates and biota for these three systems. Emphasis is given to particle-associated contaminants and other particle-associated tracers. These tracers can be a powerful tool for understanding sources, distribution, transport, and temporary and permanent sinks of contaminants throughout these coastal systems. In discussing toxic effects on biota, I briefly discuss data from combined laboratory studies and field investigations.

Contaminants were selected for inclusion in this paper based on data set availability and analytical techniques. The selected contaminants were the metals Cu, Cd, Cr, and Pb; and organic compounds dioxin, PCBs, DDT and selected DDT metabolites and hydrocarbons. Contaminant levels in biota are reported only for select species. The data sets are often incomplete and few samples have measurements of all contaminants of interest.

I should note that many more contaminants should be studied than are discussed here. Research on contaminant sources and sinks should include contaminants that are not on the priority pollutant list. Contaminants not on the priority pollutant list could be identified through chemical-specific analyses conducted under state or federal permit programs as well as through the literature (Burkhard and Ankley, 1989). In particular, identification of toxic chemicals produced by industrial and municipal point sources should be integrated into monitoring and management programs for these systems.

First, this paper discusses the limitations of the different information sources on contaminants in these systems. Second, a brief background is provided on the standards and criteria that can be used to control toxic loading to estuarine systems. Third, contaminant levels reported in the literature that occur in the three different media (water, sediment, biota) are reported for each of the three coastal systems. Fourth, effects of contaminants on aquatic organisms in these areas are briefly discussed.

DATA LIMITATIONS

HRE, LIS and NYB rank in the United States' top seven "most heavily sampled embayments" for PCBs and organochlorinated pesticides in, primarily, bivalves and fish (Mearns et al., 1988). Despite the heavy sampling, determining temporal and spatial contaminant trends by comparing and combining data sets is difficult. Data collection methods and analytical techniques are inconsistent. Less obvious, but equally important, are differences in approaches to normalizing data, statistical analyses and interpretation. For example, metal levels in water may be either a dissolved fraction (filtered and then acidified), an acidified and then filtered fraction, or an unfiltered "bulk" water sample. Each of these methods, especially in estuarine systems where changes in salinity can significantly change a metal's distribution between the dissolved and particulate phase, can result in different water column metal concentrations and different interpretations of a metal's spatial and temporal distribution. Similar methodological problems arise with data for metal and organic contaminants in sediment and biological samples. In sediment samples different approaches to "normalizing" for grain size, organic carbon, and "natural" levels of metals can affect interpretations of contaminant distribution and occurrence. In biological samples differences in collection time, in animal size/age, in biological affinity for certain contaminants, and in the selection of organs or tissues for analyses can affect interpretations of contaminant levels and trends. These problems must be considered carefully before comparing results from different studies in the same system. Also, in order to avoid misrepresenting contaminant values taken from the referenced materials, all units reported in this paper are taken directly from the reference. There has been no attempt made to standardize the units as it is not always clear from the reference how the units were determined.

Other problems exist that further preclude the effective use of historical data to establish firm spatial and temporal trends in metals and organic contamination in these systems. However, some data sets--National Oceanographic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), New York City Department of Environmental Conservation (NYCDEC), Interstate Sanitation Commission (ISC), and those conducted by university-affiliated research institutions such as Lamont Doherty Geological Observatory--while not necessarily comparable to each other, do provide good historical information for assessing levels of contaminants in water, sediments and biota. These are the studies that this paper has focused on.

STANDARDS AND CRITERIA

Several national acts and laws affect fresh and salt water quality. The Clean Water Act directs EPA and the states to set standards and establish criteria in an effort to attain fishable/swimmable levels for all water bodies in the United States. Under section 303 and 401 of the Clean Water Act, EPA or the individual states are given primary responsibility for developing water quality standards. In practice, water quality standards for estuarine systems can be adopted only to maintain designated uses of water bodies and to maintain ambient water quality characteristics. States are required through the National Pollutant Discharge Elimination System (NPDES) permit program to establish criteria to control the discharge of toxic substances into the nation's waters (Federal Register, 1984). The EPA's Water Quality Standards require the use of combined biological testing techniques and chemical-specific analyses to assess effluent discharges and to set permit limitations. Where specific numerical criteria for a chemical or biological parameter are not available, compliance with the standards must be based on general narrative criteria and on protection of the designated use. If states do not have numerical criteria, then EPA-recommended criteria may be used (USEPA, 1985). EPA's published water quality criteria are based on available scientific information and the agency's published risk assessment procedures.

EPA, New Jersey and New York established limited water quality criteria for salt water systems during the last two decades. State and federal criteria for ambient water quality in estuarine or marine waters depend on the designated use for a water body. Certain designated uses allow the water quality to fail the swimmable/fishable criteria (NJDEP, 1988; Table 1). Under this designation, further reduction in water quality is prevented through the "anti-degradation" mandate of the Clean Water Act.

TABLE 1. AMBIENT WATER QUALITY STANDARDS FOR SALTWATER FROM THE NYSDEC FINAL 1987 WATERBODY CLASSIFICATIONS (UNITS ARE IN UG/L)

Substance	SA, SAB, SC	I	SD
Cadmium +	2.7	2.7*	2.7*
Chromium (total)			
Chromium + (hexavalent)	54	50*	1200
Copper +	2.0	2.9*	3.2
Lead +	8.6	5.6*	200
Mercury	0.1*	0.1*	0.1*
Nickel +	7.1	7.1*	140
Silver			
Zinc +	58	58*	170
Arsenic x	63	36*	120

NOTE: Only standards for metals (and arsenic) are listed here. For complete list of NYS standards, see "NYS Water Quality Standards and Guidance Values". (NYSDEC, April, 1987).

+ = acid soluble form: that part of the substance that passes through a 0.45 micron membrane filter after the sample is acidified to Ph 1.5-2.0 with nitric acid.

* = NYSDEC Guidance Values 1987 (ug/l).

x = dissolved arsenic form.
(from NYCDEP, 1987)

Section 304 (l) of the reauthorized Clean Water Act of 1987 requires the states to develop lists of waters, including estuaries, that do not meet the Clean Water Act goals or their designated use. The Act requires states to identify point sources and amounts of pollutants discharged into non-compliant waters and develop control strategies for each waterway so that the water quality standards (either designated use or swimmable/fishable) are met. For New Jersey and New York this includes parts of the HRE.

EPA and the states can also use the Toxic Substances Control Act to regulate chemical substances and to prevent those substances from contaminating biota. Similar regulations can be used under the Resource Conservation Recovery Act and CERCLA (Superfund). In addition, the Federal Insecticide, Fungicide, and Rodenticide Act permits EPA to deny registrations or to cancel existing registrations for pesticide chemicals that cause fish contamination.

As federal and state governments revise the Water Quality Standards, Criteria and Guidelines there is increasing emphasis on establishing permitted levels of toxics in discharges that are protective of both human and ecological health. New Jersey Department of Environmental Protection (NJDEP) and EPA Region IV currently are revising their water quality standards. EPA Region IV is developing guidelines to predict acceptable levels of toxics in fish tissue to protect human and ecological health (Dieterich, per. comm.). For consumption of fish from fresh water systems, maximum contaminant concentrations are determined using a 10^{-6} human health risk factor for carcinogens.

A series of action levels and proposed criteria exist to protect human and wildlife consumers of contaminated fish and shellfish. The action limits are federally enforceable criteria set by the U.S. Food and Drug Administration (FDA) to prevent interstate sale of contaminated seafood (Federal Register, 1974). The National Academy of Sciences (NAS) in 1974 recommended numerical criteria for protection of predatory wildlife. Although the NAS criteria were never adopted as regulatory criteria, the FDA action levels are used frequently by the states (Mearns et al., 1988). In general, the states use the action levels set by the FDA to establish advisories for limited consumption or for prohibition of sale and consumption of specific fish or shellfish in state waters.

New York and New Jersey have identified areas in the HRE and the NYB for prohibitions and for limited consumption advisories on both resident and migratory species. In New Jersey these advisories are based primarily on levels of PCBs, dioxin, chlordane and other organic contaminants (Hauge, 1990). New York has similar restrictions for some species as they exceed FDA criteria for PCBs and cadmium (Sloan, 1987; Table 2).

TABLE 2. FDA ACTION LEVELS CLASS A HUMAN HEALTH FOR CHEMICAL CONTAMINANTS IN EDIBLE FISH[a] (MODIFIED FROM CRISTINI, 1988)

Compound	Level (ppm, wet weight)
Mercury	1.0[b]
PCB	2.0
DDT and metabolites	5.0
Chlordane	0.3
Dieldrin	0.3
Lindane	0.3[c]
Eldrin	0.3
Heptachlor and heptachlorepoxide	0.3
Dioxin	2.5, 5.0 x 10^{-5}[d]

a Unless otherwise noted, information from U.S. Department of Health and Human Services (1982).

b Information from Armstrong and Sloan (1980).

c Information from Federal Register, Dec. 6 (1974).

d Two "levels of concern" have been established. Above 50 parts per trillion, FDA recommends no consumption and below 25 ppt they place no limit on consumption. Between 25 and 50 ppt they recommend no more than one meal a week for infrequent consumers and 1-2 a month for frequent consumers (Belton et al. 1985).

No standards or criteria exist for regulating ambient levels of contaminants in sediments. The United States Army Corps of Engineers (USACOE) and the EPA developed bulk toxicity and bioaccumulation tests using several selected organisms for sediments targeted for dredge removal and ocean disposal (USEPA and USACOE, 1977). PCBs, Hg, Cd, petroleum hydrocarbons, DDT and metabolites are the only contaminants measured in sediments targeted for dredging and ocean disposal. In addition, the EPA and the USACOE are currently developing a method for evaluating dredged material contaminated by dioxin (Tavalaro and Stern, 1990).

Developing comprehensive ambient sediment quality criteria requires a testing program that includes diverse biological tests for different toxicity endpoints (e.g., carcinogen, teratogen, etc.), several different organisms and comprehensive chemical testing. Current research and numerous approaches are presented in USEPA (1989) and Zarba

(1988). It seems prudent to consider a tiered approach to toxicity evaluation which includes field measurements coupled with chemical and biological testing in the laboratory, similar to the methods proposed by the International Joint Commission Sediment Subcommittee (IJC, 1988). As most of the comprehensive sediment evaluation methods currently being proposed will be costly, decisions to determine sediment toxicity should be tied to plans for sediment management.

Although the original Clean Water Act was more specifically targeted towards fresh water systems, the 1987 Clean Water Act recognized the importance and necessity to address the specific and often unique water quality standard setting needs of estuarine and coastal waters. New programs, standards and criteria are being established to improve water quality in the coastal zone. Numerous academic and government studies were important in highlighting water quality issues in coastal waters. Many of these studies showed contaminant levels in estuaries of both ecological and human health concern. Below are outlined some of the research studies that highlighted water quality problems in the estuarine and coastal waters of New Jersey, New York and Connecticut.

HUDSON-RARITAN ESTUARY

Research studies and ambient water quality monitoring programs provide valuable data on contaminant levels in the Hudson-Raritan Estuary (NJMSC, 1987). In particular, work in the Hudson River provides a comprehensive evaluation of the concentration and distribution of PCBs in particles, fish and shellfish. In addition, NYCDEP, NJDEP and NYSDEC have various on-going monitoring programs, that include some limited measurement of toxic contaminants in the HRE.

Levels of Toxics in Water

The NYCDEP conducts annual comprehensive monitoring in the New York Harbor area which includes the measurement of concentrations of toxics in both sediment and water (NYCDEP, 1987). Results from 1987 and previous years indicate possible decreases in water column values for Cu and Pb. Cu concentrations averaged 13 ug/l and Pb concentrations averaged 70 ug/l. This, however, still resulted in a low percentage of stations that were in compliance with state water quality standards for Cu and Pb at 19% and 12%, respectively (Table 1). Cd and Cr compliance, however, was as high as 50% and 100%, respectively, with mean concentrations of 4.1 ug/l and 0.9 ug/l (NYCDEP, 1987). Pb and Cu measured in Raritan Bay in 1974 yielded concentrations up to 65 ug/l and 13.9 ug/l, respectively (Waldhauer et al., 1978). Breteler (1984), using historical data, reported for the HRE average water column values for Cu, Pb, Cd and Cr of 33 ppb, 15 ppb, 0.5 ppb and 5.9 ppb, respectively. As with other data, Cu continues to fail to meet NYCDEP water quality standards and Pb only meets their standards in waters with a limited designated use (Table 1). Searl et al. (1977) measured extractable organics in water samples collected in New York Harbor waters in 1974 and 1975. They report a mean concentration of extractable organics of 159 ug/l.

Levels of Toxics in Sediments

Studies of PCBs in the Hudson River have provided critical, detailed information necessary for development of management plans for this system (Sanders, 1989). Average concentrations for PCBs in recent sediments (post-1954) from the inner New York harbor and Raritan Bay were 3 ug/g and 0.4 ug/g (Olsen et al., 1984). Higher concentrations are found in sediments of the upper Hudson River. Maximum concentrations in river sediments range from about 100 ppm in the upper river to 8 ppm in the New York harbor (Bopp and Simpson, 1989). NYCDEP (1987) reported average sediment concentrations of PCBs for 1983 to 1986 of 0.06 to 0.70 mg/kg in Newark Bay estuary and values in New York harbor and the lower Hudson River ranging from less than 0.06 to greater than 0.70 mg/kg. Stainken and Rollwagon (1979) report a mean PCB value of 110 ng/g in sediments of Raritan Bay. Other average levels of contaminants reported by Olsen et al. (1984) include for the inner harbor: Cu, 220 ug/g, Pb, 390 ug/g, DDD 153 ng/g, chlordane 160 ng/g, petroleum hydrocarbons (PCHs), 1800 ug/g; for Newark Bay: Cu, 380 ug/g, Pb 340 ug/g, and PCHs, 4300 ug/g; and for Raritan Bay: Cu, 280 ug/g, Pb, 198 ug/g, DDD 26 ng/g, chlordane 15 ng/g, PCHs, 1600 ug/g. These values are similar to average metal concentrations reported by Breteler (1984) in the HRE for Cu, 148 ppm, and for Pb, 354 ppm, with maximum average lead values of 1027 ppm measured in the Arthur Kill. Other hydrocarbon values reported by Stainken (1979) ranged from 2.2 to 1098.2 ug/g, with concentration increasing with increased silt-clay content.

Meyerson (1988) summarized metal and organic toxics data in sediments for the HRE. Sediment surface samples from Newark Bay have ranges for Cu of 67 to 970 mg/g, Pb of 76 to 3209 mg/g, and Cd of 1 to 18 mg/g, and from Raritan Bay have ranges for Cu of less than 10 to 610 mg/g and Pb of less than 6 to 990 mg/g (Meyerson et al., 1981). Meyerson (1988) also summarized petroleum hydrocarbon ranges reported by Connell (1982) in the range of 6900 mg/g in the Arthur Kill to <10 mg/g in eastern Raritan Bay. Greig and McGrath (1977) reported ranges of metal contamination in surface (0-4 cm) sediments of Raritan Bay for Cd, Cr, Cu and Pb of <1 to 15 ppm, <2 to 260 ppm, <1.6 to 1230 ppm, and <4 to 985 ppm, respectively. These and other studies of contaminant levels in Raritan Bay are summarized by Pearce (1983).

Dioxin concentrations in sediments have been measured in Newark Bay. Recent sediments (as defined by Be-7 activity) and suspended particulate concentrations for 2,3,7,8 TCDD range from < 36 ppt in New York Harbor to 730 ppt in the Passaic River (Tong et al., 1989; Bopp, 1988). Concentrations were greatest in the lower Passaic River and decreased in lower Newark Bay. Belton et al. (1985) reported sediment concentrations in surface grab samples in the lower Passaic river ranging from non-detectable to 6.9 ppb.

Detailed geochemical studies of particle-associated pollutant transport using multiple tracers exists for PCB, chlorinated hydrocarbon and dioxin contamination in the HRE (Bopp et al., 1981; Bopp et al., 1982; Olsen et al., 1984; Bopp, 1988; Bopp et al., 1988; Bopp and Simpson, 1989; Tong et al., 1989; Bopp et al., 1990). These studies provide an understanding of both temporal and spatial sediment distribution, as well as transport, sources and sinks of contaminants in this system. As shown in these and other studies (Bopp et al., 1981; Bopp et al., 1982; Multer et al., 1984; Olsen et al., 1984; Renwick and Ashley, 1984), fine-grained particle distribution is important in controlling PCB and other particle-associated contaminant distribution.

Levels of Toxics in Biota

Elevated levels of contaminants in fish and shellfish of the HRE is a well-documented problem. Both New Jersey and New York states have prohibitions on the sale, and advisories on consumption, of fish and shellfish from this system. Areas of Newark Bay have prohibitions on sale and consumption of striped bass and blue crabs, and the New Jersey portion of the Hudson River has an advisory to limit consumption of striped bass. Both prohibitions are due to extensive dioxin contamination in Newark Bay (Belton et al., 1985). Dioxin contamination in striped bass led to limited and very limited consumption advisories for the Hudson River (Hauge, 1990). New York has limited consumption advisories and bans on consumption for numerous species in the Hudson River due to contaminants such as PCBs, dioxin, chlordane, and DDT (Sloan, 1987). New Jersey has a statewide prohibition on the sale of striped bass from all areas of the HRE, except Raritan Bay, because of PCB contamination. Other New Jersey restrictions include limited consumption advisories based on PCB contamination for American eels, statewide; for striped bass and bluefish in the HRE and northern NYB; and for white perch and white catfish in HRE.

PCB levels in Hudson River striped bass collected in 1986 had an average concentration range of 3 to 18 ppm; this was similar to average ranges reported in 1983 to 1985, but higher than reported in 1982 (Sloan, 1987). Values for total PCBs in bivalves reported by the National Status and Trends Program (NS&T) for the New York harbor and Raritan Bay were some of the highest for any station in the U.S., ranging from 4254 to 991 ng/g (NOAA, 1987a). Sloan (1987) reported mean 2,3,7,8 TCDD values in striped bass tissue of 26.4 ppt and of 32 ppt in Newark Bay. Belton et al. (1985) reported 2,3,7,8 TCDD concentrations in fish and shellfish in Newark Bay estuary ranging from a mean of 184 ppt in blue crabs to a mean of 40 ppt in striped bass. Rappe et al. (1989) reported on analysis of six samples collected in the Hudson River, Newark Bay, Raritan Bay and NYB. The highest value detected exceeded 5000 ppt of 2,3,7,8 TCDD in the hepatopancreas of a blue crab collected in Newark Bay. The muscle tissue from the same organism had a concentration of less than 100 ppt. These studies, and others, report higher concentrations of TCDD are found in organs (e.g., liver, hepatopancreas) than in muscle tissue. Metal values measured in mussels over several years by the NS&T program found an increase in concentrations of Cu, Cr, Hg and Ni in sites from the HRE (NOAA, 1989a).

LONG ISLAND SOUND

Reported toxic contaminant levels for Long Island Sound here are mostly from regional scale studies and historical data compilations (Greig, 1977; Reid et al., 1979; Reid et al., 1982; Greig and Sennefelder, 1985; Greig and Sennefelder, 1987; NOAA, 1987a; Mearns et al., 1988; NOAA, 1988; Connell, 1987; Dawson, 1989; ISC, 1989; NOAA, 1989a; LIS Study, 1989; Chytalo and Stacy, per. comm.,1990). Monitoring efforts are undertaken by the Connecticut Department of Environmental Protection and NOAA. In general, toxics in all three media -- water, sediments and biota -- show a decrease in contamination from west to east.

Levels of Toxics in Water

The Interstate Sanitation Commission compiled a series of data sets on toxic contamination in water (ISC, 1990). Their analysis of these data found considerable variability in concentrations which were difficult to separate from natural variability and inconsistencies in the data sets. In particular, much of the data are limited to the eastern portion of the sound, making regional evaluation difficult. Given these limitations the following conclusions were determined:

- Metal values decrease from west to east.
- Chlorinated hydrocarbons were mostly non-detectable.
- Copper concentrations did not meet the New York State Department of Environmental Conservation (NYSDEC) standard (2.0 ug/l) 97% of the time.
- Lead only met the NYSDEC standard (8.6 ug/l) in about 50% of the samples.
- Cadmium did not meet the NYSDEC standard (2.7 ug/l) in about 12% of the samples.

Levels of Toxics in Sediments

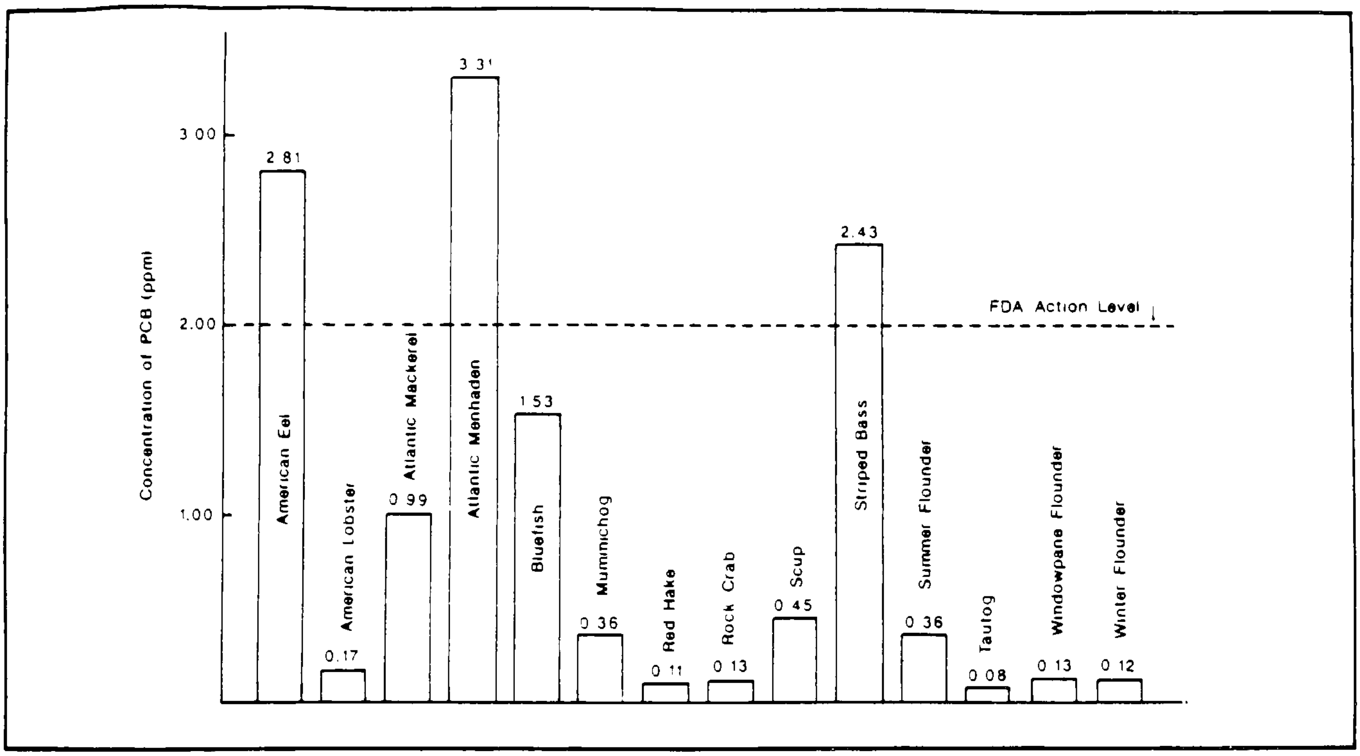
Primarily grab samples have been collected and analyzed for sediment contaminants in Long Island Sound. The levels discussed here are predominantly from several regional studies performed in the last two decades (Greig et al., 1977; Reid et al., 1979; Reid et al., 1982; Connell, 1987; and NOAA, 1988). Much of this historical information is being compiled and analyzed by Dawson (1990). In general, sediment studies indicate a decrease in particle-associated contaminants from west to east. However, some of the highest concentrations are found in harbors and the tidal portion of rivers draining into the sound. Reid et al. (1979) reported that grain size distribution in Long Island Sound generally coarsened to the east and south. As with all estuarine systems, low energy depositional environments, such as those in the tidal portions of these rivers, can be expected to accumulate fine-grained particles and provide temporary or permanent storage areas for particle-associated pollutants. Although grab samples may provide a general description of contaminant distribution, a far greater understanding of the temporal and spatial distribution of particle-associated contaminants in Long Island Sound would be gained through historical studies using cores dated with appropriate time tracers.

Dawson (1990) reports that levels for metals, PCBs and PAHs decrease from east to west, with higher values measured in harbors and some rivers. Connell (1987) reported similar values with maximum concentrations of PCBs in harbor and offshore LIS sediments of 810 ppb and 480 ppb, respectively. The LIS Study (1989) reported a general enhancement of contamination in sediments from east to west.

Levels of Toxics in Fish

Contaminant levels in certain species of fish and shellfish have been measured in LIS since the 1970s (Figure 1; LISS, 1987). Striped bass have consistently exceeded FDA's action level of 2 ppm for tissue concentrations of PCBs since the 1970s (Table 2; LISS, 1989). These concentrations are similar to levels measured in fish from other urban embayments on the Pacific and Atlantic coasts and, based on the available data, do not suggest a significant change in PCB contamination of fish since the mid-1970s (Mearns et al., 1988). Greig and Sennefelder (1985) reported mean levels of PCBs in mussels ranging from 220 to 518 ppb. These mean values were calculated from PCB concentrations measured in 10 individuals collected at each of the 10 locations in LIS. NOAA (1989a) reported a range in mean PCB concentration in mollusks of 350 to 1300 ng/g. At each station in LIS three composites were collected and their values averaged for each year from 1986 to 1988. These data showed a trend of general decreasing concentrations of chlordane, cadmium and zinc in mussels and oysters at some sites in Long Island Sound. LISS (1989) and Chytalo and Stacy (per. comm., 1990) also reported a general western enhancement of contamination for metals and organic compounds in mussels collected from LIS. Levels for PCBs in mussels do not exceed the FDA limit anywhere in the sound (Chytalo and Stacy, per. comm., 1990). Lobster samples collected in Long Island Sound in 1986 showed a range of mean PCB concentrations in tail/claw meat and hepatopancreas of <0.10 ppm and 3.7 to 2.38 ppm, respectively. The hepatopancreas analysis also suggested elevated concentrations of Cd and Pb (Chytalo and Stacy, per. comm., 1990).

FIGURE 1. HISTORICAL CONCENTRATIONS OF PCBs BY SPECIES (FROM LISS, 1986, AFTER NYSDEC)



NEW YORK BIGHT

Numerous comprehensive investigations have been conducted in the NYB. These include intensive studies of the effects of human wastes on the biota and ecosystems in the New York Bight (MESA, 1977-1978), of the sewage and dredge disposal sites by Reid et al. (1982), and of the phase-out of the sewage-sludge dumpsite (NOAA, 1989b). Mearns et al. (1988) reported that more studies on the occurrence of PCBs and chlorinated pesticides in fish and shellfish had been conducted in these marine waters than anywhere else in the United States. Most of these studies were conducted because of scientific and public concern about the human and biological risks associated with the dumping of wastes into the NYB. Although much is understood about processes in the NYB, much more must be learned in order to develop appropriate management plans to restore and enhance its ecology. Levels of contaminants in water, sediments and biota are comparable to other urbanized coastal areas (NOAA, 1987; NOAA, 1988; NOAA, 1989a). Excellent review articles and books have been published that synthesize the data collected in the NYB (Young et al., 1985; Mayer, 1982; Boehm and Requejo, 1986). These, and many other studies, focused on the possible fate and effects of the disposal of sewage sludge and dredge spoils in the NYB. The sewage sludge dumpsite was moved to the 106-mile site at the end of 1987. The National Marine Fisheries Service has an on-going intensive study (NOAA, 1989b) of the phase out of the sewage sludge dump site, and EPA and the USACOE are conducting studies to determine a new location for the dredge disposal site (Battelle, 1988; Battelle, 1989).

Levels of Toxics in Water

Hydroqual (1989) summarized data collected by EPA in 1988 and contained in the EPA STORET database on concentrations of metals in water column samples. They report that Cu and Pb exceeded EPA marine water quality criteria (2.9 ug/l and 8.6 ug/l) in the NYB. However, there is some question as to the reliability of all data contained in the EPA STORET database. Therefore, EPA conducted their own survey and collected water samples throughout the NYB in 1988. EPA found that metal concentrations tended to be highest at nearshore stations (Hydroqual, 1989). Although data for the distribution and significance of the metals were similar between the two studies, concentrations measured by EPA in 1988 were significantly lower than reported by the other data sets. Hydroqual (1989) suggests this difference is most likely an analytical effect rather than an actual decrease of metal concentration over time. The 1988 EPA survey found Cu concentrations exceeded the EPA marine water quality criterion at nearshore stations, but that Pb concentrations did not. Hydroqual (1989) notes that significantly lower Pb levels may actually indicate a true decrease in Pb concentrations in water and not just a difference in analytical methods. Data from Segar and Cantillo (1977) reported a range in Cu contamination from 1.75 to 23.75 ug/l. However, more recent data compiled by Segar and Cantillo (1984) gave a range of Cu contamination from a high in the NYB apex of 53 ug/l to a low on the outer shelf of 0.23 ug/l. They also reported a range in Pb values from a maximum of 8 ug/l in the NYB apex to a minimum of 0.69 ug/l on the outer shelf. PCB concentrations in water samples reported by MacLeod et al. (1981) and summarized by Hydroqual (1989) ranged from 0.33 to 0.6 ug/l; these values are comparable to those reported for the upper Hudson River. Segar and Davis (1984) reported PCB levels from various studies in the NYB ranged from 1 to 80 ng/l. These values were some of the highest reported in the United States, but considerably lower than those reported for the Baltic Sea and Japanese coastal waters (Segar and Davis, 1984).

Levels of Toxics in Sediments

Numerous studies and compilations of studies have been completed on toxics in sediments of the NYB (Hydroqual, 1989; NOAA, 1989b; NOAA, 1987b; NOAA, 1987c; NOAA, 1982; MESA, 1978-1979; Farrington and Tripp, 1977). Sample collection has been primarily by ponar grab, with many fewer core samples collected. Hydroqual (1989) reviewed and summarized many of these data. They report ranges for Cu concentrations in sediments in several different studies from 1972 to 1982, the major sources of data being NOAA (1982) and Dayal (1981). Hydroqual (1989) noted that mean Cu concentrations ranged from about 6 to 60 ug/g, showing a very general decrease in concentration through the Hudson Canyon to the slope. Mean Pb concentrations in sediments summarized by Hydroqual (1989) from data collected in 1973, and 1977 to 1980 range from 0.12 to 0.34 ug/g in the nearshore to 0.0004 to 0.006 ug/g in the outer shelf.

Concentrations of DDT and its metabolites in sediments were reported by MacLeod et al. (1981) and ranged from non-detectable to a maximum of 0.3 ug/g. PCB concentrations summarized by Segar and Davis (1984) ranged from 0.0005 to 2.2 ug/g. Hydroqual's (1989) summary of data for the NYB reported a maximum value, from measurements collected in 1973, of approximately 2 ug/g in the vicinity of the sewage dump site. These are different from values reported by NOAA (1987b) for similar data sets compiled from 1980 to 1983 where PCB concentrations in the inner NYB ranged from <1 to 1150 ppb (dry wt.) and in the Hudson shelf valley from <0.1 to 38 ppb (dry wt.). Battelle (1984) reported a range in PCB concentration of 1.8 to 150 ng/g from sediment samples collected in 1981 and 1983 . This variation in concentrations suggests differences in sampling and analytical methods and makes any generalizations of PCB contamination in the NYB difficult.

Various studies have focused on PAHs and hydrocarbon geochemistry of sediments in the NYB. It is difficult to compare these data because different compounds were analyzed in the different studies; however, some results from individual studies are presented. Farrington and Tripp (1977) report concentrations of hydrocarbons ranging from 500 to 3000 ug/g (dry wt.) and suggested an anthropogenic hydrocarbon source for the NYB. Koons and Thomas (1979) reported similar hydrocarbon concentrations in the NYB ranging from approximately 24 to 6500 ug/g, with maximum concentrations at the dredge spoil dumpsite and minimum values off-shore. Battelle (1984) also reported a decrease in PAH concentration with distance offshore, with levels ranging from <10 to 46000 ng/g.

Recent studies of fine-grained particulate distribution on the shelf indicate a strong relationship between particulate distribution and contaminant concentration (Young et al., 1985; Boehm and Requejo, 1986; Stumpf and Biggs, 1988; Bopp, 1989). Dayal et al. (1981) collected cores in the vicinity of the dredged material dumpsite and compared stratigraphy and metal distribution through the cores. They found that sediments associated with dredged material were enriched in metals by orders of magnitude when compared with other coastal deposits. On-going work by Bopp (1989; 1990, per. comm.), as part of the NOAA study of the phase-out of the sewage sludge dumpsite, is focusing on radionuclide dating and chemical analysis of cores collected from the former sewage sludge and current dredge disposal sites, with additional sampling sites down the axis of the Hudson Canyon to the shelf/slope break. These types of investigations, coupled with existing information on contaminant loading in the NYB, can contribute significantly to our understanding of contaminant sources, distribution and sinks, and the development of appropriate management strategies for the NYB, as well as HRE and LIS.

Levels of Toxics in Biota

Alden et al. (1985) produced an excellent, comprehensive compilation of contaminant body burdens in biota for the New York Bight. Alden et al.(1985) report ranges in winter flounder for Cu, Pb, Cd and Cr of non-detectable to 33.7 ppm, non-detectable to 2.7 ppm, non-detectable to 9.9 ppm and non-detectable to 6.0 ppm, respectively. They report levels of Cd in lobster of non-detectable to 0.715 ppm. NOAA (1982) reported metal concentrations in selected fish and shellfish samples collected in 1982. They reported that Cu levels in winter flounder and lobster muscle tissue ranged from 0.14 to 0.34 ppm and from 2.27 to 15.48 ppm, respectively. Pb values for the same species did not exceed 0.6 ppm. Cr concentrations in winter flounder and lobster were 0.12 to 1.35 ppm and <0.1 to 0.52 ppm, respectively. Cd levels were <0.1 ppm in winter flounder and ranged from <0.7 to 0.15 ppm in lobster.

Currently, the only heavy metal with a recommended action limit provided by FDA is mercury (as methyl mercury). The action level of 1 ppm was not exceeded in any tissue samples reported by NOAA (1982). Alden et al. (1985) report a mean concentration of methyl mercury in lobster of 0.51 ppm, a maximum of 1.97 ppm and concentrations of methyl mercury in winter flounder ranged from 0.0003 to 0.650 ppm.

Considerable data have been summarized about the concentrations of PCBs and organochlorinated pesticides in the NYB (Hydroqual, 1989; NOAA, 1989; Mearns et al., 1988; Sloan et al., 1988; NOAA, 1987; Alden et al., 1985; and Belton et al., 1983). Some of these studies were prompted, in part, by the occurrence of high levels of PCBs in fish and shellfish in the HRE. Measurements by NYSDEC of PCBs in striped bass, summarized by Hydroqual (1989), reported mean values in the NYB below the FDA action limit of 2 ug/g, although in the nearshore area the confidence interval exceeds this level. NJDEP studies found that mean PCB concentrations in striped bass in the nearshore of the NYB also exceeded the FDA action limit of 2 ug/g (Belton, 1983). Similar concentrations above the FDA action limit for other species, such as bluefish and eels, were also detected. A large survey conducted by NOAA (1987d) of PCBs in bluefish samples collected in the spring, summer and fall of 1985 found that mean concentrations, whether grouped by size or a combined total, only approached the FDA limit during the fall (1.99 ppm for large bluefish; 1.70 for all bluefish).

Due to the high PCB concentrations found through their own studies and others, New Jersey in 1983 issued a limited consumption advisory for striped bass and bluefish for offshore waters in the NYB extending south from Sandy Hook to Barnegat Bay. Based on the results of the NOAA study (1987d) and further NJDEP data, in 1989, NJDEP revised their bluefish advisory to include the entire New Jersey coast and to apply only to bluefish over 24 inches or 6 pounds (Hauge, 1990). This was because all of the studies found that large bluefish were more likely to exceed FDA limits than smaller bluefish. Studies of PCBs in tissue samples of lobsters and winter flounder, summarized by Hydroqual (1989), NOAA (1982) and O'Conner et al. (1982) indicate that PCB concentrations did not exceed the FDA action level in these species. Alden et al. (1985) summarized PCB and DDD concentrations for numerous species collected, primarily, in the NYB. They found concentrations for DDD averaged 0.324 ppm, with the lowest concentrations occurring in the NYB. Concentrations for PCBs ranged as high as 50 ppm, but were mostly below 2 ppm.

ECOLOGICAL EFFECTS OF TOXICS ON BIOTA

EPA is currently developing water quality standards and criteria for marine waters aimed at protecting both human and ecological health (Dieterich, per. comm., 1990). However, there is considerable controversy over the appropriateness of the endpoints and the methods used for determining human and ecological health risks. As part of the management program for these three systems, it is critical that some consensus be reached on how these risks should be measured, evaluated and, where necessary, minimized.

Numerous laboratory investigations have attempted to determine toxic endpoints caused by contaminants on abundant species. However, in urbanized estuaries and coastal zones such as the HRE, LIS, and NYB, it is critical that laboratory research be combined with field research to interpret possible toxic effects on organisms living in these systems. Carefully designed field studies are necessary to control for: gross environmental differences such as salinity, temperature, turbidity and grain size; the complex mixtures of contaminants that occur in these systems; and natural variations in species abundance and diversity. Bioaccumulation studies may address human health risks, but ecological risks require far more sophisticated research, involving field verification of the effects of pollutants on growth, disease occurrence, reproductive success and other indicators of stress.

Studies such as these have been conducted or are on-going in the HRE, NYB and LIS. Brown (1989) and Cristini et al. (1989) have conducted field and laboratory studies in Newark Bay to understand effects of dioxin on fish and shellfish. Cristini and Reid (1988) summarized studies showing that some species develop resistance to certain chemicals present in estuarine systems, but that these resistent populations may be less tolerant to other environmental variables and do not live as long or grow as well as species in less polluted systems. Sindermann et al. (1982) concluded in their summary paper that many of the pollutants found in the NYB were at levels capable of affecting early life stages of fishes, of increasing susceptibility to predation and disease, and possibly of reducing reproductive capability. Studies in Long Island Sound of the reproductive success of lobsters and flounder suggest that hatching successes and embryo survival appeared to correspond to an inshore-offshore gradient of pollutants rather than an east-west variant (LISS, 1989). More detailed particle-associated pollutant distribution and transport studies might strengthen Long Island Sound correlations between pollutant concentrations and biota reproductive success. The above studies suggest that toxic contaminants at their present levels in these systems may have numerous effects on the life-cycle of the biota. Difficult management decisions must be made based on acceptable biological and human health risks and on the observed toxic contamination of the water, particulates and sediments.

SUMMARY

Considerable research and monitoring has been conducted in the HRE, LIS and NYB over the last two decades. A literature review highlights the difficulties in comparing data sets and in reaching scientific conclusions that may help in designing management plans for these coastal waters. Few studies cover more than one component of the coastal system, and those that do frequently lack the data necessary to solve complex environmental problems.

Federal and state standards, criteria and guidelines, and FDA action levels exist for some toxic contaminants in the water and biota of coastal systems. There are no standards regulating toxic levels in sediments. Earlier inconsistencies between fresh and salt water quality criteria were resolved by the Clean Water Act of 1987. The more stringent controls outlined in this Act may improve estuarine water quality. The USEPA is developing comprehensive ambient sediment quality criteria for toxic contaminants. Current investigations that use a tiered approach to assess sediment toxicity by combining field and laboratory analyses are promising techniques for developing sediment criteria. However, any method developed is likely to be costly and the method's appropriateness should be evaluated in conjunction with local sediment management plans.

An overview of toxic contaminant levels throughout these systems shows that concentrations of certain pollutants exceed federal and state criteria in certain areas. Toxic levels in water seem predominantly controlled by proximity to source. Water quality most frequently fails to meet toxic criteria in the highly urbanized areas of these systems. Contaminant sources that contribute to toxic accumulation in biota are less clearly defined; however, contaminant concentrations exceeding federal action levels occur in several different species of fish and shellfish in all three systems. Particle-associated contaminant concentrations are controlled primarily by source and sediment grain size distribution. However, the widespread distribution of particle-associated toxics in these systems is attributable primarily to removal and disposal of particulates through dredging activities.

Continued research and monitoring are critical to any management plan. Geochemical tracers can provide useful information on contaminant sources, distributions and sinks, and enhance policy decisions on the management of dredge material. Investigations of the spatial and temporal distribution of toxics throughout these systems are necessary for evaluating trends in contaminant loading and will be fundamental in guiding current and future management programs for these coastal waters.

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CONTROLLING TOXIC INPUTS--
SOURCE REDUCTION
AND TREATMENT OPTIONS

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Wastewater treatment technology is undergoing profound changes at this time. This phenomena has been triggered by changes in regulations and permit requirements. In the past, permit requirements primarily related to conventional pollutants, namely BOD and suspended solids. Over the years, the kinetics of BOD removal were refined, leading to rational design and operational criteria. More recently, the kinetics of relating to specific organics; e.g., phenol, have been developed and applied to both industrial and municipal wastewater treatment plants. In all of these cases, reasonably predictive models now exist for the performance of biological wastewater treatment facilities.

The major problem now facing wastewater treatment plants is the aquatic toxicity requirement as defined by a bioassay. Toxicity is defined in terms of toxic units, which is related to the LC_{50} of the wastewater. Toxic units are non-specific and include all wastewater constituents including synergistic and antagonistic effects and, as such, no models presently exist to predict toxicity reduction through biological wastewater treatment facilities.

Toxicity data has been developed for a wide variety of aquatic species for most of the common organic and inorganic pollutants. While this is useful information when considering specific compounds, most of these are either removed or transformed through a wastewater treatment plant. A better approach is necessary, therefore, to relate toxicity to treatment technology in a cost-effective manner. The present approach by the EPA is to address toxicity at the source through industrial pretreatment programs. While this makes sense in many cases, it must be recognized that resulting effluent toxicity from a wastewater treatment plant is frequently due to oxidation by-products from the biological process which may or may not be controllable at the source. A comprehensive program is thereby required to evaluate source control and resulting impacts on the wastewater treatment plant. The proposed protocol is shown in Figure 1.

An equalized sample is pretreated for the removal of heavy metals, volatile organic carbon, and ammonia. The presence of ammonia may significantly affect the toxicity of the sample and can be removed in a pretreatment step or through nitrification in the bio-oxidation step. Following pretreatment, a priority pollutant scan and a bioassay is run on the sample. The

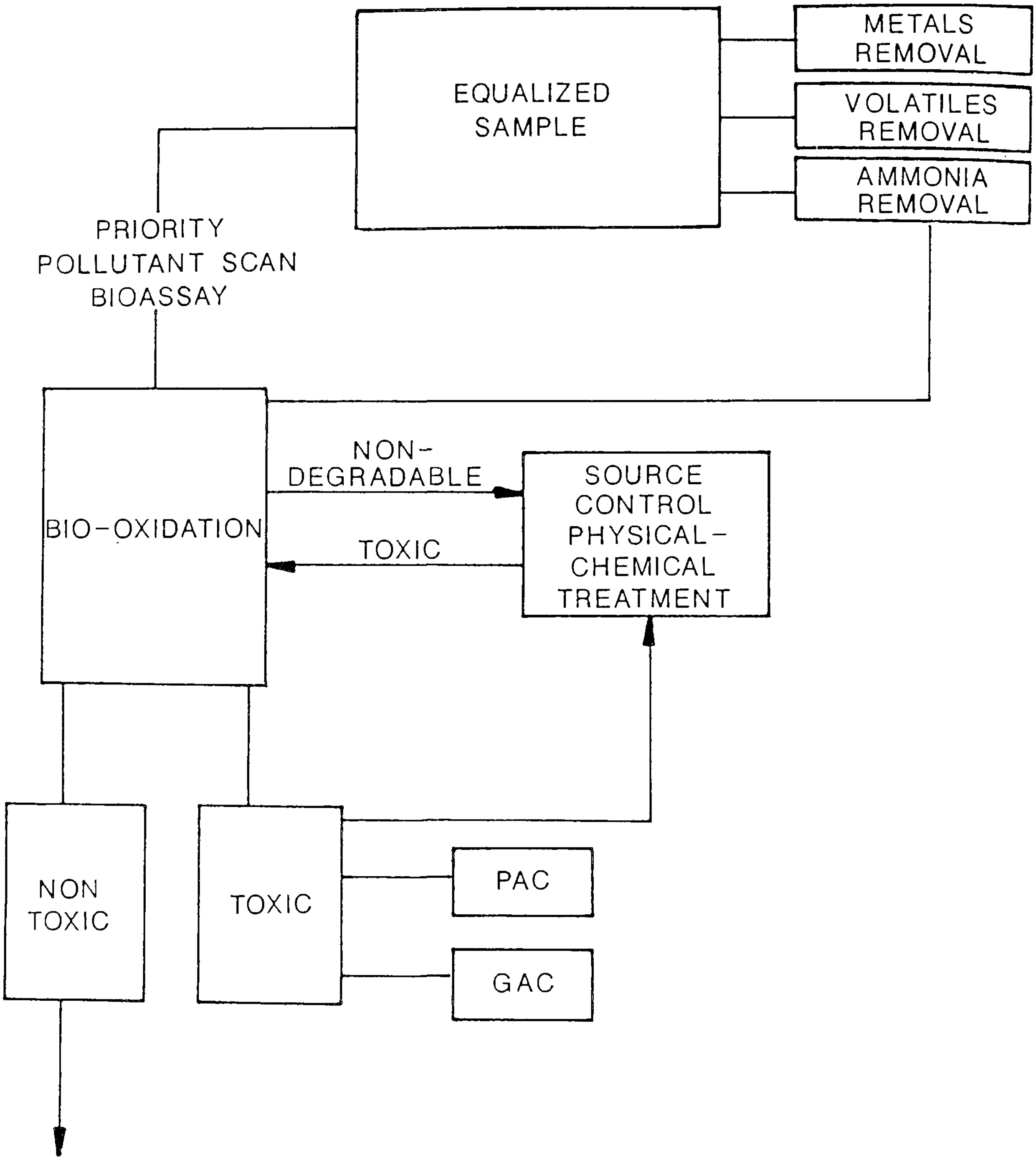

Figure 1. Protocol for source toxicity evaluation

sample is then subjected to bio-oxidation in order to oxidize all the biodegradable components. Several test protocols are available for this purpose including the Fed Batch Reactor, the Zahn Wellens procedure, and continuous activated sludge reactors.

If the waste stream in question is non-degradable and toxic, then it is segregated for source control and/or physical-chemical pretreatment. Following pretreatment, the wastewater may be returned to the biological process.

After bio-oxidation, the sample is again evaluated for toxicity. If it is still toxic following bio-oxidation, additional treatment employing powdered activated carbon or tertiary granular activated carbon may be employed. Alternatively, prior to bio-oxidation physical-chemical treatment may be applied to the wastewater stream.

SOURCE TREATMENT

The source treatment options are shown in Figure 2. The process selection will depend on the pollutants as identified in Figure 1.

Chemical oxidation is a promising technology for a wide variety of organics and inorganics. In most cases, the primary objective of chemical oxidation is detoxification and to render the organics more biodegradable in subsequent treatment processes. Results using H_2O_2 for several toxic organics are shown in Table 1. Organics oxidized by H_2O_2 with a UV catalyst are shown in Table 2. Ozone is an effective oxidant for many of the toxic organics. Depending on the volatility of the organic, both stripping and oxidation will occur. Table 3 shows some organics removed by ozonation.

Many organics which are non-degradable, toxic or degrade very poorly aerobically will degrade to end products under anaerobic conditions. In these cases, anaerobic pretreatment may effectively reduce toxicity and render the wastewater amenable to subsequent aerobic biological treatment. Toxic organics amenable to anaerobic treatment are summarized in Table 4.

Granular carbon columns will effectively remove many toxic organics. GAC has been successfully employed for the treatment of pesticide wastewaters and others which are both non-degradable and toxic.

TABLE 2. ORGANICS REMOVED BY HYDROGEN PEROXIDE WITH UV CATALYST

Trichloroethylene
Tetrachloroethylene
2-Butanol
Chloroform
Methyl isobutyl ketone
4-Methyl-2-pentanol
Carbon tetrachloride
Tetrachloroethane

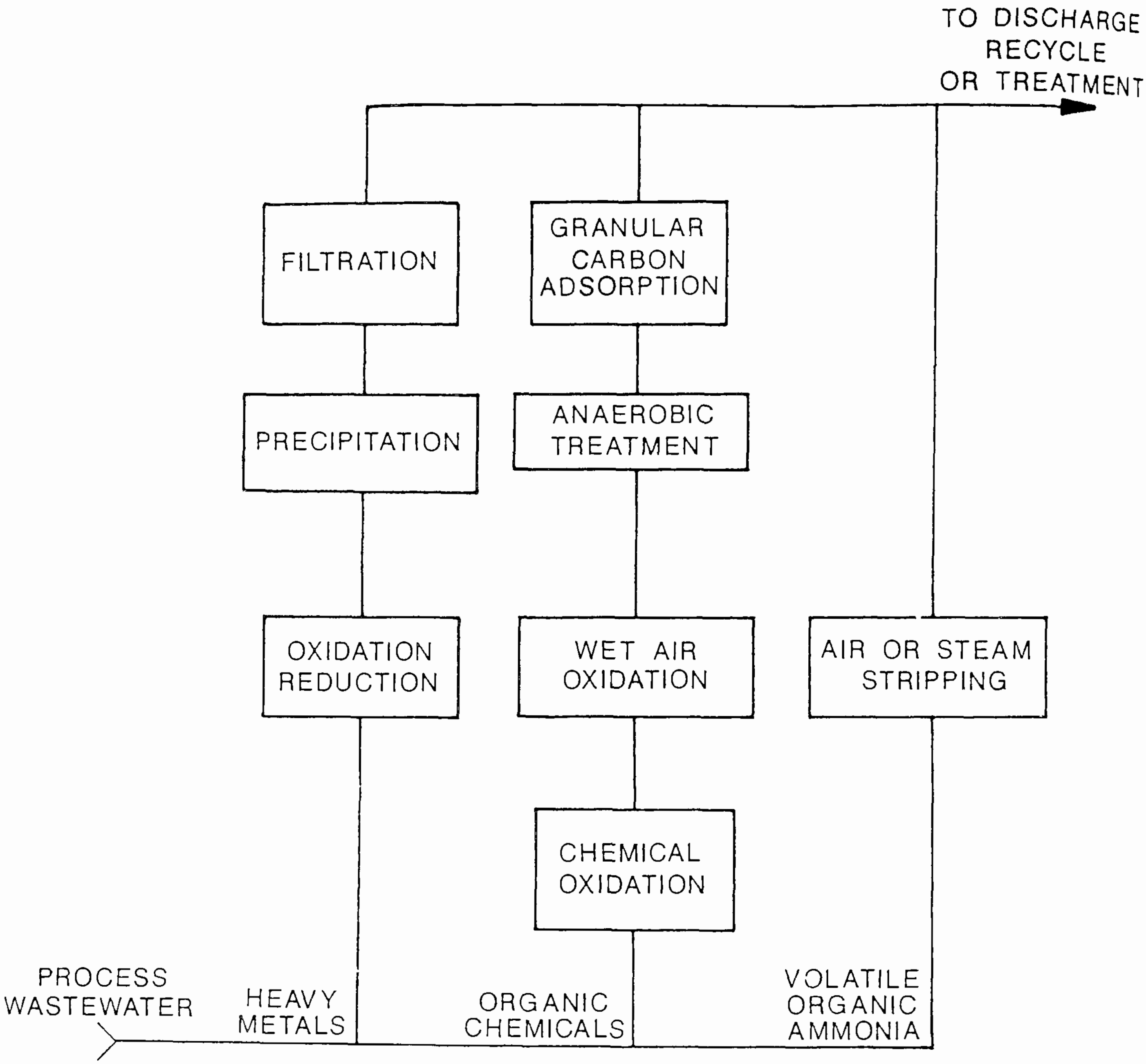

Figure 2. Source treatment technologies for toxicity reduction

TABLE 1. HYDROGEN PEROXIDE OXIDATION OF ORGANICS

Compound	Percent reduction		LC50 (%)		COD reduction in 2 days (10%)	
	COD	TOC	Before oxidation	After oxidation	Before oxidation	After oxidation
Phenol	76	44	6.1	NT	41	47
Benzoic acid	76	48	24.0	NT	69	32
Nitrobenzene	72	38	6.0	76.2	59	31
Aniline	77	43	35.7	NT	0	40
o-Cresol	75	56	2.5	NT	16	51
m-Cresol	73	38	1.3	NT	0	51
p-Cresol	72	40	0.4	NT	65	47
o-Chlorophenol	75	48	5.1	NT	18	37
m-Chlorophenol	75	41	1.8	NT	0	40
p-Chlorophenol	76	22	0.3	NT	0	39
2,3-Dichlorophenol	70	53	1.0	NT	12	31
2,4-Dichlorophenol	69	50	0.6	NT	9	32
2,5-Dichlorophenol	74	42	1.9	NT	14	38
2,6-Dichlorophenol	61	33	5.7	17.3	0	9
3,5-Dichlorophenol	69	49	0.5	NT	0	9
2,3-Dinitrophenol	80	51	6.3	85.6	0	19
2,4-Dinitrophenol	73	51	2.0	NT	0	49
2,4,6-Trichlorophenol	47	44	2.8	52.2	0	39

Conditions--stochiometric dosage of H_2O_2, pH 3.5, 50 mg/l Fe^{++}

NT = Not Toxic

TABLE 3. ORGANICS REMOVED BY OZONATION

Methyl ethyl ketone
Tetrahydrofuran
Methyl isobutyl ketone
2-Butanol
4-Methyl-2-pentanol
1,1-Dichloroethylene
Toluene
Trichloroethylene
Xylene

TABLE 4. ORGANIC MINERALIZED UNDER ANAEROBIC CONDITIONS

Acetylsalicylic acid	Phloroglucinol
Acrylic acid	Phthalic acid
p-Anisic acid	Polyethelene glycol
Benzoic acid	Pyrogallol
Benzyl alcohol	p-Aminobenzoic acid
2.3 Butanediol	Butylbenzylphthalate
Catechol	4-Chloroacetanilide
m-Cresol	m-Chlorobenzoic acid
p-Cresol	Diethylphthalate
Di-n-butylphthalate	Geraniol
Dimethylphthalate	4-Hydroxyacetinilide
Ethyl acetate	p-Hydroxybenzyl alcohol
2-Hexanone	2-Octanol
o-Hydroxybenzoic acid	Propionanilide
p-Hydroxybenzoic acid	Butylbenzylphthalate
3-Hydroxybutanone	m-Chlorobenzoic acid
3-Methylbutanol	o-Chlorophenol
1-Octanol	m-Methoxyphenol
Phenol	o-Nitrophenol
	p-Nitrophenol

Source: Shelton and Tiedje (1984)

After screening those wastewaters which are toxic and non-biodegradable for source treatment, those which are biodegradable are subjected to aerobic biological treatment.

It has been shown that under conventional process operating conditions (SRT >10 days) even the more recalcitrant organics are oxidized to low residual concentrations. Results for several recalcitrant organics are shown in Table 5. What is significant to note from Table 5 is the buildup of organic by-products in the system. For the compounds shown in Table 5, six to nine percent of original COD results in non-degradable by–products.

There is evidence that many of these by-products are high molecular weight and toxic to aquatic life. In these cases, since the toxicity cannot be removed by pretreatment, additional technology must be added to the activated sludge process for the removal of these constituents. At this point in time, carbon has been shown to be the most viable technology to remove residual toxicity in activated sludge effluents. In several cases, PAC has been successfully used as shown in Figure 3. It has also been shown that GAC may selectively remove toxic high molecular weight organics. Treatment of a toxic bioeffluent by GAC is shown in Figure 4 As can be seen, the TOC breaks through after 16 days operation, but the toxicity breakthrough does not occur for 60 days. It can be postulated that the toxic, high molecular weight organics are replacing non-toxic molecules on the carbon. In cases where this situation exists, GAC may be a cost-effective technology.

ECONOMICS OF TOXICITY REDUCTION

It is probably obvious that that the first step in developing an economic analysis of toxicity reduction is an evaluation of source control and/or source treatment for those wastewater streams identified in the protocol outlined in Figure 1. Substitution of non-toxic chemicals for toxic ones in the manufacturing process should be explored. In some cases, improved yield or by-product recovery can generate income offsetting the costs of disposal. Source treatment as shown in Figure 2 should then be evaluated. because of the diverse nature of the wastewaters involved, baseline economics cannot be developed and each case will be site specific.

TABLE 5. SOLUBLE MICROBIAL PRODUCTS IN SECONDARY EFFLUENT FROM AN ACTIVATED SLUDGE PLANT(2)

Compound	SRT (days)	Residual COD of Compound (mg/l)	COD of Microbial Products mg/l^{-1}
Nitrilotriacetic Acid	6.5	2.7	39.7
Sulfanilic Acid	6.9	3.2	33.8
Morpholine	15.0	2.8	33.9

Initial COD of compound was 500 mg/l.

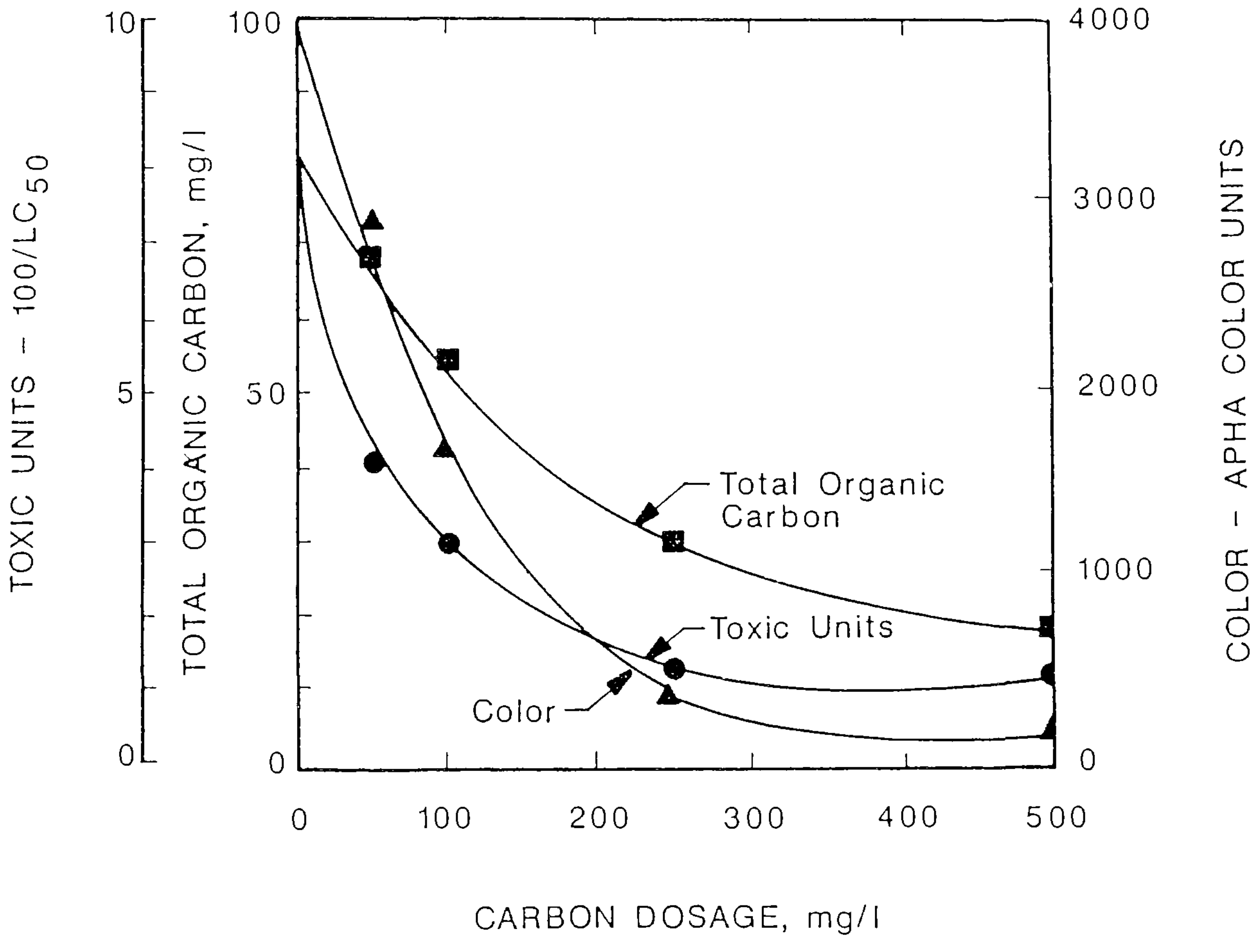

Figure 3. PAC performance in the treatment of a chemicals wastewater

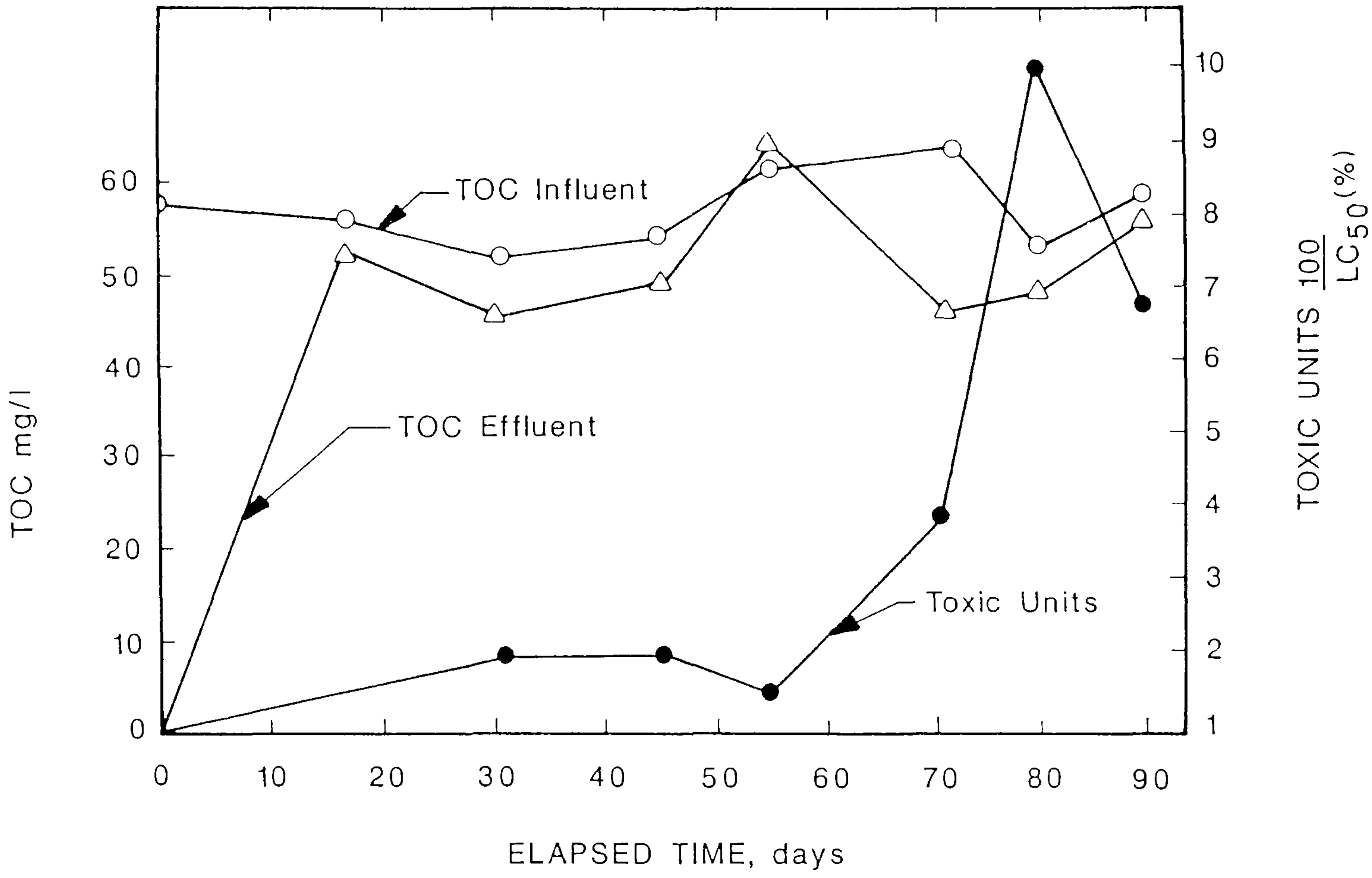

Figure 4. TOC and toxicity reduction using granular carbon columns

In many cases, source control will not remove toxicity from the effluent as discussed earlier and add-on end of pipe technologies must be employed. Figures 5 and 6 show comparative capital and O&M costs for the more common technologies. These costs were developed for a 10 MGD wastewater flow with a raw wastewater COD of 1,000 mg/l treated in an activated sludge plant. Chemical oxidation or anaerobic digestion would be provided as a pretreatment for the wastewater for detoxification and improved biodegradability. The capital cost may range from 32-95 percent of the activated sludge plant and the O&M cost from 70-90 percent of the activated sludge plant. Granular activated carbon is the most expensive with respect to both capital and operating cost and would normally only be considered where toxicity is selectively removed as shown in Figure 4. Powdered activated carbon will frequently retrofit into an existing plant thereby substantially reducing the capital investment.

DISCUSSION

It is apparent that there is no simple solution to the problem of aquatic toxicity. While source treatment is effective and necessary in many cases involving toxic, non-degradable organics and inorganics, in cases involving toxic or non-toxic degradable organics source treatment may not eliminate the resulting toxicity. A comprehensive identification procedure is necessary to define the most cost-effective solution to any particular problem. Since in most cases a wastewater treatment plant exists, the protocol should be tailored to optimize use of the existing facilities. This inevitably becomes a case by case evaluation.

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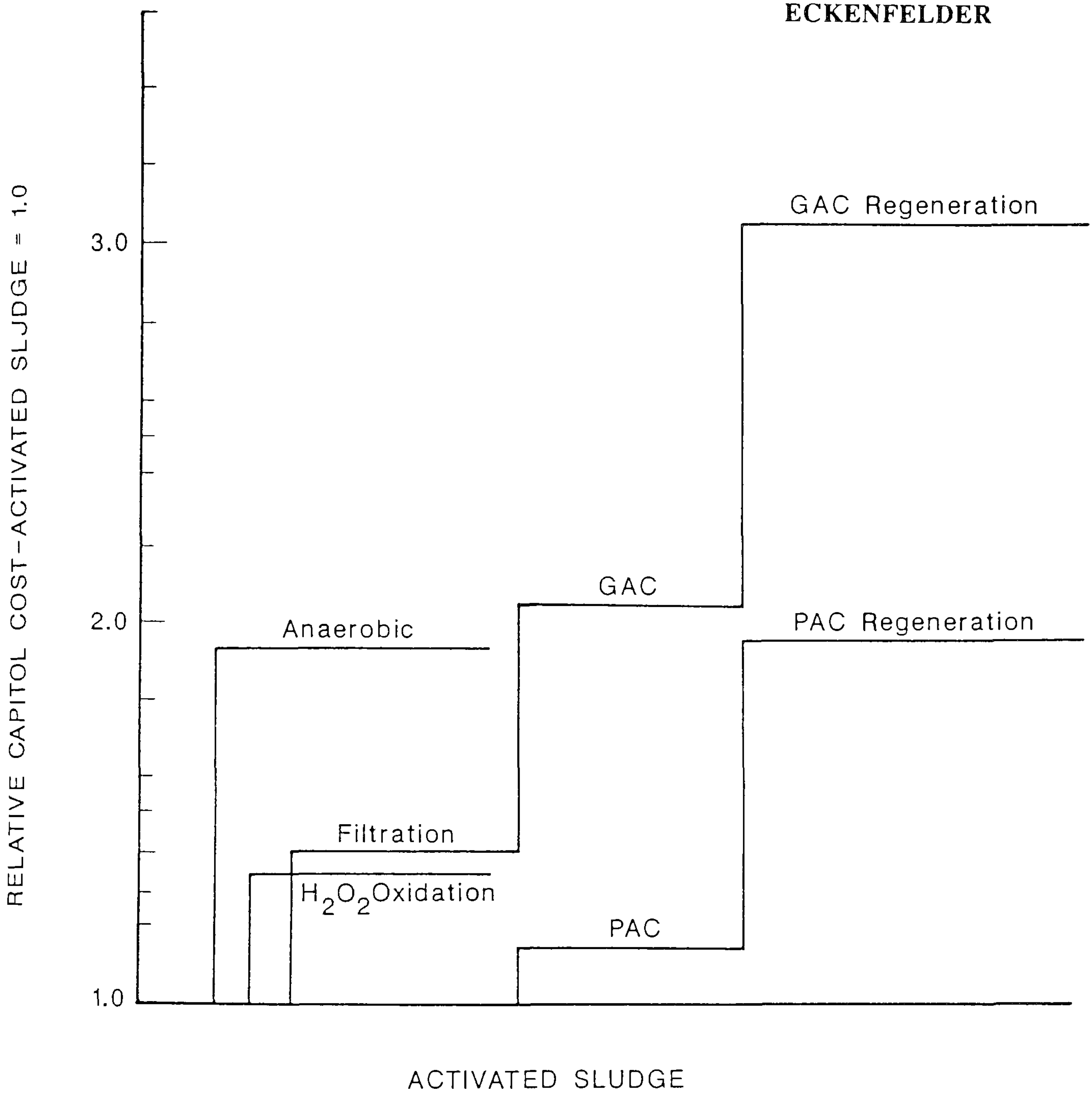

Figure 5. Relative capitol cost of physical-chemical technologies for toxicity reduction basis 10 mgd, COD = 1000 mg/l

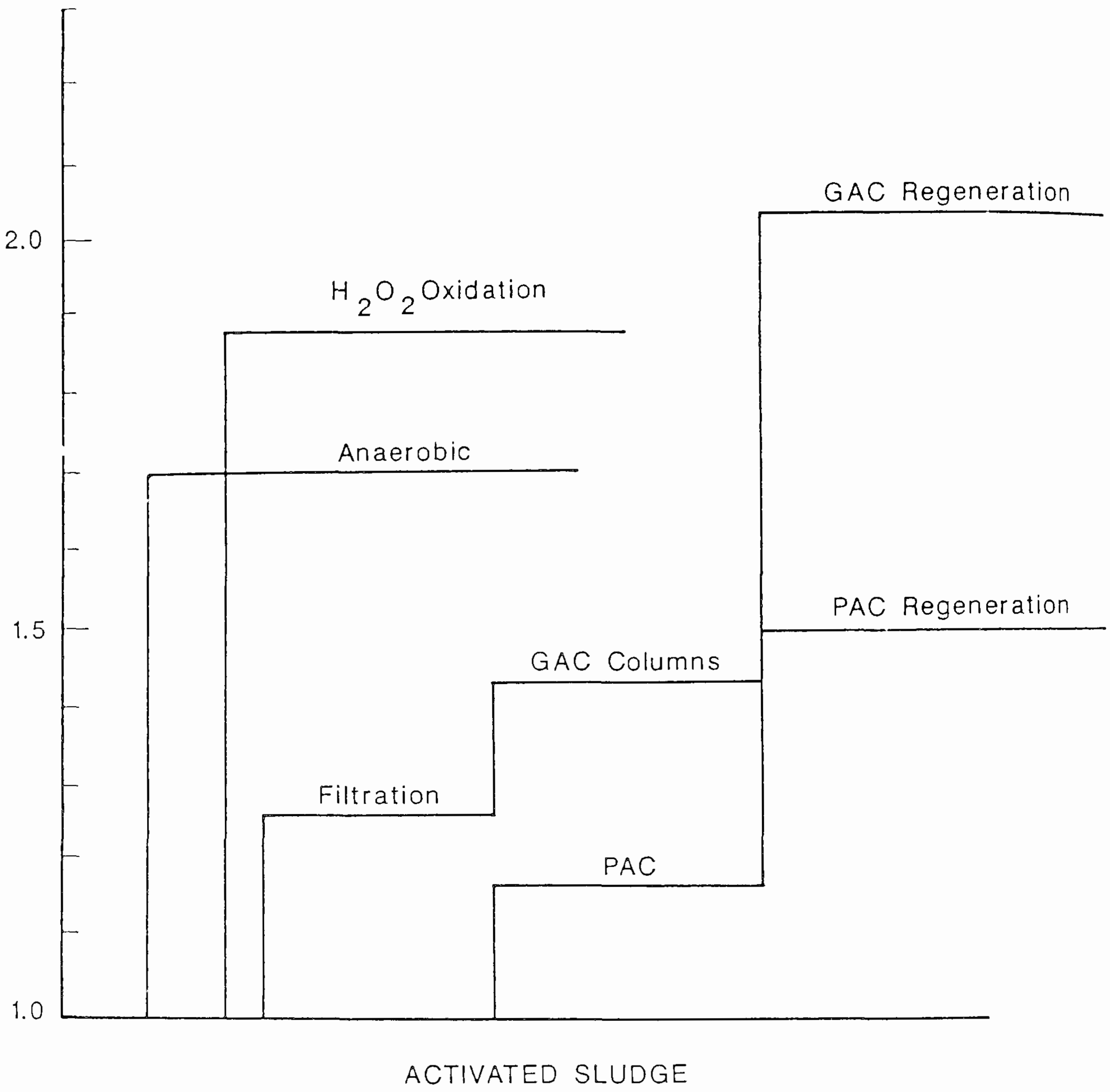

Figure 6. Relative operating and maintenance cost of physical-chemical technology for toxicity reduction basis 10 mgd, COD = 1000 mg/l

CONTROLLING TOXIC INPUTS

A REGULATORY PROSPECTIVE

Albert W. Bromberg
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March 13, 1990

INTRODUCTION

It is generally accepted that toxic substances are not good for man and his environment. Toxics control and reduction is required by federal and state law and is accomplished through complex technical and legal mechanisms which attempt to integrate risk vs. benefit vs. cost on media-by-media basis. Regulatory agencies are faced with implementing controls based on economically achievable control technology and applying substance specific criteria for the protection of human and aquatic life.

This presentation is intended to provide a environmental status report on our ability to come to grips with controlling toxic substances using existing regulatory mechanisms. Since the theme of this conference is the near-shore coastal waters, the ongoing regulatory initiative will be presented from a water program perspective. However, I have also attempted to include relevant ongoing efforts in other media programs such as air, land, and solid waste.

BACKGROUND

A State's water toxic regulatory control program is set by the requirements of the federal Clean Water Act, as amended. This program consists of technology based treatment requirements as a minimum coupled with water quality based limitations to protect the best use of the receiving water.

For industrial discharges, "Technology" treatment consists of Best Available Treatment Economically Achievable (BATEA). Where federally promulgated BAT effluent guidelines are not available, states develop guidelines using Best Professional Judgement (BPJ). For municipal discharges, minimum treatment is secondary treatment or its equivalent. Pre-treatment programs are required of municipal facilities with flow greater than 5 MGD or smaller if it has significant industrial waste contributors.

As a supplement to technological treatment requirements, water quality based effluent limits are required, where necessary, to meet the designated best use of the receiving water. This consists of the use of chemical specific effluent limits or biological (toxicity) testing, or both, to assure that water quality standards are met and designated uses are maintained and protected.

Toxics control in other media is similarly governed by companion federal legislation. The Resource, Conservation and Recovery Act (RCRA) serves to control the treatment, storage and disposal of solid and hazardous waste. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) and the Superfund Amendments and Reauthorization Act (SARA) establish programs and principles for the remediation of hazardous waste sites, active and inactive. The Clean Air Act is under significant review this year on a national level to address issues such as the emissions of toxic substances and the control of acid precipitation and deposition.

STATE PROGRAM SUMMARY

Of obvious interest to this Conference is the status of toxic control programs in the states immediately adjacent to the New York Bight, namely Connecticut, New Jersey and New York. The following is a summary of these State toxic control actions with emphasis on the water program and water program involvement in other media activities.

The following elements of Permitting activities in the Water Program will be compared:

Technology Treatment Requirements

- Best Available Treatment (BAT)
- Best Professional Judgement (BPJ) represent a state's determination of effluent limitations (including toxics) to satisfy the technological requirements of the Clean Water Act in the absence of USEPA promulgated categorical industrial effluent guidelines
- Industrial Waste Pretreatment for publicly owned treatment works
- Anti-backsliding

Water Quality Based Requirements

- Water Quality Standards
- Biological monitoring
- Anti-degradation

Other media programs have direct and indirect impacts on water quality. Water program review is provided for the following actions:

Solid Waste
- Landfills
- Sludge disposal

Hazardous Waste
- Hazardous Waste Treatment
- Hazardous Waste Site Remediation

Air Emission Control

Table 1 present a summary of the respective state regulatory activities as they relate to wastewater discharges and state water program involvement in other media (air, land, etc.) regulatory activities.

TABLE 1

Regulatory activity	Connecticut	New Jersey	New York
Water Program - Permits			
Technology Treatment BAT/BPJ/Anti-Backsliding	All "technology" requirements applied.	All "technology" requirements applied.	All "technology" requirements applied.
Pretreatment	Program delegated and being implemented.	Program delegated and being implemented.	Program not delegated but being implemented.
Water Quality Requirements Standards, Bio-monitoring	Few standards in-place; some under development; whole effluent toxicity limits and bio-monitoring applied site-specific.	Limited number of standards in-place; an additional 14 developed, others under development; whole effluent toxicity limits applied, bio-monitoring required.	Chemical specific effluent limits developed based on promulgated water quality standards; biological monitoring applied site-specific.
Anti-Degradation	Policy in place; applied where applicable.	Policy in place; applied where applicable.	Policy in place; applied where applicable.
Solids Waste Program			
Landfill	Controlled by water permit.	Controlled by water permit.	Limited by water permit.
Sludge Disposal	Disposal regulated by water or solid waste permit.	Disposal regulated by water permit.	Disposal regulated by Solid Waste permit.
Hazardous Waste Program			
Hazardous Waste Treatment	Water permit establishes technology and water quality effluent limits.	Water permit establishes effluent limits.	Water permit establishes technology and water quality effluent limits.
Hazardous Waste Site Remediation	Receives water quality review; limits in consent order or water permit.	Receives water quality review; limits contained in water permit.	Receives water quality review; limits in consent order or water permit.
Air Program			
Toxic Emissions Control	Air guideline levels established for over 800 substances. Control technology required to meet guideline.	Required "state of the art" control technology; 11 toxic standards must be met; ambient air guidelines under development.	Air guidelines established for over 400 substances categorized as high, moderate or low concern. Control technology applied to meet guideline.

ANALYSIS OF STATE PROGRAMS

All elements of a point source toxic control program are in-place and consistent with federal legislative requirements. The principle weaknesses in existing programs are the following:

The inability to conduct a multiple-state toxic wasteload allocation analysis for the establishment of toxic effluent limits. Such an analysis is predicted on a) the existence of compatible substance specific toxic marine water quality standards for each state involved, and b) toxic waste discharge inventories for all significant point sources.

For Long Island Sound (Connecticut and New York), point source discharges are sufficiently distant from each other that application of individual state toxic control strategies on a site specific basis should be adequate to assure maintenance of toxic standards. For New York-New Jersey Harbor (New Jersey and New York), the number and location of point sources are such that development of a bi-state toxic wasteload allocation process is desirable. The water program staffs have initiated discussions directly on this topic. Toxic wasteload allocation is also identified as a work plan element in the New York-New Jersey Harbor Estuary Study.

The absence of chemical specific marine water quality standards in Connecticut and New Jersey. This is compensated by strong whole effluent toxicity control efforts in both states employing biological (toxicity) monitoring. Both states are in the process of reviewing technical information toward developing chemical specific criteria for adoption as water quality standards. This process is hindered by the general lack of scientific data on the effect of toxic substances on marine water species.

Toxic discharge load inventories for all potential waste sources. There is relatively good toxic discharge data for industrial and municipal point sources. However, there is considerably less information on toxics for combined sewer overflows (CSO's), stormwater runoff, nonpoint sources and atmospheric deposition. The first cut of a bi-state effort to establish a harbor-wide toxic wasteload allocation will, of necessity, focus on point sources with the integration of other sources (CSO, stormwater, etc.) as data becomes available.

Toxics from air emissions are being controlled; however, there has been no assessment of the benefits to the water environment to be gained by different or better emission control.

A positive point is that the contribution of toxics from solid and hazardous waste receives the same scrutiny as toxics resulting from other water discharges.

WHAT MORE CAN BE DONE

The federal Clean Water Act stipulates the technical and legal procedures for implementing the goal of "elimination" of the discharge of pollutants" and national policy of the "prohibition of the discharge of toxic pollutants in toxic amounts." These procedures include the application of technology and water quality based effluent limits. The following are USEPA/State actions which would enhance the reduction of toxic discharges.

- EPA review of previously promulgated federal categorical effluent limitations to ensure that the most up-to-date treatment technology is being applied for pollutant control.

- States review and update best professional judgement (BPJ) treatment technologies for industrial categories where EPA has not promulgated effluent guidelines.

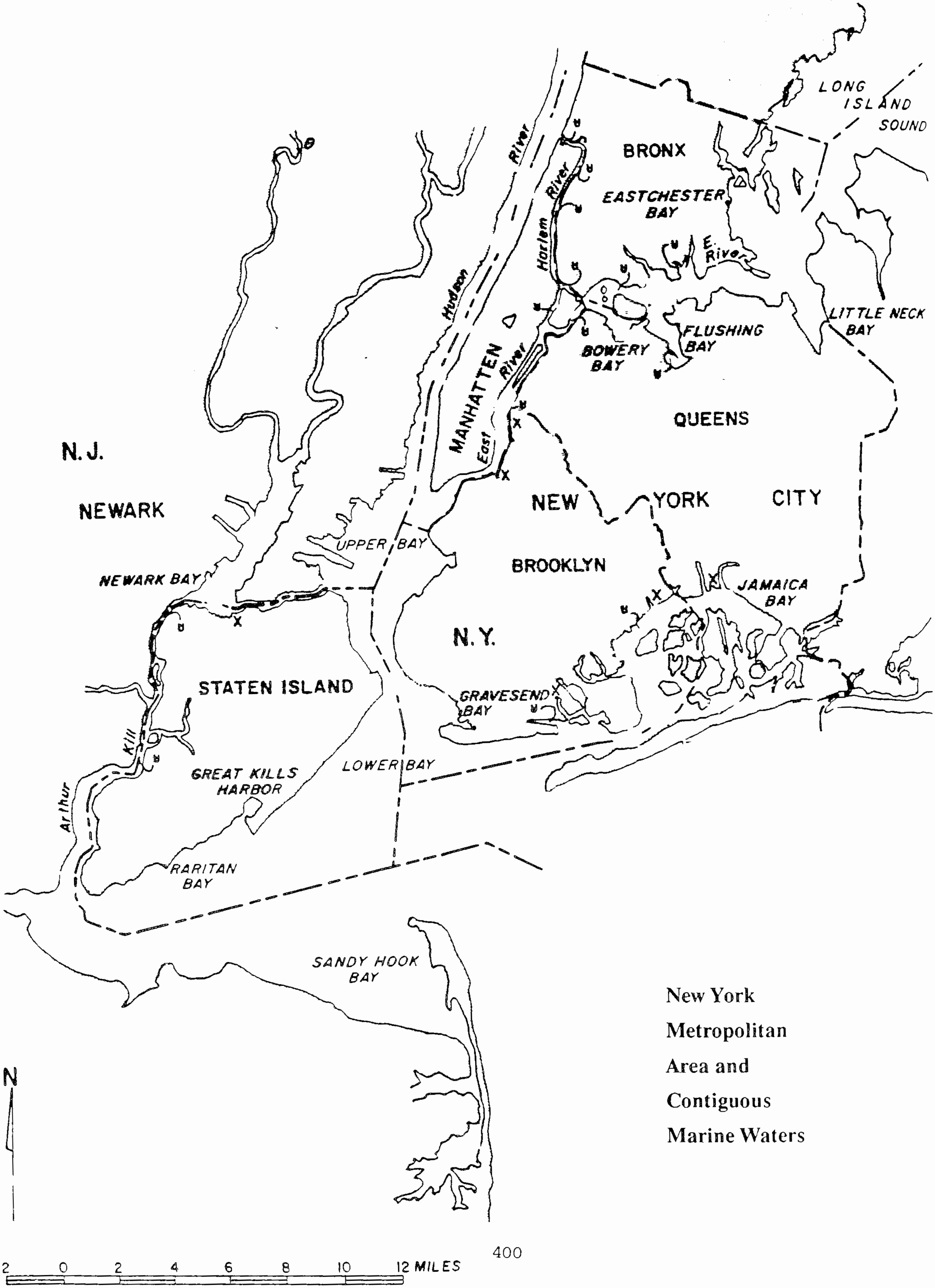
- EPA should continue to support the development of water quality criteria for the protection of marine aquatic life. Up to now, much more effort has been devoted to the development of fresh water criteria than marine water criteria.

States place priority emphasis on the implementation of and compliance with municipal pre-treatment program requirements for the control of toxic pollutants.

EPA work with the States to develop a national implementation strategy for applying anti-degradation to further reduce persistent toxic pollutants.

States incorporate best management practices (BMP's) in industrial wastewater discharge permits to control toxics in stormwater runoff.

States implement the control strategies in the recently adopted State Nonpoint Source Management Plans for the control of toxic pollutants.



New York
Metropolitan
Area and
Contiguous
Marine Waters

WORKSHOP SESSIONS ON THE PRIMARY FACTORS CAUSING USE IMPAIRMENTS AND OTHER ADVERSE ECOSYSTEM IMPACTS

HABITAT

A Historical Review of Changes in Near-Shore Habitats in the Sound-Harbor-Bight System

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Introduction

This paper retraces the changes which have occurred in the near shore habitats of the New York Bight, New York Harbor and Long Island Sound since the invasion of the North American continent by Europeans, a time hereinafter called the "contact." Following that summary, the factors which have been primary in causing destruction or degradation of aquatic habitats over the past 50 years are summarized. Then, finally, measures taken in that period of the past 50 years which have improved aquatic habitats are identified.

Human population growth has been a dominant factor in alteration of the North American environment, both directly and indirectly as a consequence of pollution. Humans had been in North America for many millennia prior to the European contact, but they had been few in numbers and their culture was such that their environmental impacts were slight. But within a century of settlement, European colonists had had a substantial impact on the coastal environment.

How do human populations influence near-shore habitats? Among other influences are the following:

1. Physical destruction of habitats in preparation of sites for industrial, residential and other construction;

2. Dredging of channels and spoil disposal;

3. Construction of bulkheads, armored shorelines, dams, dikes, seawalls, levees, etc.;

4. Drainage of habitats for crop production, mosquito control or other purposes;

5. Flooding by construction of impoundments;

6. Mining for sand and gravel or other materials; and

7. Discharges of toxic pollutants, loadings from sewage disposal, both treated and untreated, and sedimentation from runoff resulting from land development, agriculture, etc.

Additionally, there are many indirect human-caused impacts upon shorezone habitats caused by sediment diversion, alteration of local hydrology, and subsidence resulting from groundwater withdrawal.

The Region

Three states bound the aquatic regime consisting of the New York Bight, New York Harbor and Long Island Sound. These states differ from each other in significant ways for their history, and consequently the pattern of their development resulting from their resources, population and economies, has led them in different pathways.

New Jersey is the most densely populated state in the Union and is second only to California in industrialization, much of which is concentrated in the area surrounding the Port of New York. Of the state's population, 90% lives in cities and, by census definition, some of the state's counties are wholly urbanized. While those counties abutting the New York Harbor have been urbanized and industrialized for almost a century, the central coastal region is only now rapidly developing. Ocean County's population grew 90% in the 1960's and other rural areas have increased in population by over 50% since that time. New Jersey's coastal areas are one of the most industrialized and heavily developed in the United States and its coastal recreational and park lands, among the most utilized (U.S. Department of the Interior, 1988C).

New York, the largest state in the northeastern United States, is also the most diverse in geography, natural resources, population and economy. Fourth in numbers of residents, the state's population is unevenly distributed: almost 50% live in the 320-square-mile area surrounding and including New York City. Long Island's 1,475 miles of shoreline (46% of the state's total) have been intensively developed for residences with the greatest concentration being on the south shore of the Island. New York Harbor, a premier national port, fostered the development, principally on Manhattan Island, of a center of commerce, banking and other commercial services. New York City has now a position as the nation's financial capital as a consequence of its long history in maritime commerce. Yet, today, the shores of the port are undergoing a transformation from sites of commerce and industry to mixed use development of service industries and residences (U.S. Department of the Interior, 1988B).

Connecticut's protected shoreline, in contrast to the open sandy shores of New York and New Jersey, features rocky headlands and many small bays and estuaries -- there are only 79 miles of sandy beach in the state. The extensive salt marshes and tidal environments -- these embayments fostered were early infilled by European settlers as this coastally oriented state developed. But, while industry once dominated the shoreline, residential use is now predominant and has, in large part, displaced industry. Between 1960 and 1970, commercial development in the coastal region increased 133%. Residential areas now occupy about 25% of the shorefront. In the 36 coastal townships, residential purposes accounted for almost 50% of all new land development in the 1970-1975 period (U.S. Department of the Interior, 1988A).

People and the Tri-State Coastal Region

Human population growth and resultant impacts on the coastal environment were first examined by analysis of population growth in the metropolitan core and outward along three radii: a western comprising largely the New Jersey coast; a central of Long Island; and a northern, the Connecticut shore (Figure 1). Population history of the coastal counties of the three states was used in the analysis as provided in data of the U.S. Census Bureau. The results are shown in Figures 2 and 3, Regional Population Growth and Regional Population Density, respectively. Tables 1 and 2 provide data on population history and population density, respectively. The definition used of the coastal region as including only those counties which border on the coast differs from the definition of coastal population used by the U.S. Census Bureau. That agency differentiates the coast as that area 50 miles from the tideline but includes all of the population of New Jersey and Connecticut in its coastal tabulation.

Figures 2, 3, 4, and 5 reveal what one intuitively understands: Population is concentrated in the urban center and decreases in density outward from that center. A small centrum of lesser population density at the urban center (Manhattan) may reflect urban decay or census undercounting. This population distribution results from growth of the metropolitan region as a locus of employment and a subsequent spread of housing, industry and support systems around the perimeter of the metropolis. Population density reflects the same pattern, i.e., a decreasing density along the three radii from the core outward. Note the rather considerable disparity between the population density of the Connecticut coast -- an almost uniform 500+ persons per square mile -- and the variation in New Jersey's coastal counties. In Connecticut, at present, the coastal land use is largely residential except for three urban port cities, whereas in New Jersey the socioeconomic profile ranges from industrial to rural agricultural land use.

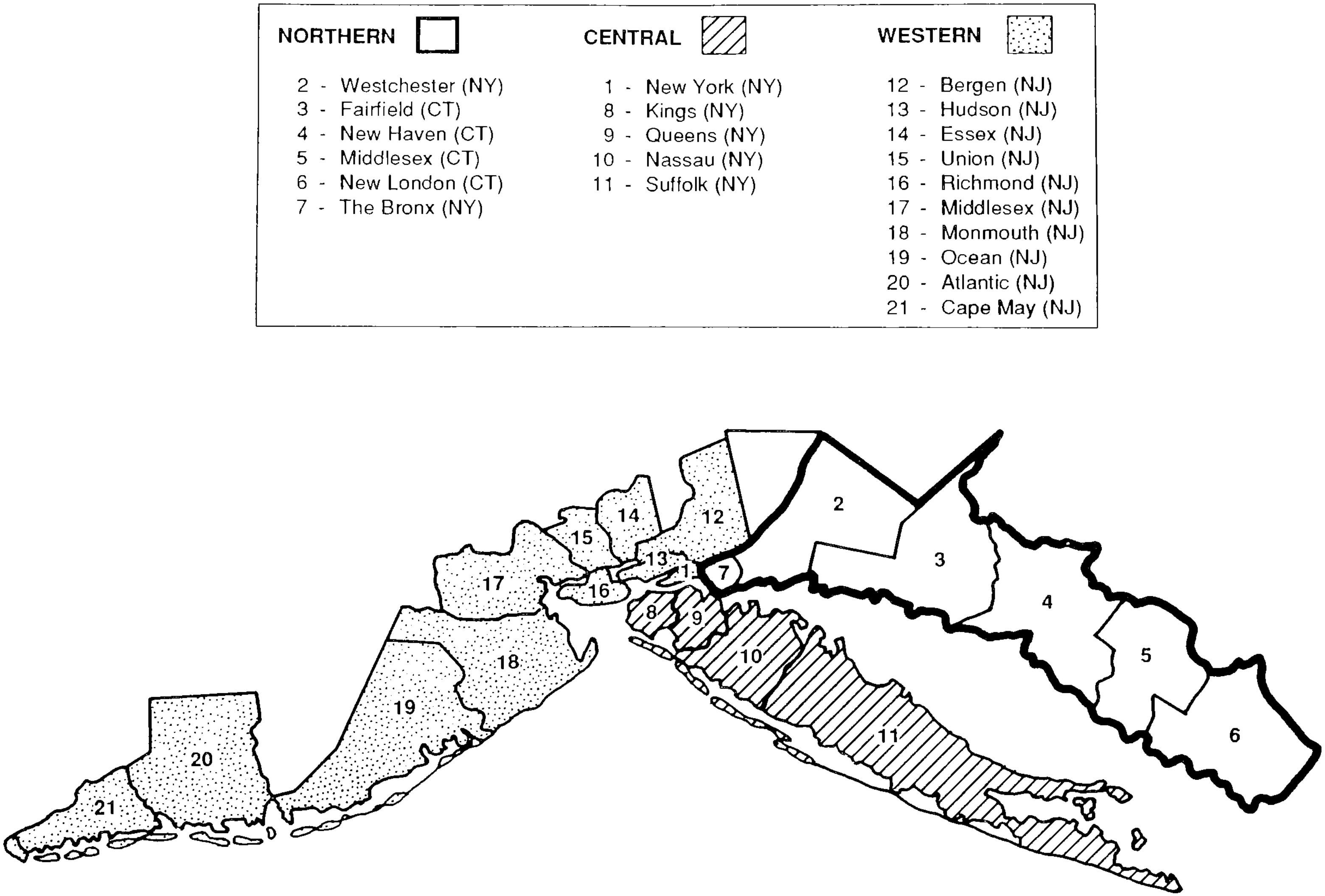
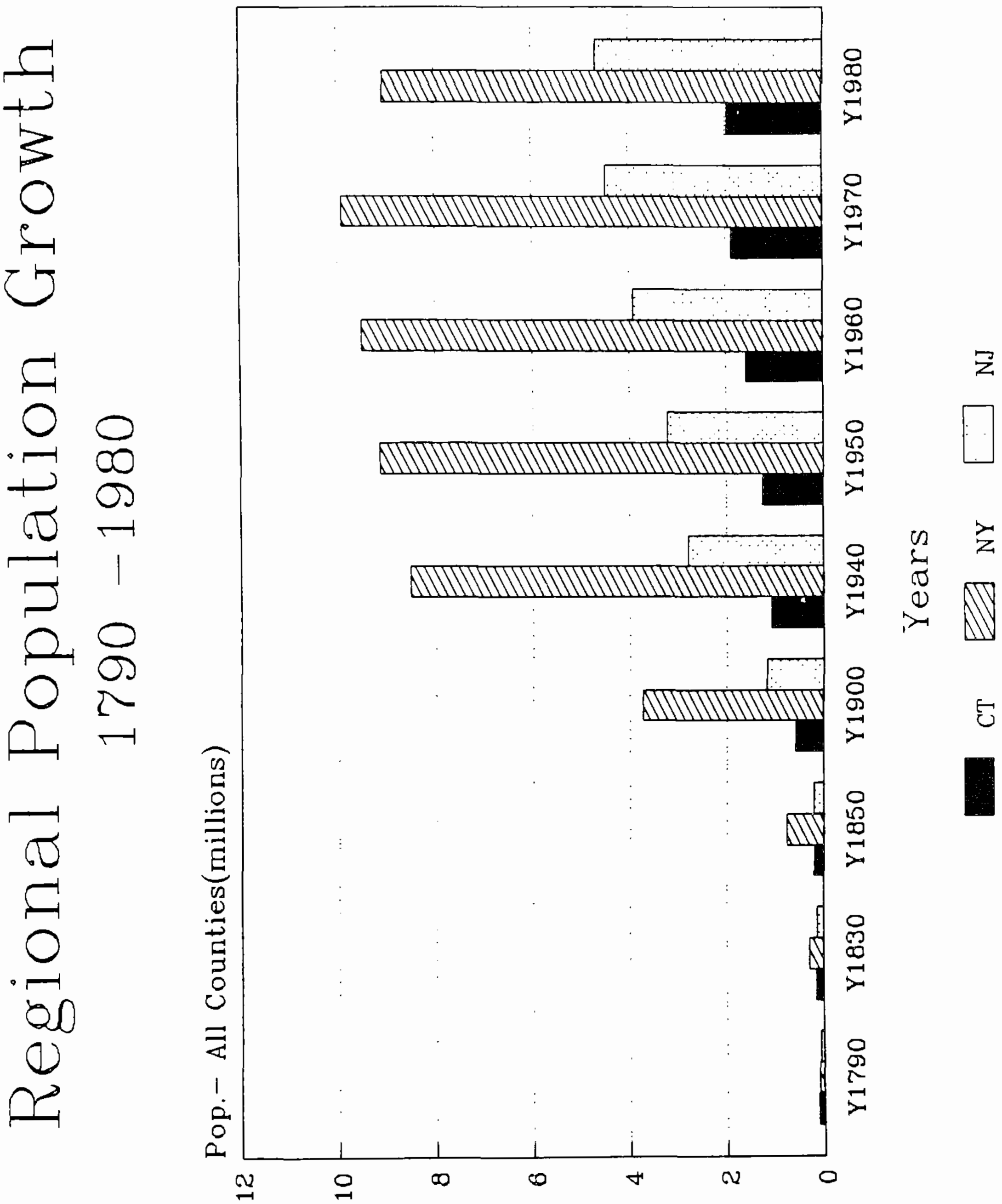
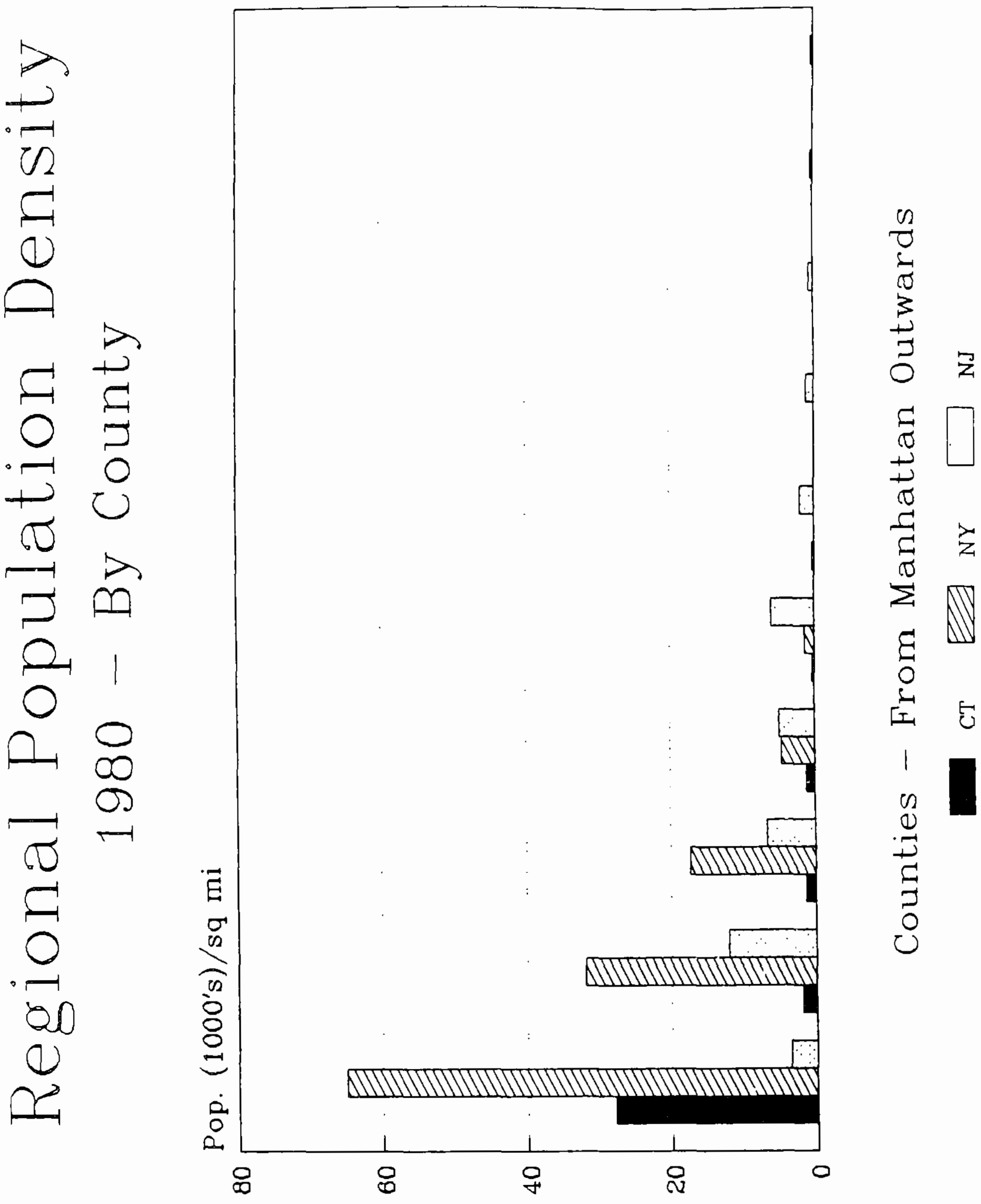


Figure 1. Counties of the tri-state coastal region.



Total population of those counties comprising the three radii defined in Figure 1 is shown for this period. Explosive increase in population at the beginning of the 20th Century is clearly shown. Data are presented in Table 1.

Figure 2. Regional population growth: 1790-1980.



Population density of the tri-state region according to data from the 1980 census is shown for the coastal counties in the three radii defined in Figure 1. Population density decrease from the core area outward along the radii is clearly apparent. Data are presented in Table 2.

Figure 3. Regional population density.

TABLE 1. POPULATION HISTORY OF THE TRI-STATE REGION[a]

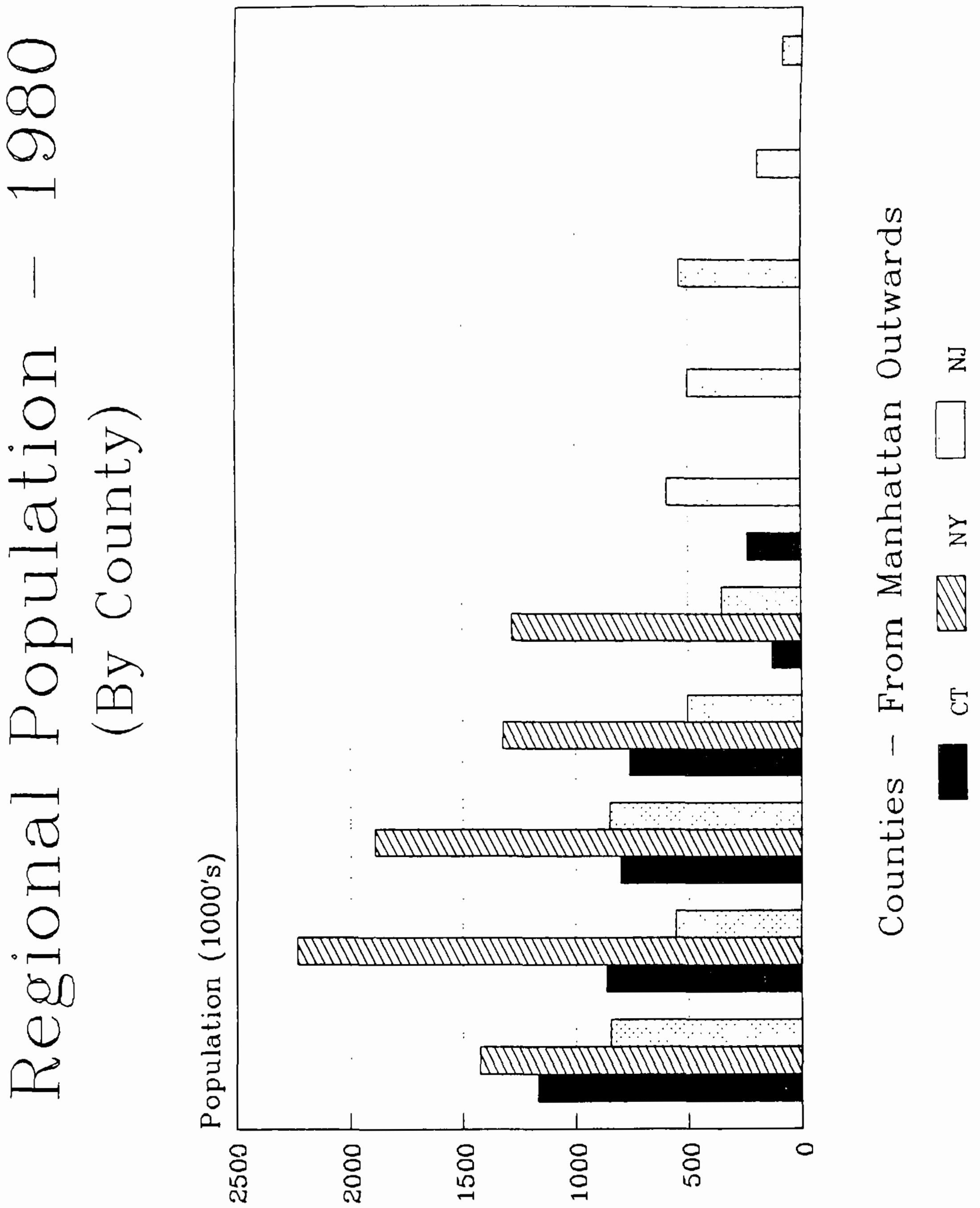
County	1790	1830	1850	1900	1940	1950	1960	1970	1980
Connecticut									
Fairfield	36	47	60	184	418	504	654	793	807
Middlesex	19	25	27	42	56	67	89	115	129
New Haven	31	44	66	269	484	546	660	745	761
New London	33	42	51	83	125	145	186	231	238
New York									
New York	11	70	177	705	1890	1960	1698	1539	1428
Bronx	22	133	338	1346	1395	1451	1425	1472	1169
Kings	5	21	139	1167	2698	2738	2627	2602	2231
Queens	4	6	10	153	1298	1551	1810	1987	1891
Nassau	12	16	27	55	406	673	1300	1429	1322
Suffolk	17	27	37	78	197	276	667	1127	1284
Richmond	4	7	15	67	174	192	222	295	352
New Jersey									
Bergen	6	11	15	78	410	539	780	897	845
Hudson	1	2	22	386	652	647	611	608	557
Essex	10	23	41	359	837	906	924	932	851
Union	8	19	33	99	328	398	504	543	504
Middlesex	16	23	29	80	217	265	434	584	596
Monmouth	7	12	30	82	161	225	334	462	503
Ocean	10	17	10	19	38	57	108	208	540
Atlantic	7	14	9	46	124	132	161	175	194
Cape May	3	5	6	13	29	37	48	60	82

[a] Population data are from U.S. Census Bureau reports of county populations. For those counties not in existence in early years, population data have been disaggregated from precursor civil divisions assuming uniform distribution of population within the reporting unit. Data are in thousands of persons.

TABLE 2. POPULATION DENSITY IN THE TRI-STATE REGION[a]

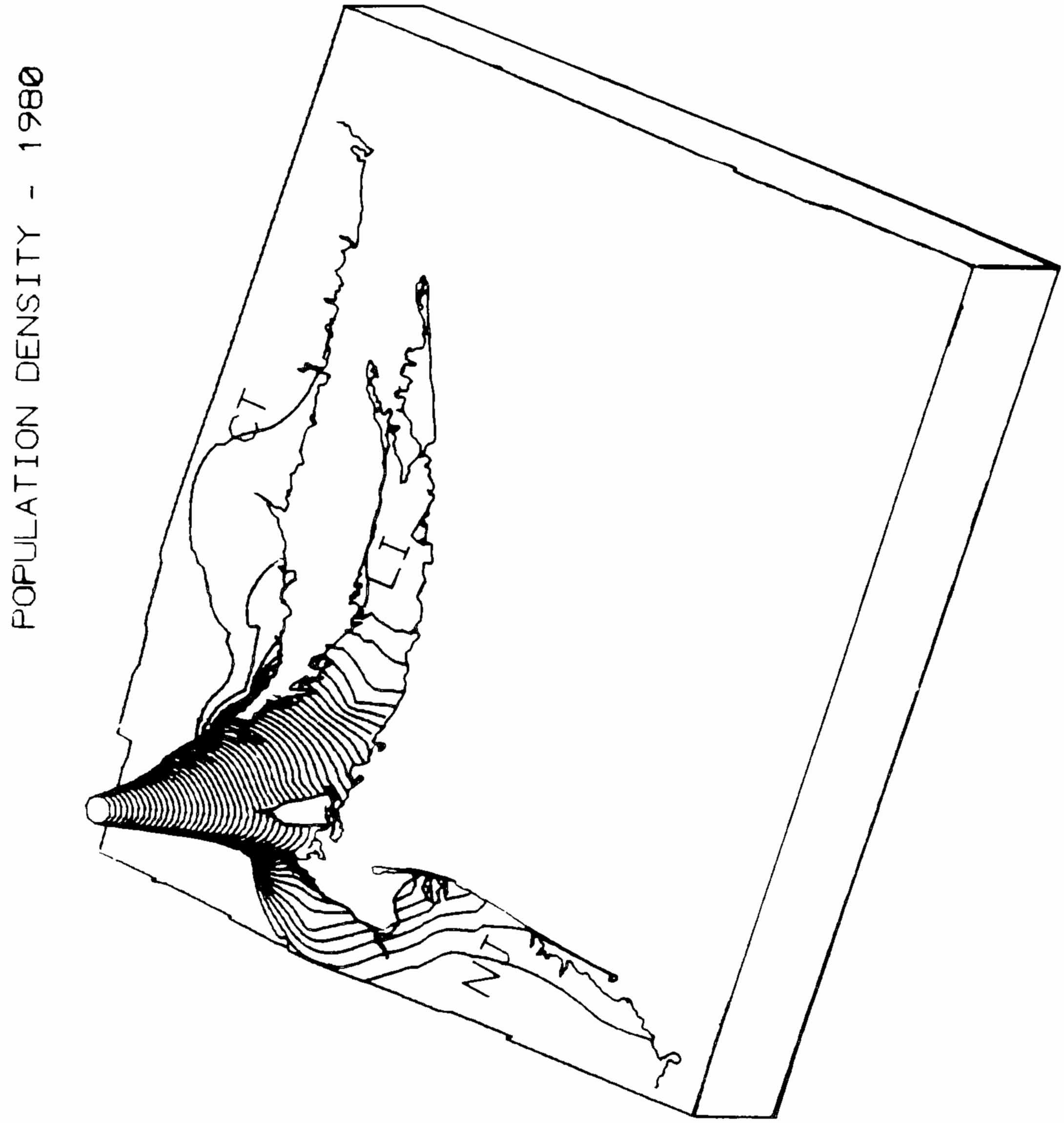
County	1790	1830	1850	1900	1940	1950	1960	1970	1980	Area
Connecticut										
Fairfield	0.1	0.1	0.1	0.3	0.7	0.8	1.2	1.3	1.3	632
Middlesex	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	373
New Haven	0.1	0.1	0.1	0.4	0.8	0.9	1.1	1.2	1.2	610
New London	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	669
New York										
New York	0.5	3.2	8.0	32.0	85.9	89.1	77.2	70.0	64.9	22
Bronx	0.5	3.2	8.0	32.0	33.2	34.5	33.9	35.0	27.8	42
Kings	0.1	0.3	2.0	16.7	38.5	39.1	37.5	37.2	31.9	70
Queens	0.1	0.1	0.1	1.4	11.9	14.2	16.6	18.2	17.3	109
Nassau	0.1	0.1	0.1	0.2	1.4	2.3	4.5	5.0	4.6	287
Suffolk	0.1	0.1	0.1	0.1	0.2	0.3	0.7	1.2	1.4	911
Richmond	0.1	0.1	0.3	1.1	2.9	3.3	3.8	5.0	6.0	59
New Jersey										
Bergen	0.1	0.1	0.1	0.2	0.9	1.2	1.8	2.1	1.9	237
Hudson	0.1	0.1	0.5	8.4	14.2	14.1	13.3	13.2	12.1	46
Essex	0.1	0.1	0.1	0.3	0.7	0.8	1.4	1.8	1.9	316
Union	0.1	0.2	0.3	1.0	3.2	3.9	4.9	5.3	4.9	103
Middlesex	0.1	0.1	0.1	0.3	0.7	0.8	1.4	1.8	1.9	316
Monmouth	0.1	0.1	0.1	0.2	0.3	0.5	0.7	1.0	1.1	472
Ocean	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.8	641
Atlantic	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	568
Cape May	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	263

[a] Population data taken from Table 1. County area were uniformly taken from U.S. Census Bureau County Areas for 1980. For those counties not in existence in early years, estimates have been made of their area by aggregation and a uniform distribution of population waws assumed as for Table 1. Data are in thousands of persons per square mile.



Population of the coastal counties along the three radii described in Figure 1 as counted in the 1980 census is shown. Data are presented in Table 1.

Figure 4. Regional population: 1980.



Population density of the coastal counties along the three radii described in Figure 1 is shown in three dimensions. The dominance of the metropolitan core is apparent. Data are from Table 1.

Figure 5. Population density: 1980.

The Nearshore Habitats

Nearshore habitats are defined here as the actual shore zone, or interface between water and land; a landward buffer of the areas which can impact upon aquatic resources; and the shallow, nearshore waters. Of the complex of habitats to be found in this zone, tidal wetlands have been the best mapped, quantified and inventoried. Least well mapped and inventoried are the tidal flats and other nonvegetated, nearshore, submerged lands. We will now examine the ways in which human activities impact upon these habitats.

Habitat Destruction

Many traditional port functions are now being closed out or threatened by rising land values and are being replaced by mixed-use developments. But these shifts in waterfront use configuration are not new. They may be considered but a stage in the continuum of urban evolution. Buttenweiser (1987) has usefully summarized patterns of development of American urban waterfronts. In her analysis, early waterfronts were largely shaped by the character of the ships and the cargoes they carried. But the bulky goods, the stuff of imports to a developing nation, were increasingly superseded by the export of finished goods. This required alteration in the configuration of shoreside structures and in the transport of goods to those facilities. Ships became larger as iron and steel replaced wood for construction and steam replaced sail for motive power. Greater depths of water were required for the passage of larger ships into and out of ports. Docks were extended as storage space required for the greater volume of goods transported increased. Containerization displaced labor from the shorefront to other locations and required new and enormous facilities.

And most recently, financially highly productive mixed-use (housing/office/retail) projects have displaced less financially fecund, per unit of area occupied, industrial and transport functions. These are a modern manifestation of the combined effects of technological obsolescence and lessened waterfront property values (e.g., Moss, 1980). Simply put, as containerization became the favored mode of ocean transport, the facilities for "break-bulk," the former mode of transport, were rendered obsolete. The Hudson River coast, lined with mile-long finger piers and warehouses, quickly became passe and the piers deteriorated. Today, often all that remains of these noble structures are the pile-fields which once supported the pier and warehouses. The value of these pile-fields as aquatic habitat, or as surrogate habitat, is the subject of current debate. As trucks replaced railroads as the favored mode of surface transport, the great marshaling yards of the port became redundant. These unused or underutilized properties have depreciated rapidly in value until it has become profitable to refurbish them for new uses -- housing, retail commercial, and service offices.

New York Harbor, in its pre-contact form, had gently sloping shores fronting on shallow flats extending far out into the Harbor as well as extensive wetlands. Settlers, particularly those of English ancestry, were quick to bulkhead that shoreline, using timber cribs, and to backfill. The first primitive dock was built before 1624; the first stable pier (rock fill in timber cribbing) was built in 1647, and the first landfill to straighten the shore and provide a level land surface and uniform depth of water was started in 1654 (Condit, 1980). Buttenweiser (1987) catalogued the filling of Manhattan's coastal margin. These data are summarized in Table 3.

TABLE 3. LANDFILLING ON MANHATTAN ISLAND: 1609-1978

Period	Acres of fill	Acres per year
1609-1700	321	3.5
1700-1800	408	4.1
1800-1900	452	4.5
1900-1980	167	2.1

Data from Buttenweiser, 1987.

By 1925, the boosters of New York's Harbor were trumpeting that more miles of its waterfront were bulkheaded than any of the harbors of Europe, Asia or South America. Today virtually all of the commercially developed port has bulkheaded, rip-rapped or otherwise modified shorelines.

To handle shoreside traffic, increasingly trucks, roads were built -- later highways -- right to and on the margin of the nearshore habitat zone. The concentration of highways built along the shore during the 1930s and 1940s reflected the lesser costs of land acquisition in those routes. Coastal marshes, then largely unappreciated for their habitat value and considered nuisances because of their biting insect populations, were readily infilled.

Finally, the nonvegetated shoal water flats, shellfish beds, sand bars and other shallow water habitat other than wetlands have been extensively disturbed. Dredging of channels, dumping and disposal of solids, shellfishing, and commercial fishing with towed nets have all combined to reconfigure the harbor bottom and its biota. Of these, dredging has been the most destructive as it results in a modified bathymetry as well as related effects such as sedimentary plumes, altered hydrology, etc. Serious channel dredging commenced in the late 1800s with the invention of the hydraulic dredge (Edwards, 1893). Between 1884 and 1892, 16 miles of channel had been dredged (Klawonn, 1977). Between 1888 and 1900 the Harlem Ship Canal was dredged with a cut 400 feet wide and 15-18 feet deep through Dyckman's Meadows -- a tidal marsh (Klawonn, 1977).

This general pattern of port development has been followed, in one form or another, in almost every port city in the tri-state region. These structural changes, induced by technological innovation, occurred in conjunction with regional economic change, social and political events such as migrations and wars.

Because of the body of quantified information about tidal wetlands, that component of nearshore habitats is here used as an indicator of the degree of modification of all nearshore habitats. One must be careful, however, for there are many uses of the term "wetlands", not all of which have been clearly defined or used consistently in the literature. Only recently has the U.S. Fish and Wildlife Service (Cowardin et al., 1979) developed a comprehensive classification of fresh and marine wetlands.

Wetlands of the region were massively destroyed prior to the mid-1900s. As yet unquantified acreages were filled, ditched, drained and otherwise mutilated. Some of the largest scale losses were in New Jersey where, on the eastern coast of the Bayonne Peninsula, extensive landfills were created to provide space for the railroad yards. This activity extended from about 1850 until shortly after the first world war. Some of the landfilling commenced earlier. For example, Near Exchange Place, Jersey City, landfilling commenced as early as 1804 and by 1840 had extended 400 to 500 feet eastward (Kardas and Larrabee, 1979). The Hackensack Meadowlands, to the west of the Peninsula, were severely disrupted by draining and the creation of tide gates as early as the mid-1700s and by regular burning from 1804 onwards to rid the marshes of thieves and pirates (Wright, 1988). In the view of those inventorying New Jersey's wetlands in the mid-1950s, this alteration, from salt marsh to cat-tail marsh, degraded the wildlife value of the Meadowlands -- a view not all would agree with. An estimate of the pre-contact coastal wetlands of New Jersey has not been identified, and so the losses are unquantified. By 1954, 257,260 acres of coastal wetland remained (U.S. Fish and Wildlife Service, 1965C).

Along the Connecticut shore, the coming of the railroad from New York to Boston, from 1850 to 1875, meant that many embayments were cut off from Long Island Sound by causeways, often with deleterious impacts on wetlands. Ditching and draining of salt hay meadows commenced as early as 1904 (State of Connecticut, 1982). Reliable estimates of coastal wetlands in 1914 suggest that over 23,000 acres of what has been estimated as 60,000+ acres of contact era wetlands were existent (Niering, 1961). Of these, 17,000 acres remained in 1954 (U.S. Fish and Wildlife Service, 1965B) and about 17,500 acres remain today.

Long Island was subject to lesser developmental and industrial pressure than either New Jersey or Connecticut, so while the New York Harbor region was losing wetlands to landfill at a galloping pace, Long Island's loss occurred later. Of an estimated 50,000 or more acres of wetland in the past, 34,000 remained in 1954 (U.S. Fish and Wildlife Service, 1965A) and about 25,000 acres today.

The five boroughs of New York City originally had extensive tidal marshes. Indeed, lower Manhattan was almost separated from the rest of the island at high tide by the flooding of the Beekman Marsh on the East River, which was connected to Fresh Pond (later The Collect) and small streams flowing west to the North (Hudson) River (Bolton, 1922). The full acreage of those marshes is not known at this time, nor are most maps adequate for the task of delineating them with accuracy. Some estimates have been made of the disappearance of the tidal marshes. They are summarized in Table 4.

TABLE 4. TIDAL/COASTAL MARSHES OF NEW YORK CITY

	Acreage/Borough					
Date	Manhattan	Brooklyn	Bronx	Queens	Staten Island	Source
1900	<640		27,200			Barlow, 1971
1935			29,000			Flebus, 1935
1940			15,000			City of NY, 1940
1947	NA[b]	1,920	1,510	1,570[a]	9,310	Fenton, 1947
1948			10,000			Aeryns, 1946
1954	NA[b]	1,853	945	2,425	3,198	City of NY, 1958
1969			3,840			Barlow, 1971

[a] Island marshes of Jamaica Bay not included.
[b] Not available.

Data from various sources as indicated. See Bibliography for full reference.

But not all coastal marshes were victims to the housing boom for in the post-war period mosquito control was of great health importance. In 1958 New York City's Planning Department undertook an inventory of marshes and lands underwater at the behest of the City's Department of Health because of concern for mosquitoes and other large insects. The concern did not result from the nuisance of biting insects, but from real concerns over outbreaks of mosquito-borne disease such as malaria and encephalitis. The Department of Health had found spraying "not completely effective" as a control measure and was "interested in the establishment of a plan and of an orderly program for filling in these offending marsh areas" (City of New York, 1954). Of course, as 70% of the marsh and underwater land areas identified were in City ownership and under the control of the Department of Parks, Robert Moses, then Commissioner of Parks, was more than ready to see them filled with rubbish and garbage, topped with dredge spoil and converted to coastal parks (Caro, 1974).

It is also instructive to recall that attitudes toward wetlands, marshes and swamps was quite different prior to the 1960s than at present. Notes from an in-service training course for New York City, Department of Sanitation, workers lauds landfills for eliminating "useless tracts of land...rat-infested, malaria-breeding eyesores for the community" (City of New York, 1940). Such evaluations were not limited to the advocates of landfills (e.g., Squires, 1988).

As the making of new land progressed, diversity of materials used for the landfill increased. While ashes, household refuse and night soil were often disposed of in these operations, more common was the use of rock and soil resulting from land clearing and leveling operations. In this fashion, for example, the entire northern shore of Brooklyn was slowly pushed into the Harbor (Stiles, 1870). With later mechanization, dredge spoil became a popular material for such landfills. For example, most of the Port Newark, Port Elizabeth and Newark Airport landfill was derived from the dredging of Newark Bay. Suszkowski (1978) has noted that the dredging of the Bay and spoiling of its margins has resulted in a Bay of smaller area but approximately same volume of water. Similar developmental patterns may be found in almost all of the industrialized harbors of the region, although to a lesser extent.

Through about 1888, most New York City refuse was dumped into the Harbor. With the termination of this practice by congressional action, other "waste reduction" and disposal practices were sought. From about 1896 until 1917, most City refuse was collected and taken to Barren Island, Jamaica Bay, where garbage (food wastes) was rendered, rubbish was largely recycled and ashes (from home cooking and heating fires), then a major constituent of solid wastes, were disposed of. A major private concern in waste removal was the Brooklyn Ash Removal Company, which operated incinerators and landfills. The operations of this company were ultimately utilized in landfills in Flushing Meadows (eventually the site of a World's Fair and Alley Pond Park. Rikers Island was the Fresh Kills of its day. Refuse, coal and incinerator ash were first dumped on the island in 1895 and by 1938 this 60-acre island had grown to over 400 acres. It was later reduced in size as ash was taken from the Island to the site of LaGuardia Airport and used as fill (Corey, 1989).

Other transportation facilities were the cause of massive landfill projects, often with a mixture of refuse, garbage, construction debris and hydraulic spoil being used for filling. For Newark Airport, filling started in 1913 and ultimately 2200 acres of marsh were obliterated by the 1970s (Port Authority of New York and New Jersey, 1979A); LaGuardia airport is built on 357 acres of landfill, mostly 12 million cubic yards of cinder and ash from Rikers Island dumped on tidal mudflats. An additional 28 acres of marsh and lagoon were later filled with hydraulic spoil (Port Authority of New York and New Jersey, 1979B); and, construction of Kennedy International Airport took 4930 acres of wetlands filled with hydraulic spoil to a depth of 10-15 feet between 1942 and 1979 (Port Authority of New York and New Jersey, 1979C). The Port Authority's major container shipping facility, Port Elizabeth, was built on 1165 acres of wetlands between 1958 and 1962. Over 1100 acres of marsh were bulkheaded and filled to create Port Newark.

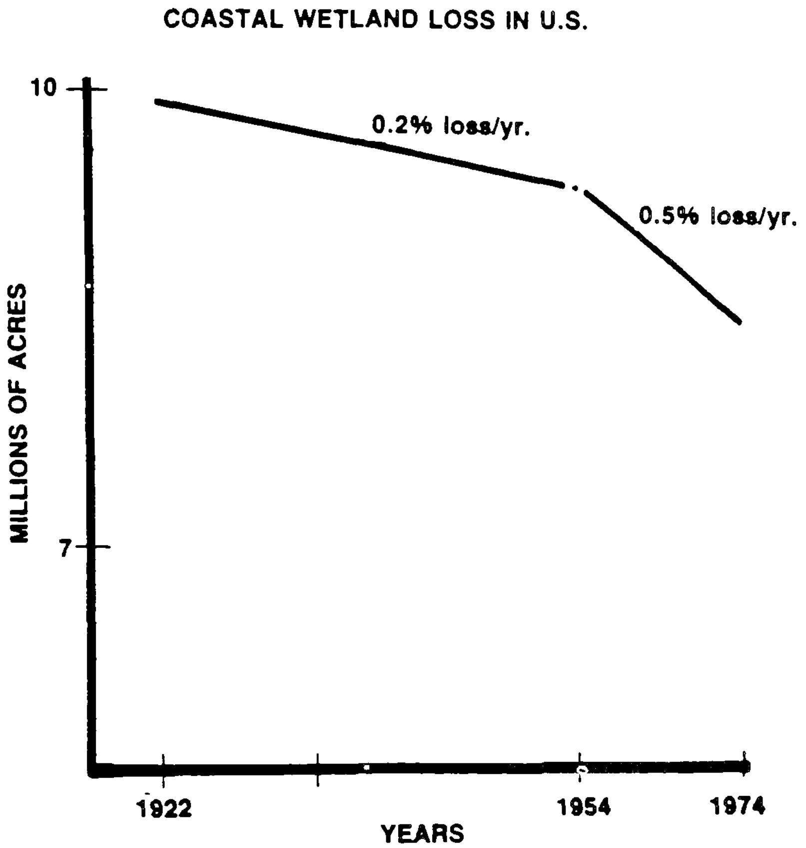
Effectiveness of Control Measures

To determine how effective control measures taken to limit habitat loss have been, we shall first examine the rate of loss of habitats. In the anecdotal material presented, it is apparent that enormous nearshore habitat destruction occurred in the last half of the 19th century and the first quarter of the 20th century. However, the task of quantifying that habitat destruction is only now under way (Squires, in progress). Further, only very few nearshore habitats have been examined in any systematic and quantified fashion -- tidal wetlands being the best example.

To assess the rate of loss of nearshore habitats, we have examined coastal wetlands data from the period between the 1950s and the 1970s. This was a period of rapid loss of coastal wetlands all over the nation (Figure 6). In the late 1960s and early 1970s, States began to take actions to protect wetlands and so provide a baseline from which to measure effectiveness of controls on habitat loss.

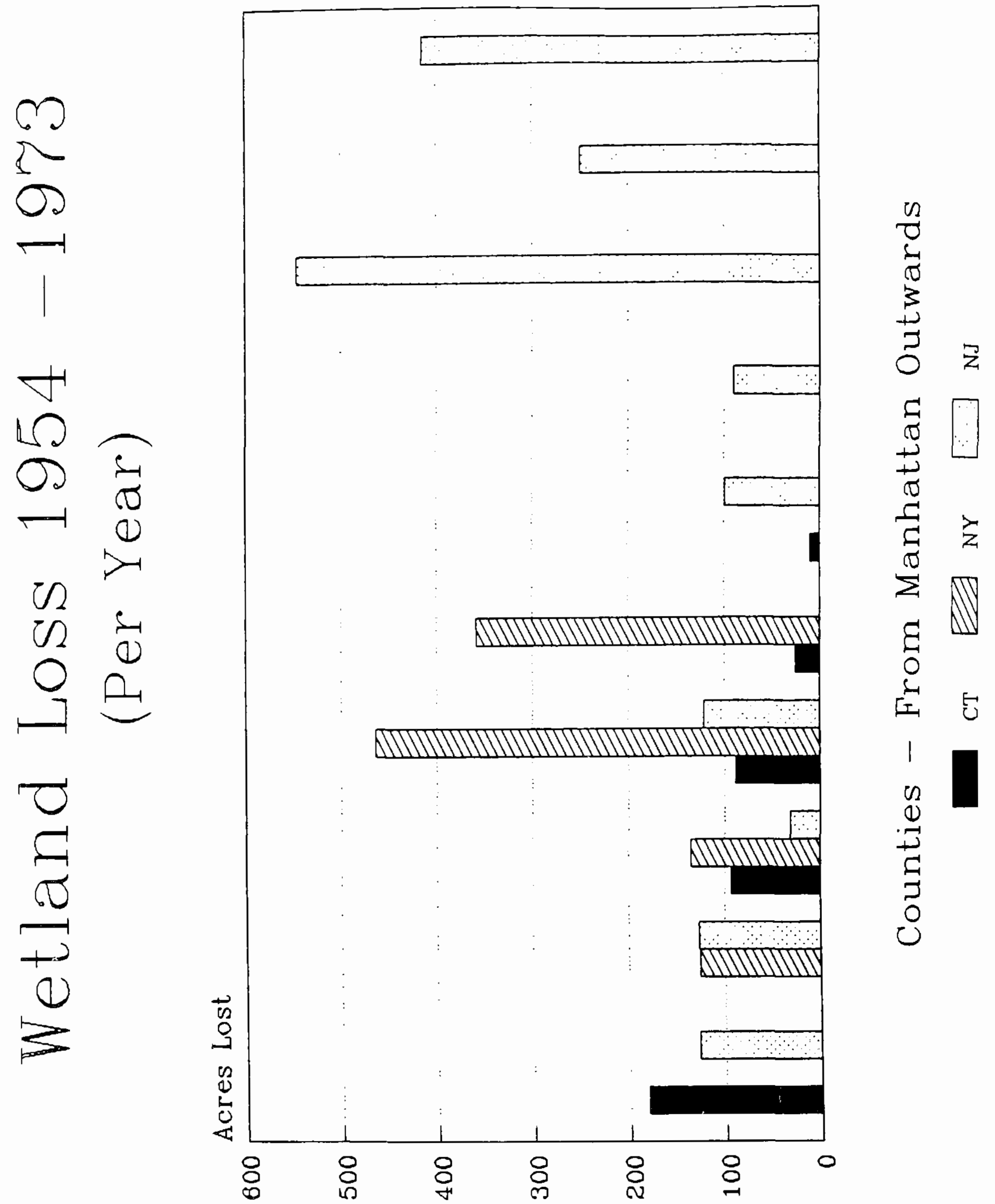
Wetlands began to be inventoried and quantified in the early 1950s, permitting some analysis of the pre-regulation rate of loss. For this study, we used "tidal wetlands" in the fashion of the U.S. Fish and Wildlife Service in its 1960-70 wetlands inventories. Ralph Tiner, U.S. Fish and Wildlife Service (Personal Communication) assures that there is a degree of comparability among the habitats included within that term in the inventories of the several states. Mudflats and other tidally exposed areas as well as open waters seaward of low tide or open fresh coastal waters were not included. We have not found comparable data for these habitats. The data presented in the following tables and figures record what might be popularly termed "tidal marsh areas" (Figures 7 and 8).

What is immediately evident from these data is what we should expect: where population is greatest, the environmental impact, in this instance on tidal wetlands, has been greatest. Tiner (1984) reports that in the lower 48 states, agricultural development is the greatest threat to all wetlands, causing 87% of the loss. Urbanization follows causing 8% of the loss. However, in the most populated areas such as New York and New Jersey, dredge and fill for residential sites is responsible for the major losses. Factors causing loss of wetlands in the decade between 1954 and 1964 have been catalogued (U.S. Fish and Wildlife, 1965A, 1965B, 1965C) and are shown in Table 5. It should be remembered, however, that prior to 1950, agriculture and industrial port development were the primary factors causing wetlands loss.



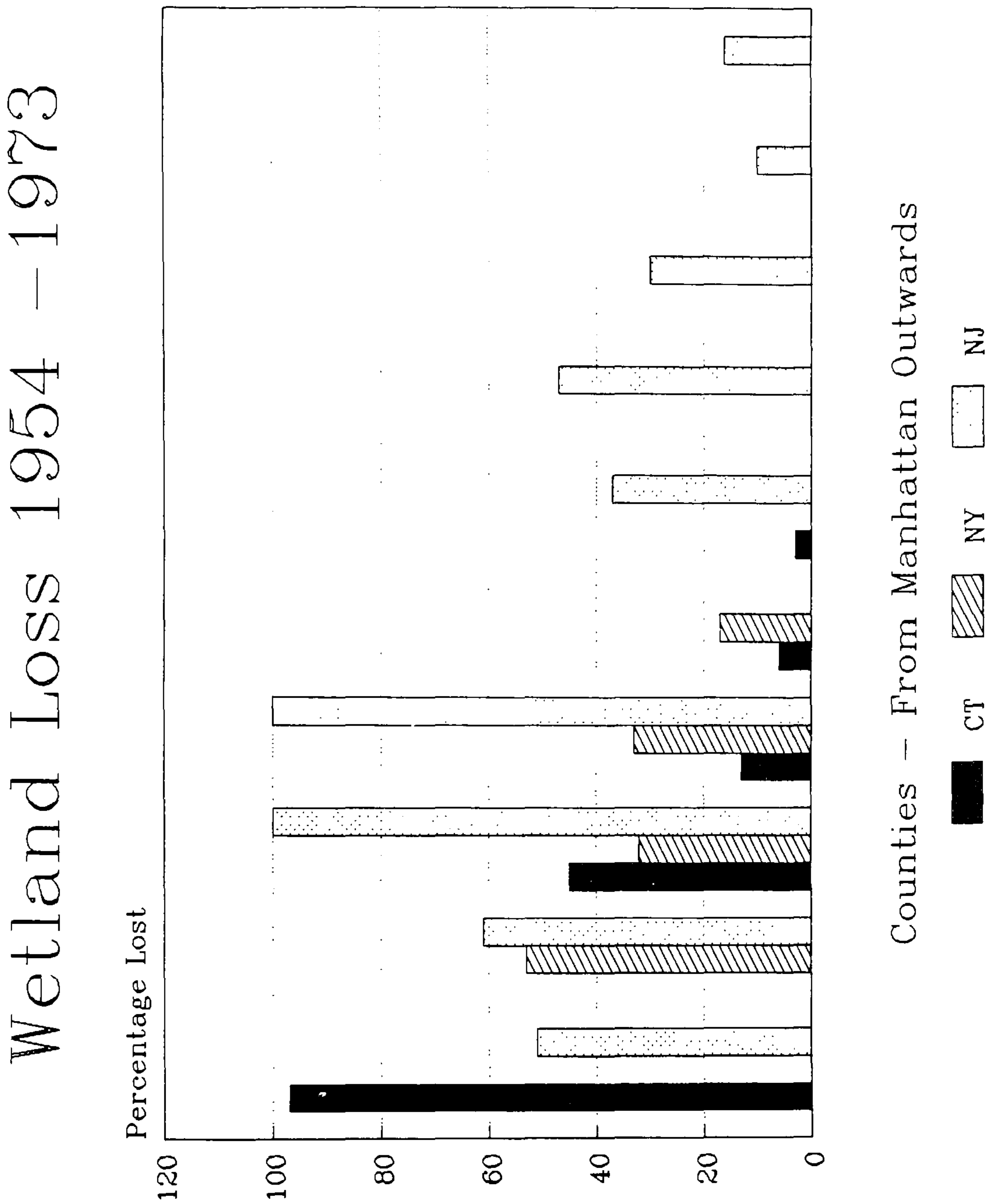
Rate of loss of coastal wetlands between 1922 and 1974 is shown. The estimates of wetlands lost includes both estuarine and tidal wetlands. (From Gosselink and Baumann, 1980; after Tiner, 1984).

Figure 6. Rate of wetlands loss in the coterminous United States.



Wetlands lost, measured in acreage per year in coastal counties of the three radii described in Figure 1, from Manhattan outwards. Wetlands loss is not greatest in the central urban area because of the near total destruction of those wetlands by 1954, but rather is greatest on the periphery. Data from Table 3. Data for Connecticut and New York are for the period 1954-1964. Data for New Jersey are for the period 1953-1973.

Figure 7. Wetlands loss 1954-1973. Acres lost per year.



Data are for coastal counties in the three radii described in Figure 1, from Manhattan outwards. Losses are relatively greater on the furthest periphery where existing wetlands are of the greatest extent.

Figure 8. Wetlands loss 1954-1973. Percentage of existing wetlands lost during the period.

TABLE 5. PERCENT OF WETLANDS LOST IN THE DECADE BETWEEN 1954 AND 1964, LISTED BY CAUSATIVE FACTOR[a]

Connecticut	(%)	New York	(%)	New Jersey	(%)
Misc. fill	48	Housing	34	Misc. fill	38
Waste disposal	14	Misc. fill	20	Housing	29
Bridges/roads	9	Recreation	17	Marinas/docks/ channels	11
Industry	7	Industry	13	Waste disposal	10
Airports	7	Marinas/docks/ channels	6	Bridges/roads	6
Marinas/docks/ channels	6	Airports	4	Industry	4
Housing	5	Bridges/roads	3	S&G mining	1
Recreation	3	Waste disposal	1	Recreation	1
Schools	1	Schools	1		
Agriculture	1				

[a] Data for Connecticut, New Jersey and Long Island are from the U.S. Fish and Wildlife Service Coastal Wetlands Inventory (1965A, 1965B, 1965C).

All tidal wetlands are not the same in their value as habitat. In Connecticut, the compilers noted that those marshes considered as being of high-moderate value (as wildlife habitat) were destroyed at about the same rate as those of low-moderate value but that many of the higher value marshes were degraded by pollution, siltation and intensified use of nearby areas by humans. In New York and New Jersey, loss of high-quality marsh, or its degradation, was exacerbated by siltation, adjacent fill, ditching for mosquito control and other factors. But, in New Jersey, this type of degradation was most noted in the Hackensack Marshes where the 12,000 acres of remaining wetlands have been so altered by ditching, diking and draining "...as to retain little or no value to waterfowl" (U.S. Fish and Wildlife Service, 1965C). In southern New Jersey, the same source reports that 10,000 acres were degraded by diking to permit production of salt meadow hay. Losses in New Jersey tended to be greatest in the low- and negligible value marshes.

Attention has been paid to wetlands loss in the decade from 1954 to 1964 because this period is possibly representative of the peak of wetland destruction in the three-state region. The enormous losses were so disturbing to officials and to environmentalists that all three states enacted coastal wetlands protection laws: Connecticut in 1969; New Jersey in 1970; and New York in 1972. These laws have been effective in slowing the rate of loss.

Tiner (1985) identified 201,000+ acres of salt and brackish marsh and an additional 48,000+ acres of intertidal flats in New Jersey in 1973. These enormous acreages had already been decimated by filling, ditching and placement of tidal gates by the 1900s. New Jersey had been losing marshes at the rate of 3000+ acres per year prior to its protective legislation, but has seen that rate slowed, by one estimate, to 50 acres per year (JACA Corporation, 1982). But those losses are now out on the perimeter, for many of the core counties have lost all but those most highly protected wetlands. Those now suffer from illegal dumping, trespass and abandonment and pollutional degradation.

New York's present coastal wetlands are heavily concentrated on Long Island. Various estimates suggest that 50,000 to 55,000 acres may once have been present, of which about 24,900 acres remain. New York's tidal wetlands regulations are considered by the State's Department of Environmental Conservation to be quite stringent and, according to officials of that Department, have resulted in minimal loss of vegetated underwater lands. However, non-vegetated lands such as tidal flats and shoals have not been protected and have suffered severe loss from dredging. Because of protection and sea level rise, the shoal shores of Long Island may now be gaining new wetlands acreage. In the New York Harbor, extensive wetlands once existed. I know of no estimates of their area. Barlow (1971) suggests that by 1900 less than 600 acres remained on Manhattan and that of the 27,000 acres remaining elsewhere in the five boroughs, most were in Jamaica Bay, The Bronx and southern Staten Island. By 1969, only 3800 acres remained.

It is estimated that Connecticut had, in 1914, over 23,000 acres of tidal wetlands. This has been estimated as less than half of that which had once been present. Today something like 17,500 acres remain. Connecticut's tidal wetlands legislation, unlike that of New York, has the effect of protecting not only vegetated wetlands but also non-vegetated tidal flats and shoals. According to the Connecticut Council on Environmental Quality (1988), loss of coastal wetlands has been in the order of 0.5 acre per year since protective legislation. Officials of the Connecticut Department of Environmental Protection note that under that Department's restoration effort, about 1500 acres of coastal wetland have been restored. At present, it is felt that stormwater discharge into coastal wetlands may, through the introduction of freshwater at critical periods, be destructive of tidal wetlands. Attention is now being given to the location of stormwater drains.

The Urban Shoreline

Large populations of human beings are of considerable threat to the environment. Such populations tend to develop a wholly new environment dominated by humans themselves and their technological creations. Wildlife of many kinds are intolerant of such an environment and avoid it, not only because of habitat destruction or degradation, but also because of the ultimate social and cultural conflict between species. To attempt to "restore" an element of wilderness to the urban environment may seem desirable but more often results in artificialities of zoological and botanical park-like situations in which both human and wildlife roles are defined and partitioned. Yet, nature shows considerable resiliency and where human activity is decreased or absent, wildlife seem to re-establish and habitats to restore themselves. This is seen, for example, in those portions of the inner harbor along the Arthur Kill where extensive petroleum tank "farms" provide extensive areas free from human intrusion. Bird colonies have become established and new wetlands are emerging in these areas.

Perhaps what is required is more attention to the interfacing of human populations and wildlife by constructive land use planning. It is desirable to recognize the gradations which exist between the heavily impacted to lightly touched habitats and to work harder towards the preservation and restoration of the latter.

Certainly, if nothing else, much attention should be given to the reduction of degradation of habitats by illegal rubbish and fill dumping and the persistent stress of toxic pollutants placed into coastal waters. Coastal cities developed with the ideation of the flush toilet. Proximity to the twice daily cleansing of the shoreline by tidal flow was a decided asset for unrestrained population growth in the absence of sewerage and sewage treatment and was delightfully less expensive. The flush toilet was also found to work for all manner of fluids and debris other than human fecal material and was used for such purposes, but as in all good things, was soon overutilized. Consequences of the input to coastal waters of human fecal material may include eutrophication and hypoxia and closure of shellfish grounds and beaches in the interests of public health. Debris and rubbish clog the waterways and drift to distant beaches to annoy shore visitors who wish to leave their own garbage on the beach. Almost 200 years after the first efforts to control this nuisance, we find that amazing progress has been made in the technological artifacts thus disposed of and in the technologies applied to the treatment of that which is disposed of in the coastal ocean.

New York Harbor has experienced what seems to be devastating alterations and habitat destructions -- yet wildlife persist in surprising array and numbers. But this should not suggest that it is feasible, although technically possible, to restore the Harbor to its pre-contact state. Effort should be expended on lessening the loss of all nearshore habitats on the periphery of the city and on reducing the degradational insults to the urban nearshore environment. In the final analysis, humans are social animals and many enjoy clustered living and the social and cultural advantages it brings. It is, in the final analysis, easier to collect and treat concentrations of wastes -- industrial or sewage -- than dispersed wastes. We know that dispersion costs the environment dearly in energy consumption, etc. One must conclude that cities are not inherently environmental enemies, but rather are opportunities to concentrate on limited areas the impact of human populations. Within urban environments we should invent new ways in which to coexist with the biological communities that are willing to tolerate our excesses.

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Preventing Further Degradation of Aquatic Habitat: A Regulatory Perspective

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Destruction and degradation of aquatic habitat is a usual consequence of man's alteration of the environment to suit his own uses. Human actions are often in conflict with the resource needs of the rest of the biota occupying the area and in fact, many activities sacrifice long-term sustainability for short-term gain. Past philosophy has often been that resources are "inexhaustible" and are available for quick gain without examining the long-term impacts on the regional and global environment. This idea, coupled with the fact that the bulk of our population is concentrated along the coastal regions of our country has resulted in the loss or impairment of much our coastal habitat. To think that places like Brooklyn, Manhattan, Newark, and Jersey City were once large wetland expanses is hard to imagine. Only small remnants of the aquatic habitat that once existed still remain. What has come about is an isolation of habitat into small parcels which are of reduced use to fish and wildlife. If we are to preserve remaining natural habitat and restore or enhance areas that have been lost, we must change the development trend.

Unfortunately, existing regulatory programs are not adequate to protect nearshore habitat from the many human activities and influences that negatively affect them. Despite present concern over the loss of habitat, many acres are still being degraded or destroyed. The ironic part of it is that much of the loss is fully within the law. Part of the problem stems from the fact that there are many competing laws, some development-oriented ones focusing on use by humans, and some habitat-oriented ones focusing on the environment. Until the laws are integrated in such a way as to give the environment full consideration, there will continue to be loss of habitat and the fauna that depend on it.

The Coastal Zone Management Act (CZM), is designed to guide the development of nearshore habitat in a controlled manner by allowing activities that are dependent on, or consistent with, being located in the coastal zone. This development can be in the form of constructing shoreline structures such as roads for access to public beaches, bulkheading to maintain slips for marinas, placement of rip-rap to keep shipping channels from eroding, etc. CZM encourages creation of open spaces and preservation areas , but with the idea of promoting public access and recreational use, which then competes with its utility as habitat. So although it appears as though CZM should protect the environment, it actually has the opposite effect. Present Coastal Zone Management is development oriented. It was designed to manage a logical build-out of the coastal zone, not to protect habitat.

Section 10 of the Rivers and Harbors Act, gives the Army Corps of Engineers the power to regulate the maintenance and creation of channels within navigable waterways and the construction of certain structures in waters of the U.S. While a certain amount of these activities are unavoidable in an urban area, and many are not disastrous by themselves, the cumulative impact over time is tremendous. NEPA, the National Environmental Policy Act, states that cumulative impacts should be examined, however, this is rarely carried out to the degree that is necessary.

Section 404 of the Clean Water Act provides for the protection of waters of the United States from the deposition of dredge or fill material. Waters of the United States include wetlands and special aquatic sites such as mudflats, vegetated shallows, spawning and shellfish areas, etc. The 404 program is administered by the Army Corps of Engineers with USEPA oversight. Section 404 also regulates the construction of certain types of shoreline structures considered to be fill but does not generally prohibit modification of the coastal zone and rarely fully considers cumulative or regional impacts of the regulated activities.

It is ironic that most of the wetland losses that the region is experiencing now is not from non-regulated activities, but from permitted activities such as draining or dredging of coastal habitats, ditching and diking of marshes, and modification of upstream headwater areas. Many of these problems stem from the issuance of Nation-Wide Permits and General State-Wide Exemptions for these activities.

A new concern is for the recent proliferation of proposals to construct very large pile-supported structures in tidal and non-tidal waters. These projects are designed to avoid any discharges of "fill" material, and therefore be more likely to receive approval despite potential substantial impacts. Also, with Congressional approval, portions of navigable waterways can be designated non-navigable which removes them from Section 10 jurisdiction, thus removing projects which don't require 404 Authorization from federal review and protection. For instance, portions of the Hudson River by Battery Park and the East River along the Riverwalk Project site have been deregulated in this manner.

When mitigation is used to compensate for wetland loss due to a regulatory action, there is a large degree of uncertainty as to the success of the effort due primarily to inadequate follow-up. This lack of compliance monitoring is a direct result of insufficient resources. In addition, mitigation is rarely considered on a watershed-wide basis. Not only must discrete areas be protected and enhanced, but the future of the surrounding area must be considered as well. If the upland areas deteriorate to the point where the habitat value of the mitigation site is lost or severely diminished, then the whole reason for the mitigation is also lost.

New York and New Jersey have programs for tidal wetlands that are similar to the 404 program. Though there are many overlaps between state and federal jurisdiction, there are inconsistencies between the programs in terms of sizes and types of habitats that are protected. New York's Freshwater Wetlands Program has done much to regulate the destruction of freshwater sites in the state. However, the program generally deals only with sites that are larger than 12.4 acres. Sites smaller than that can be altered without the need for a permit.

It is important to recognize that there are also cyclical and successional phenomenon which of themselves, are natural, but when coupled with over-development, are also destructive. An example is the rise in sea level. Rising sea levels would normally extend existing coastal habitats landward, however where shoreline development has hemmed in the coastal habitats there is no chance for this to happen. Therefore, even those areas which are now protected could eventually be lost to erosion and flooding along with the organisms that depend on them.

Protection of nearshore habitat requires a holistic approach. Regulators can no longer consider just individual parts of the environment, but rather they must consider the habitat as an interconnected system. Destruction of parts of the system, as a rule leads to the degradation of the whole ecosystem. It is important to protect large areas of habitat because small disjunct patches, though ecologically important, often cannot function to their full potential. If the upland areas that drain into the wetlands are degraded to the point that their run-off destroys the site, then the whole effort of saving the wetland in the first place was in vain.

Thus, in assessing the impacts on a habitat as the result of regulatory action, one must go beyond considering only the direct impacts on the project site. It is also necessary to have alternate habitats for organisms in the event that their primary habitat is destroyed or altered in ways that render it unsuitable. A good example are bird breeding areas where discrete breeding islands can be devastated by disease or rat infestation, or get washed away by a storm. If there are no alternate sites in the area, the birds will not be able to breed and will likely abandon the area. Organisms cannot be confined to small niches without having alternate sites available.

In general there is a philosophical approach taken in addressing adverse environmental impacts to habitat associated with proposed projects that places the burden of proof on the regulating program to show harm. This approach puts us in a position of waiting/hoping that our prediction of no significant impact is accurate, thus leaving the environment at risk. The inverse approach would be more protective of the environment by taking a bias in favor of environmental quality. In order to accomplish this, a regulatory policy change would need to be made.

Much can be done to reach this goal of preventing further destruction and degradation of aquatic habitat. A good start would be strict enforcement of existing habitat protection laws. Changing the regulatory definition of "fill" to include pile-supported structures would ensure that the protection of aquatic habitat through the federal process wouldn't be circumvented by an act of Congress. Intact, publicly owned aquatic habitats could be protected and those areas that have been degraded or destroyed could be enhanced in the short-term by cleaning up shorelines, restricting human access, replacing lost vegetation, reducing pollutant inputs, restoring the hydrology, etc. Privately owned lands could also be preserved by obtaining the development rights through a public or private agency such as the Nature Conservancy or the Trust For Public Land.

Long-term prevention of the destruction and degradation of aquatic habitat must start by enlightening decision makers and the general public as to the importance of habitat and modify their attitudes towards preserving it. Ideas and regulations must be supported before they will be accepted and effectively enforced.

More specific measures could include expanding the Coastal Zone Management Program further inland, recognizing the need to take a broader consideration of the entire ecosystem, and to change the focus to one of environmental protection. For instance, the creation of upland buffer zones are necessary around wetlands and other special aquatic sites in order to minimize the degradation of habitat by pollutant run-off and human intrusion.

Mitigation should be rigorously mandated and enforced for any loss or impairment of aquatic habitat that is unavoidable. Gaps in existing regulatory program authorities must be closed so that all activities potentially affecting coastal resources are considered. We need to identify all remaining special aquatic sites in the Bight so that preservation and restoration of habitat can be planned most effectively. Small sites cannot be overlooked.

Other measures that can be taken include setting a goal of increasing the quantity and quality of wetlands and other special aquatic sites, increasing acquisition of wetlands for the purpose of preservation, and requiring all government agencies to provide full compensation for any wetland altered by facilities they build or support.

The no-net-loss policy, if strictly enforced, could go far to protect the remaining wetlands. This policy should be expanded to include all special aquatic sites. However, if this policy is eroded, further habitat loss will certainly occur.

Development must be compatible with the function of the entire ecosystem, not just the immediate site in question, before any balance can be struck. The piece meal, site by site approach to evaluating environmental value has been ecologically disastrous and can no longer be tolerated. Past land use practices have not adequately addressed habitat preservation, thus allowing the destruction of many important habitat areas. If we are to preserve, enhance, and restore habitat as mandated by the Estuary Management Conferences, it will be necessary to thoroughly reexamine and modify present land use and development practices with full consideration being given to the ecosystem.

One method of getting at the problem of unifying regulations, management and enforcement would be to refocus and combine all federal environmental laws into a single Environmental Protection Act, administered by a single Federal environmental protection regulatory agency. A similar Act should be enacted and regulated at the state level. In order to avoid unnecessary duplication, some portions of the federal program could be delegated to the states with the oversight of the federal agency.

The last point I'd like to make is that the prevention of further degradation of aquatic habitat is not solely the responsibility of regulatory agencies. It is the public's responsibility to recognize their role in degrading the environment. People have to understand that the "environment" doesn't start at the boundary of some park or preserve, but it includes their lawn, driveway, and route to work. People have to change their perception that the environment is some precious patch of land protected from the onslaughts of overwhelming development. Rather, it is the entirety of our living space, a portion of which we choose to modify to suit our needs and comfort. That act of modification however, in no way removes that space from the environment, which continues to affect the remaining natural area. It is left up to us to decide which aspect of our environment has the dominant influence on our quality of life.

PREVENTING FURTHER DEGRADATION OF AQUATIC HABITAT: A CITIZEN'S PERSPECTIVE

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Habitat: Freedom and Sound Planning

This citizen's view of habitat is that the locally based protection of the home of the shellfish, the migrating waterbirds, or the spawning grounds of the striped bass means far more than an environmental concern for diversity. It is necessary for preserving our western values of freedom. For if we -- thee and me -- will not take the steps necessary to preserve our precious water supply, to purify our air, and clean up our waterways, some higher power will do it for us in the name of survival -- and may do it badly.

It is, after all, a matter of will, as well as know-how. It is a question of boundaries. Will we continue to move within: the mindsets of the past? the constraints of agency roles and responsibilities? the equally limiting narrow agendas of neighborhood priorities? or have we the vision and the courage to come together across political boundaries, across professional disciplines, beyond the comfortable desire to deal only with facts easily obtained? Will we plan comprehensively and substitute pollution prevention for end-of-the-pipe control? Restoring this ecosystem will take all our combined intelligence and unified dedication.

Odyssey of a Citizen

Let me first share with you the experience that has brought me to this view. I appear before you as a citizen. Except for the fact that I would add activist to that sobriquet, it is a title I use with pride. Apart from the fact that I believe there are many "lay" citizens today far more knowledgeable and thoughtful than many professionally trained scientists, I must also confess that I am an engineer (trained, I am afraid, in an institution not so quick as this one in recognizing the importance of the environment), but capable of assessing technical solutions.

I am also a born and bred New Yorker, encouraged by my family to share any talents or energies I possess "for the greater good." So, I have seen service as an elected Democratic Leader, a Coordinator of Housing & Development and Director of Model Cities for Mayor John Lindsay, and Executive Deputy to Secretary of State Basil Paterson when I was privileged to gain passage for the Coastal Zone Management program. I have also been a proactive member of countless advisory committees on parks and open space (when that was "the environment"), on Sea Grant and Coastal Management, and on Clean Water when Federal guidelines provided the impetus for full public participation. In other words, I have spent forty years working with, meeting with, and being part of the public and public officialdom, seeking to devise palatable decisions for unpleasant problems in a democratic society.

I have watched bureaucrats, both as colleagues and as adversaries, hide behind the limitations of the law or the budget, and fail to take on problems that "were not their job" even if the connections were obvious. I have watched legislators mandate responsibility without resources. I have watched engineers build ever greater structural solutions, confident of success without any evaluation of the consequences, because government provided billions for construction and hardly pennies for research or planning. I have watched citizens defend their backyards with intransigent vehemence, but I have also seen citizens use their collective skills wisely when given a real opportunity to contribute.

The NYC 208 CAC: Citizens at the Cutting Edge

We learned a most extraordinary lesson when we organized the New York City Citizen's Advisory Committee for the 208 planning program. We learned that we citizens were not fettered with the boundaries of the government planners. Our vision was not narrowed to the letter of the law or the restrictions of budget authorizations.

We organized to consider wastewater planning and coastal management together and focused on the water quality of tributaries where the impact on people is greatest. We reached out to other 208 CACs to form a regional coalition. We preached the doctrine of combined sewer overflows before money was made available to treat the problem.

And, we were also tight-fisted visionaries. We were skeptical of the need for secondary treatment if it was more important to capture combined sewer overflows. We called for new institutional arrangements to make the City's water resources program self-financing. Because we learned to be concerned about all media, not just water, we dared to question the wisdom of getting out of the ocean before we found alternatives more suitable than incineration for sludge.

We suggested the experts consider the impact of greenhouse effect, highlighted the need for interstate negotiation on wasteload allocations, and opposed Westway because it was a misplaced infrastructure investment.

In summary, we left a legacy of unfettered lessons which we must continue to apply today:

- Plan for water and shore together -- Clean Water and Coastal Management are two sides of the same coin.

- Plan with attention to cross-media impacts -- the price of excellent water cannot be unacceptable air.

- Think regionally and organize regionally around shared waterbodies -- only the regional scale encompasses sources, fates, and effects.

- Think frugally -- money, too, is ecological and subject to limits.

- Look beyond tomorrow -- in a global greenhouse, the most basic "givens" about water, air, and land may be subject to change.

Breaking Down the Thought Barricades

We must discard old mindsets. We must realize we are all in this together, and it is going to cost us. Not just tax money, but sacrifices in life style. Nothing earth shattering, but the kinds of changes we have all been pursuing in the interests of better health, such as natural food diets, more exercise, no smoking, and more bicycles.

I am not a fanatic, but I am an optimist with a strong belief in what citizens can do if armed with strong intentions and good data. Notice I say good data, for there is nothing worse than the distortions resulting from good intentions and bad data.

First of all, let us appreciate the importance of citizen solidarity in raising environmental concerns to preeminence during the last decade. Using the power of the ballot, the person in the street has escalated environmental issues to the top of the list -- internationally -- so that there does not exist a government that does not mouth the requisite homilies.

Winning the Peace

Okay, so we've won the war. Now let's win the peace. Let's sharpen our agendas and widen our horizons. But let's not lose sight of the problem. The problem is -- the problem has always been -- too many people in the wrong place.

That is not just an environmental problem, but also an economic problem, and one that the entire globe is wrestling with. Not only are we propagating at an excessive rate, destroying our limited resources with unpardonable speed, but we have congregated those populations along the waterways in some of the richest, most sensitive areas of the globe.

We are just beginning to learn how detrimental man has been to his planet.

It has, after all, been a very short interval in which we have concerned ourselves with protecting the environment. And, in that short interval, we have been deadly efficient in inventing more complex ways to poison the Earth, and abominably complacent about delegating the solution for the problem to governments we barely trust and to scientists from whom we expect miracles.

Critical Issues

So, those of us who are privileged to participate in open goal setting for this estuary management planning must examine the carrying capacity of this region, particularly from precious parts of this region, before reaching decisions on environmental impact. The aim of good development, says NEPA, is to achieve consensus on environmental protection and economic growth. We can all salute that. We simply must not forget three important rules.

1. Goal setting is an exercise in mutual compromise. Before we do the evaluation of cost efficiency of proposed solutions, let's also do a risk assessment of whether we are considering the right priority problem

2. Lasting solutions require a comprehensive analysis. Before deciding priorities for the management of the ecosystem, we must consider all of the insults and all the impacts on all of the media (air, land, and water).

3. We need a different concept for managing growth. As our civilization becomes more and more high tech, as our region increases its graduation of functionally illiterate youngsters or continues to discard middle-aged or elderly workers, we need to evaluate whether economic growth must permit population growth, particularly in coastal regions without infrastructure services. We must examine our land use controls and our practices for designating critical areas; we must impose restrictions on the use of public monies to support inappropriate development.

Time To Take Stock

My message, therefore, is relatively easy to state and extremely difficult to achieve. Those of us who have spent our professional and civic lives urging our elected leaders to provide resources for "meaningful research" must now cry, "Better planning! Less waste!"

No more misspent tax levy dollars chasing the "latest" pollutant devil. No more narrow visions constricting assignments to "do-able" tasks. No more pollution control that simply shifts pollution around.

This momentous meeting, recognizing that we are dealing with a total ecosystem, is hosted by a prestigious institution with the foresight to celebrate fifty years of an environmental engineering curriculum. Let's harness all of the know-how in this region and work together constructively to decide what our most pressing problems are, what it will cost to solve them, and do they represent the greatest risk. And let's consult the citizen who will pick up the tab and who must modify his habitat, if not his life style.

This is a convocation of informed citizens; all of you who today are labeled "citizen," are citizens, too, with an equal stake as citizens in this process of constructing a CCMP for the Hudson/Raritan ecosystem.

And, as we come together, unite if you will, to make those critical choices, let us destroy the boundaries which separate our thinking or limit our visions, so that we may continue to enjoy this remarkable habitat which nourishes us.

BALANCING HABITAT PROTECTION AND URBAN GROWTH
A DEVELOPMENT PERSPECTIVE

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INTRODUCTION

The basic question facing regulators today concerning development in the urban environment is whether a balance can be struck between protecting nearshore habitat while allowing for nearshore development. Over the last 50 years, the New York-New Jersey metropolitan area nearshore habitat has, for the most part, been degraded or destroyed as a result of prior industrial and port-development activities. Perhaps the only way that this nearshore habitat can be restored will be as a result of joint participation between citizens of the environmental community, the public sector, and the development community. Furthermore, development adjacent to waterfront areas may, in fact, be a prerequisite and catalyst to fostering habitat protection and enhancement through redevelopment and rehabilitation activities. However, a growing impediment to the private sector's willingness to participate is the ever-changing uncertainty associated with federal, state and local regulatory permitting requirements and the inconsistencies existing between all three.

Within the metropolitan area, there are virtually no areas of undeveloped or uninhabited waterfront lands and, therefore, most nearshore or onshore habitats have been significantly altered. The purpose of this discussion is to highlight the development community's concern and suggested role in balancing habitat protection and urban growth. It is my opinion that restoration of our urban waterfront environment will not be accomplished unless appropriate development takes place.

Among the issues that I would like to address today are current regulations affecting coastal development; conflicts which occur in regulatory review at the various levels; the need for regional planning strategies; and the need for a cooperative effort between various parties in the development process to accomplish the cleanup of the urban waterfront environment by establishing criteria for aiding in consistent regulatory review and decision-making.

CURRENT REGULATIONS AFFECTING COASTAL DEVELOPMENT: A NEW JERSEY CASE STUDY

The area of redevelopment activity that I am most familiar with in the New York metropolitan area is that which is occurring in New Jersey along its urban waterfront areas. The activity is found along the "Gold Coast" of the Hudson River; along the Sandy Hook-Raritan Bay shorelines; and in the previously decaying urban areas of Atlantic City, Asbury Park and the City of Camden. Federal regulation of these developments is found largely in the U.S. Army Corps of Engineers, Section 10 and 404 permitting process; New Jersey State review occurs largely through the permits required as part of the State's Coastal Zone Management Program. Federal review is largely limited to wetland-related activities and those activities waterward of the mean high water line; State review extends to those waterward and upland activities (up to 500 feet upland), but both reviews most times require regional impact analysis well beyond project boundaries.

What follows is a general discussion of this legislation and its evolution into regulatory policy. Section 404 was enacted as part of Public Law 92-500, the Federal Water Pollution Control Act Amendments of 1972 (FWPCA), to control pollution from discharges of dredged or fill material into waters of the United States. Although the Environmental Protection Agency (EPA) is responsible for administration of the Clean Water Act, Congress authorized the Secretary of the Army, acting through the Corps of Engineers, to issue permits under Section 404, since that agency had been regulating dredging and placement of structures in navigable waters under the Rivers and Harbors Act of 1899. However, Congress, in Section 404(b), directed the EPA, in conjunction with the Corps, to develop the environmental standards for the program, known as the Section 404(b)(1) Guidelines. Nothing in Section 404 of the FWPCA delineated the role of the guidelines in the permit review process, but Congress clearly intended that the guidelines should provide environmental criteria by which to judge the suitability of disposal sites. In addition to the guidelines, Congress, under Section 404(c) gave EPA the authority to prohibit, withdraw or restrict the specification of a 404 discharge site. This authority, which is known as a 404(c) "veto," can be used by EPA to present the unacceptable adverse impact of a 404 project. (Kruczynski, 1989)

As the Section 404 Program evolved through Corps Regulations, EPA Guidelines, judicial review, and the passage of the Clean Water Act (CWA) in 1977, the following components of the program were established:

- In 1975, the regulations set forth a presumption that no permits shall be issued unless an applicant can clearly demonstrate that there are no less environmentally damaging, practicable alternatives available for non-water dependent projects.

- In 1977, the definition of "waters of the United States" was expanded to include wetlands. The regulation declared that "wetlands are vital areas that constitute a valuable public resource, the unnecessary alteration or destruction of which should be discouraged as contrary to the public interest."

- A public interest review policy was established within the scope of the 404(b)(1) Guidelines, requiring the Corps to consult with the U.S. Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), Soil Conservation Service (SCS), EPA, and State agencies in reaching a decision on a proposed alteration.

Furthermore, the review process was streamlined into a definable sequence which required that the Corps examine a proposed project in the following order: avoidance, minimization, and compensating mitigation. The 404(b)(1) Guidelines clarify this sequence as: 1) avoiding impacts to waters of the United States through the selection of the least damaging practicable alternative; 2) taking appropriate and practicable steps to minimize impacts; and 3) compensating for unavoidable impacts to the appropriate extent practicable. This sequence has been clarified in a recent Section 404 Memorandum of Agreement (MOA) between the ACOE and EPA. This MOA allows for flexibility with President Bush's goal of "no net loss" of the nation's wetlands by providing for the realization that it is not possible for every permit action to achieve no net loss of wetland values and functions.

Section 10 was enacted in 1889 in response to a Supreme Court decision holding that there was no federal common law prohibition against the obstruction of navigable waters by private parties. (Anderson, 1984) In today's urban development setting, Section 10 is most commonly applied to projects proposing pier rehabilitation and development. Similar to the Section 404 program, Section 10 is administered by the Corps with the participation of the EPA, FWS, and NMFS through a public interest review. Unlike Section 404, the Section 10 process is less involved, focusing mainly on the potential environmental impacts of a proposed project.

As indicated, I am personally most familiar with New Jersey regulations and for purposes of this discussion will limit my comments to just that State. As early as 1914, New Jersey has regulated activities along the waterfront of navigable waters of the State under the Waterfront and Harbors Facilities Act. The original purpose of this law was much the same as that of the Section 10 program. In the late 1970s, New Jersey adopted Coastal Management Policies within its State Administrative Code as required by the Coastal Area Facility Review Act (CAFRA) of 1973 (N.J.S.A. 13:19-1 et seq.). These policies constituted specific rules and guidelines governing coastal, and later all tidal waterfront development activities. These development rules were reviewed federally through an EIS process and deemed consistent with federal policies governing coastal zone management, specifically Section 306 of the Federal Coastal Zone Management Act under the authority of the National Oceanic and Atmospheric Administration (NOAA). Accordingly, the State of New Jersey, through the New Jersey Department of Environmental Protection (NJDEP), has the authority to administer the Federal Act through CAFRA.

It is my opinion that sufficient regulatory authority exists at both the federal and state level to protect the nearshore habitat and to prevent further destruction and degradation of the aquatic environment in both the long term and the short term. It is my considered opinion that a balance can be struck between protecting nearshore habitat and development. In order to accomplish this, consideration must be given to certain issues as identified below.

THE REGULATORY AGENCY REVIEW PROCESS: A QUESTION OF CONSISTENCY

At times, one major area of concern confronting developers of waterfront properties is the duplicity and inconsistency in the regulatory review process. Consistency in the review process is vital if a developer is expected to design a project in conformance with various Federal, State and local policies concerning coastal development.

The State of New Jersey Coastal Zone Management Program provides a basis for a consistent review policy in their Rules on Coastal Resources and Development (N.J.A.C. 7:7E-1.1 et seq.). Here, regional priorities are established and specific sensitive or "special" areas are protected. The rules allow specific, predetermined uses at appropriate coastal locations while providing for the protection of resources in conformance with existing State regulations (i.e., water quality regulations, noise standards, air quality standards, etc.). In attempting to eliminate arbitrary decision-making or unrestrained administrative discretion, N.J.A.C. 7:7E-1.5(b) of New Jersey's Rules on Coastal Resources and Development incorporates the following principle: ". . .the limited flexibility intentionally built into the Coastal Resource and Development Policies provides a mechanism for incorporating professional judgement by DEP officials, as well as recommendations and comments by applicants, public agencies, specific interest groups, corporations, and citizens into the coastal decision-making process." Furthermore, NJDEP review is guided by eight basic coastal policies, which summarize the direction of the specific policies.

The federal review process is more subjective. At times, the process works well. There are numerous instances whereby extremely difficult problems are resolved by negotiations with the appropriate federal agencies, ultimately profiting our environment. However, in other instances, the federal review process seems to lack a coherent, uniform approach for regulating waterfront development projects. The current state of federal regulatory review is founded upon an interpretation of broad-based guidelines which, to the dismay of the developer, can entrap a project in a sometimes subjective whirlpool of criticism from various commenting agencies. This situation is often compounded when "cooperative" agencies lack consensus on coastal policy in advance of a permit application, leaving the developer to gamble on which design approach will lead to the path of least resistance. For example, in the "last resort" mitigation process provided for under the Section 404 review sequence, the Corps usually defers to the FWS to assess mitigation requirements and expects to receive advice from the FWS after the developer's application is submitted and a commitment has been made to a certain plan. If the Corps does not agree with FWS or other commentators, including EPA and NMFS, a prolonged and expensive delay often occurs. (Clark, 1989)

There are times when the "requests for additional information" process commonly encountered in a Section 404 or Section 10 permit application review results in unwarranted delay. After a developer complies with such a request, a review agency may then ask for additional information on an unrelated issue. As the months go by, the developer has no recourse but to start questioning the agency's motives - are they attempting to address legitimate concerns in light of defined criteria or are they seeking to obstruct a project? In many cases, it is clear that the lack of predetermined regionally formulated criteria for regulatory agency review leaves the developer grasping for solutions while his project flounders.

In view of the plight which the development community faces when considering coastal development projects, it appears clear that the current regulatory review process must be re-evaluated. Specifically, it is my opinion that review agencies must begin to focus on regional strategies which respond to such needs as the restoration and enhancement of locally degraded nearshore habitat. All too often, the lack of a consistent review process between the various agencies leads to an over-reliance on the personality of the regulatory reviewer. Project approval relies on qualitative traits as opposed to quantitative criteria. A tendency exists to "drag out" the permit process which, at times, causes developers to withdraw projects.

NEED FOR REGIONAL PLANNING STRATEGIES AND DEVELOPMENT CRITERIA

Regional planning strategies must be developed which define a set of protection and/or restoration goals vital to the survival of a particular ecosystem. These strategies must also establish a set of review criteria which is identifiable at the outset and which must be followed by the reviewing agency. Based on past history, it is obvious that the consequence of uninhibited waterfront development is a reduction or elimination in local habitat value and productivity. However, current regulatory policy fails to associate this local loss with the resultant degradation of the larger aquatic ecosystem due to the dependency of the regional system on local habitat functions.

The management of our nearshore environment must consider the needs and expectations of the larger aquatic ecosystem. This may include the re-establishment of habitats critical to the survival of threatened or endangered species or necessary for the propagation of desirable animal or plant species. Additionally, regional needs for flood or erosion control, pollutant assimilation, storm damage protection or groundwater recharge may depend on our ability to restore locally degraded habitats which are integral parts of the larger ecosystem in which they are a part. Whereas current regulatory policy, which considers the need to mitigate as a last resort, may be appropriate in protecting existing high value habitats in rural areas, alternate policies must be established in urban waterfront revitalization to account for restoration goals set on a regional basis. (Clark, 1989)

Steps at the national level to establish a nationwide planning strategy for development in wetland areas have implications to development along the waterfront in the urban environment, with specific implications to the development of regional planning strategies. As I have previously noted, the Clean Water Act and the Section 404(b)(1) Guidelines require the incorporation of the sequence of: 1) avoiding impacts to waters of the United States (i.e., wetlands) through the selection of the least damaging practicable alternative; 2) taking appropriate and practicable steps to minimize impacts; and 3) compensating for the unavoidable impacts to the appropriate extent practicable. This sequence has been clarified in the recent Section 404 Memorandum of Agreement (Feb. 7, 1990) between the ACOE and EPA. This MOA allows for flexibility with President Bush's goal of no overall net loss of wetlands. This is a clarification of earlier stated goals and in itself does not establish a no net loss policy. The MOA can contribute toward a goal of no overall net loss of the nation's current wetland base but it also realizes that it is not possible for every permit action to achieve a no net loss of wetlands values and functions due to regional considerations.

It would be advisable to develop a similar strategy on a regional level with respect to development along the waterfront in the urban environment. Regulatory agencies currently review each application on a case-by-case basis, often ignoring regional considerations along the way. As an example, if a small pocket of wetlands is encircled by development, it is considered of some habitat value, even if it is completely isolated by the surrounding development. This blind interpretation of the regulations does not consider the true habitat or functional value of the wetland pocket and the effects of the surrounding development.

Development and restoration/mitigation areas should be differentiated based upon regional considerations. A wetland pocket surrounded by paved and other impervious surfaces is of no service to wildlife. The pocket will tend to concentrate the urban runoff that, over time, will seriously degrade this area. Mitigation should be required for such a situation, but the mitigation requirement should be incorporated into a larger regional strategy that would be of greater value (i.e., a long-term restoration project). Efforts should be concentrated on previously disturbed areas of greater potential value rather than attempt to save smaller isolated pockets that offer limited diversity. In the situations where low value wetlands in developed areas can be compensated for a high value system, mitigation should be given greater weight than avoidance and alternative sites.

The case-by-case review process usually does not consider the above and is not always consistent from review process to review process in different districts and between agencies. The MOA's between the federal review agencies and the ACOE create an adversary environment, especially when mitigation is considered. The agencies tend to doubt the success of mitigation projects overall. The fact of the matter is, there has not been an extensive evaluation of these projects to determine their success and how they function. (Shisler, 1989) It is true that some nearshore areas are not ideally suited for habitat restoration, but degraded and dysfunctional habitats that were once highly productive local systems should be highly considered as mitigation sites within the bounds of appropriate environmental strategies. Areas targeted within the scope of a regional planning policy with a high potential for enhancement should not be greeted with skepticism.

In summary, it is my view that the development of regional planning strategies for waterfront development should be a joint effort involving regulatory agencies, the development community, environmental groups, and the public sector, similar to the national effort on the wetlands issue. Proper planning among these groups can lead to the identification of preservation and restoration goals on a site-specific basis, allowing regulatory agencies to review mitigation proposals as they conform to predetermined restoration targets and procedures. This would afford developers the opportunity to enter the regulatory review process with a plan which is already consistent with regional planning criteria.

SUMMARY

It is my considered opinion that a balance between development in the urban environment and protecting the nearshore habitat can be achieved and, in many instances over the last ten years, has been achieved in various waterfront development projects in New Jersey. A primary key in obtaining this balance is to establish a dialogue with the various development, environmental and public sector interests. This dialogue should focus on establishing development criteria which could be put in place so that a developer will be able to plan towards a specific program with some level of certainty.

The use of private funds along with environmental and public sector input will be a strong factor in re-establishing the nearshore habitat. As a matter of fact, it is my opinion that development may be a prerequisite and catalyst which will foster habitat protection and enhancement through redevelopment and rehabilitation activities. The restoration of degraded areas by private funding not only benefits the developer by allowing the project to take place, but also benefits the environment (i.e., restored ecosystem) and the public (i.e., new jobs, new public spaces), in both the short and long term. By denying such practices, the government will eventually have to compensate the developer for the loss of use of his property. The government loses; the developer loses; the environment loses; and, therefore, the public loses. The entire package of potential benefits should be considered as part of the review process.

The federal review is complicated by the various state and local agencies that may have differing goals. The states tend to encourage regional plans for development, preservation and enhancement while the federal agencies appear to follow their own agenda. I want to read for you a quote from Justice Sandra Day O'Connor on how she chooses law clerks. Justice O' Connor said "I am the one who has to make the decisions around here, so I am not concerned or interested in the individual's particular philosophy. However, I don't want to hire someone who has a particular ax to grind in terms of legal structure." Project reviewers at all levels of government should pay attention to the philosophy expressed by Justice O'Connor. Their concerns should be given great weight within the scope of their review, but they should not use the process to comment on anything other than their respective agency's policies and development criteria which should evolve from a dialogue of all interests. A consistent policy must be established and enforced. Only in this way can the ever-changing uncertainty associated with the current regulatory process be overcome.

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WORKSHOP SESSIONS ON THE PRIMARY FACTORS CAUSING USE IMPAIRMENTS AND OTHER ADVERSE ECOSYSTEM IMPACTS

SEAFOOD SAFETY

SEAFOOD SAFETY: A REGULATORY PERSPECTIVE

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BACKGROUND

Any discussion of safety should begin with a definition of "safe" and a reminder that safety is a very personal concept. Webster defines safe as "freed from harm or risk". Although this would on face value translate to zero risk, regulatory agencies recognize that "zero" is very difficult to attain and few scientists would characterize any activity or exposure to a hazardous substance as having zero risk. Scientists are able to measure concentrations of toxic chemicals at ever diminishing levels, and our knowledge of the biological mechanisms underlying such illness as cancer is sufficiently incomplete that regulatory agencies generally must assume that exposure to even very small concentrations of a potential carcinogen carries a finite, though probably very small risk. Such risks are calculated and used when regulatory agencies develop numeric standards, criteria or other guidelines to protect public health.

However, equally important from a regulatory point of view, is society's ambivalence with safety and the very personal concept of "acceptable risk". Regulations by their nature are proscriptive. Speed limits prohibit excessive speed; environmental standards control the discharge of obnoxious or toxic materials to the environment; and food standards prohibit the sale of produce containing pesticides, preservatives, additives, etc. in excess of certain amounts. Someone's behavior is constrained by regulation, his or her freedom is restrained. This restraint is designed to protect others from harm, and in general most of us accept these losses of liberty willingly in the interest of public safety.

Regulation is easiest when the harm is potentially severe and the restriction of individuals relatively benign. However, the regulation of foods is rarely easy. Food standards, including those for seafood, must consider the beneficial qualities of the food as well as the risks of illness. In addition, public policies have generally encouraged keeping a balanced, high-quality diet within the financial reach of every citizen. Thus, the establishment of food standards must consider the effect of the standard on the supply of a food as well as the risk of illness.

Fish and shellfish are an important source of high-quality protein and are low in saturated fats. Fish oils have been reported to lower plasma cholesterol and triglycerides and their consumption has been reported to be associated with lower than normal risks of coronary heart disease. Increasing fish consumption is useful in reducing dietary fat and controlling weight. Finally, many people enjoy fishing and eating their catch. Eating freshly-caught fish and knowing where it was caught can be a benefit in addition to the intangible benefits of the recreational experience.

Shellfish from the bays at the mouth of the Hudson River, the Long Island Sound and the Bight (Harbor-Sound-Bight system), as well as worldwide, have been and continue to be a source of illness from infectious diseases. In addition, some fish and shellfish from these waters have also been found to contain potentially harmful levels of chemical contaminants. This paper summarizes what is known about existing levels of fish and shellfish contamination in the Harbor-Sound-Bight system and how regulatory agencies have responded to this knowledge.

SHELLFISH-BORNE DISEASE

Shellfish (clams and oysters) are filter feeders that feed on very small particles, including bacteria and viruses, in the water. Bacteria and viruses that are present in the water are concentrated in the shellfish intestine and remain viable. Where sewage treatment is inadequate, the bacteria and viruses can include human pathogens. When contaminated shellfish are eaten raw or partially cooked, these pathogens can cause illness.

The Northeast Technical Services Unit of the Food and Drug Administration (FDA) has compiled a list of reported shellfish-borne disease outbreaks (Rippey, 1989). These reports undoubtedly underestimate the actual incidence of shellfish-borne disease, and Rippey notes an estimate (Archer and Kvenberg, 1985) that only 5-10% of cases occurring in the US are actually reported. Since 1900, more than 11,600 cases of shellfish-borne disease have been reported in the United States and Canada. Prior to 1950, typhoid fever was the most commonly reported disease associated with shellfish consumption. In 1924 a typhoid epidemic with 150 deaths reported was traced to contaminated oysters from NY. Typhoid fever was replaced by hepatitis A from 1960-1980. In recent years, reported outbreaks of gastroenteritis of unknown etiology have been increasing. Norwalk virus has been implicated in outbreaks with similar symptoms, and it may be responsible for much of the reported gastroenteritis where no agent was identified. Bacterial agents (a variety of *Vibrio* species including cholera) are still reported for some outbreaks in the United States, particularly in waters of southern United States. *Vibrio* species have not been identified in the Harbor-Sound-Bight system.

TABLE 1. SHELLFISH-ASSOCIATED ILLNESS IN NEW YORK STATE 1980-1989

Year	Number of Outbreaks	Number of Cases
1980	1	2
1981	1	234
1982	110	1043
1983	35	504
1984	19	238
1985	10	134
1986	4	37
1987	2	13
1988	1	2
1989	10	184

Source: Bureau of Community Sanitation and Food Protection, NYSDOH

In the last decade, shellfish-borne diseases reported in New York have generally declined, with the largest number of outbreaks and individuals involved in 1982 and one outbreak affecting two individuals reported in 1988 (Table 1). In 1982, the source of illness was traced most frequently to clams harvested in Rhode Island (NYSDOH, 1983). However, in 1989 the ten outbreaks were associated with consumption of raw or partially cooked clams from Long Island waters (Table 2). In New York, gastroenteritis, probably associated with the Norwalk virus, was the most common illness (Morse *et al*, 1986).

New Jersey, New York, and Connecticut regulate shellfish harvesting through programs that comply with the National Shellfish Sanitation Program developed by the FDA. In general, these programs rely on monitoring water in shellfish harvesting areas for enteric bacteria (*Escherichia coli*) indicative of inadequate sewage treatment. When *E. coli* levels in the water exceed the standards, the area is closed to shellfish harvesting and posted. Recreational or commercial licenses are required to harvest shellfish, and a listing of closed waters is provided to all license holders. Shellfish shippers are required to attach tags to shellfish which they sell, identifying the source waters. Shellfish tags have facilitated identifying the source of contaminated shellfish, but the system does not always make it possible to trace the shellfish source to a particular digger.

TABLE 2. SHELLFISH-ASSOCIATED OUTBREAKS REPORTED TO NEW YORK STATE, 1989

County	Date of Onset	Suspected Agent	Number Ill	Source
Broome	5/07	Norwalk-like virus[a]	36	Long Island Huntington Bay
Cortland	5/08	Norwalk-like virus	11	Long Island Huntington Bay
Erie	5/14	Norwalk-like virus	3	North Carolina Core Sound
Erie	5/15	Norwalk-like virus	59	North Carolina Core Sound
Rockland	5/21	Norwalk-like virus	15	Long Island Huntington/Oyster Bay
Rockland	5/21	NA	NA	Long Island Huntington/Oyster Bay
Westchester	7/10	Norwalk-like virus	15	North Carolina Core Sound
Suffolk	7/21	Norwalk-like virus	12	Long Island Oyster Bay
Nassau	8/02	Norwalk-like virus	2	Long Island Huntington Bay
Monroe	10/12	Norwalk-like virus	31	Long Island Great South Bay

[a]Confirmed case.
NA information incomplete, suspected shellfish-associated outbreak.

Source: Bureau of Community Sanitation and Food Protection, NYSDOH

TABLE 3. FDA STANDARDS FOR CHEMICALS IN FISH AND SHELLFISH

Chemical	Standard	Type of standard
Mercury	1.0 ppm	Action level
DDT	5.0 ppm	Action level
PCBs	2.0 ppm	Tolerance
Chlordane	0.3 ppm	Action level
Dieldrin	0.3 ppm	Action level
Heptachlor	0.3 ppm	Action level
Dioxin	50 ppt	Guideline

Chemical concentrations are as wet weight in edible portions.
Abbreviations: ppm = parts per million; ppt = parts per trillion.

CHEMICAL CONTAMINATION OF FISH AND SHELLFISH

As noted above, the health risks associated with eating shellfish contaminated with pathogens are well-documented. Illness strikes soon after the meal and in most cases its etiology can be determined. This relationship has been understood for at least 100 years.

In Minamata, Japan between 1953 and 1965 severe illness and death from mercury poisoning were traced to fish and shellfish contamination. By the late 1960's fish were discovered throughout the world to contain chemical contaminants such as mercury and DDT. Mercury contamination in swordfish from the North Atlantic led to the proposed federal action level for mercury in fish and shellfish (FDA, 1974) which was modified and finally adopted in 1979 (FDA, 1979). Since 1974, the FDA has adopted action levels or tolerances for a number of chemical contaminants in fish and shellfish (Table 3). Fish in excess of these standards are prohibited in commerce. Although the FDA has not adopted standards for toxic metals in seafood other than mercury, a number of other countries have (Table 4). State health and resource management agencies refer to these standards, to USEPA and World Health Organization guidelines, and their own evaluations of health effects of toxic metals when evaluating contamination in fish and shellfish.

Health Advisories and Fishery Closures

All three states bordering the Harbor-Sound-Bight system monitor fisheries for chemical contaminants and have issued health advisories for those fish that exceed the FDA standards or have sufficiently high metals levels to warrant concern. In addition, polychlorinated biphenyl (PCB) contamination of striped bass contributed to the prohibition of commercial harvest and sale of that species in all three states.

TABLE 4. TOXIC METAL STANDARDS FOR EDIBLE SEAFOODS AND SEAFOOD PRODUCTS

Country	Metal (ppm-wet weight)				
	As	Cd	Cr	Cu	Pb
Australia[a]	1.0,1.5[b]	0.2-5.5		10-70	1.5-5.5
Canada	3.5				0.5
Chile	0.12,1.0	0.5		10	2.0
Ecuador	1.0			10	5.0
Finland	5.0				2.0
Hong Kong	1.4-10	2.0	1.0		6.0
India	1.0			10	5.0
Italy					2.0
Netherlands		0.05-1.0			0.5,2.0
New Zealand	1.0	1.0		30	2.0
Philippines	3.0				0.5
Poland	4.0			10-30	1.0-2.0
Switzerland		0.1			1.0
Thailand	2.0			20	1.0
United Kingdom	1.0			20	2.0-10
Venezuela	0.1	0,0.1		10	2.0
Zambia	3.5-5.0			100	0.5-10
Range					
Minimum	0.1	0	1.0	10	0.5
Maximum	10	5.5	1.0	100	10

[a] Limit varies among states.
[b] Inorganic.
Abbreviations: As = arsenic; Cd = cadmium; Cr = chromium; Cu = copper; Pb = lead; ppm = parts per million.

Source: modified from Tetra Tech, 1986 which was derived from Nauen, 1983.

TABLE 5. PCBS IN STRIPED BASS FROM LONG ISLAND WATERS 1985

Length (mm)	Length (inches)	N[a]	Mean PCBs (ppm-wet wt)
450-510	18-20	12	1.68
510-560	20-22	35	1.69
560-610	22-24	37	2.04
610-660	24-26	94	2.04
660-710	26-28	67	2.46
710-760	28-30	37	3.19
> 760	> 30	73	3.41

Fish collected from Long Island Sound and the South Shore of Long Island.
[a]N = number of fish in sample.
Abbreviations: mm = millimeter; ppm-wet wt = parts per million on a wet weight basis.

Source: unpublished summary by R. Sloan of data from Sloan *et al*, 1986.

TABLE 6. PCBS IN STRIPED BASS FROM LONG ISLAND WATERS 1987

Length (mm)	Length (inches)	Harbor/Western LIS PCB	Harbor/Western LIS N	South Shore/Eastern LIS PCB	South Shore/Eastern LIS N
450-610	18-24	1.64	69	1.25	172
610-840	24-33	2.57	91	1.66	188
> 840	> 33	4.92	91	2.65	183

PCB concentrations are mean parts per million-wet weight for edible portions.
Abbreviations: mm = millimeters; N = number of fish; LIS = Long Island Sound.

Source: calculated from Sloan *et al*, 1988.

Monitoring efforts and a number of special studies to assess chemicals in fish and shellfish from the Harbor-Sound-Bight system provide a general understanding of where the contamination exists. The New Jersey Department of Environmental Protection (NJDEP) has issued a number of reports on chemical contamination of fish and shellfish from this area (Belton *et al*, 1982; Belton *et al* 1983; Belton *et al*, 1985; Eislie, personal communication). The New York Department of Environmental Conservation (NYDEC) has also reported on chemical contamination of marine fish and shellfish (Sloan and Horn, 1985; Sloan *et al*, 1986; Sloan *et al*, 1987; Sloan *et al*, 1988; Bush *et al*, 1989). In 1984-86, the National Oceanic and Atmospheric Administration (NOAA) in cooperation with FDA and the Environmental Protection Agency (EPA) conducted a survey of PCB levels in Atlantic Coast bluefish (NOAA, 1986). In 1985-86, Connecticut and New York evaluated chemical contaminants in several fish and shellfish species as part of the Long Island Sound Study (CTDEP, 1987; Chytalo, 1989).

Striped bass (*Morone saxatilis*)

Soon after the FDA announced that the PCB tolerance would be changed from 5.0 ppm to 2.0 ppm (FDA, 1984), the states moved to evaluate PCB levels in striped bass. By 1986 commercial harvest and sale of this species was prohibited throughout the Harbor-Sound-Bight system as a consequence of resource protection measures to prohibit harvesting small (i.e. young) fish and excessive PCB contamination of larger fish (Table 5). Each of the states warn anglers to limit consumption of striped bass or not eat them at all, depending on where the fish are caught. Women of childbearing age, infants and young children are cautioned to not eat any striped bass. PCB levels in striped bass are highest in the Harbor area and western Long Island Sound and in larger fish (Table 6).

Bluefish (*Pomatomus saltatrix*)

In 1985, PCB levels in bluefish were generally less than the 2.0 ppm tolerance level (Table 7). However, recreational anglers and their families who consume large amounts of bluefish may be at greater risk than consumers of commercially-caught fish. The Bluefish Survey (NOAA, 1987) reported recreational catch statistics for the New York Bight which indicate that recreational anglers caught more than 22 million pounds of bluefish in the New York Bight (Table 8). The report notes that the PCB tolerance adequately protects the average consumer of commercially-caught fish. Such individuals eat "a variety of fish from various locations, most of which contain little or no measurable PCBs." The FDA has advised that PCB intake should not exceed 1 μg/kg/day. If fish are at the tolerance level, an adult would consume this amount of PCB with an average of 30 g fish/day of 8 ounces of fish per week.

Using regional catch rates and household size, the Bluefish Survey (NOAA, 1987) calculated the number of fishing trips that would be required for an angler to catch enough fish that if eaten by his family within a year would exceed the 1 μg/kg/day guideline. For the New York Bight, using average catch rates per trip, as few as four trips on a charter or party boat would provide enough large fish to equal the recommended daily intake guideline. The report recommended that State agencies

TABLE 7. PCBS IN BLUEFISH FROM THE NEW YORK BIGHT 1985

Length (mm)	Length (inches)	N[a]	Mean PCBs (ppm-wet wt)
250-500	10-20	178(66)	0.52
500-760	20-30	577(169)	1.26
760-1000	30-39	523(143)	1.79

[a]N = number of fish analyzed (number of analyses).

Source: unpublished summary by R. Sloan of data from NOAA, 1986.

TABLE 8. RECREATIONAL CATCH OF BLUEFISH IN THE NEW YORK BIGHT, 1985

Month	<300 mm (12 in)		300-500 mm		>500 mm (20 in)		Total Catch	
	lbs[a]	%	lbs[a]	%	lbs[a]	%	lbs	%[b]
May-June	69	1	2616	53	2287	46	4973	22
August	236	4	1125	18	4834	78	6195	28
Oct-Nov	1312	12	1495	13	8348	75	11154	50
Total	1617	7	5236	24	15469	69	22322	

Fish lengths are in millimeters (mm) and inches (in) fork length.
Percent (%) catch is percent by length except as noted.
[a]Catch weights are thousands of pounds (lbs).
[b]Percent (%) of total catch by month.

Source: calculated from Tables 15-17 in NOAA, 1987.

consider issuing advisories to limit consumption of large bluefish (>500 mm or 20 inches). All three states have issued advisories recommending limited consumption (one meal per month) of large bluefish.

American eels (*Anguilla rostrata*)

American eels from the New York Harbor-Raritan Bay area as well as a number of other localized areas along the western Long Island Sound shore exceed the 2.0 ppm tolerance for PCBs. Thus, New York and New Jersey have issued advisories recommending limited consumption of this species. In addition, the commercial harvest and sale of American eels from the Hudson River and Newark Bay Complex in New Jersey and the Hudson River-Harlem River-East River area in New York is prohibited, and no consumption of eels from these areas is recommended.

Lobster (*Homarus americanus*) and blue crab (*Callinectes sapidus*)

Blue crab and lobster concentrate PCBs, cadmium, and dioxin (2,3,7,8-tetrachlorodibenzo-*p*-dioxin) in their hepatopancreas (tomalley). In Long Island Sound, New York samples (n = 80) of hepatopancreas from American lobster average 3.2 ppm PCBs and 6.1 ppm cadmium (Chytalo, 1989), and Connecticut samples (n = 29) average 3.2 ppm PCBs and 8.8 ppm cadmium (CTDEP, 1987). The highest concentrations of PCBs and cadmium in lobster hepatopancreases came from waters off-shore of the Housatonic River (12 ppm PCB and 18 ppm cadmium in a sample of 6 lobsters). New Jersey has documented elevated PCB and dioxin in the hepatopancreases of blue crab and lobster in the Newark Bay Complex, Raritan Bay, and the "Northern Mud Hole", located in the Hudson Canyon about 32 km (20 miles) off-shore (Belton *et al*, 1985).

PCB and cadmium levels were very low in claw and tail meat from blue crab and lobster at all these locations. Thus, the States recommend that the tomalley of lobster and blue crab caught anywhere in the region not be eaten. New Jersey prohibits the commercial harvest or sale of blue crab from the Newark Bay Complex. Lobster are not caught in that area.

Other fish and shellfish

The States have evaluated chemical contaminant levels in other species of commercial or recreational interest. In general, other fish and shellfish have much lower levels of chemical contaminants. New Jersey has measured elevated levels of chromium and lead in soft clams (*Mya arenaria*) in the vicinity of a wastewater discharge off-shore of Port Monmouth and Atlantic Highlands (Eislie, personal communication). In Connecticut, eleven samples of sixteen oysters (*Crassostrea virginica*) had somewhat elevated levels of cadmium, copper, and zinc (1.1 ppm, 49 ppm, and 1030 ppm, respectively) but lower levels than are found in the hepatopancreases of lobster (CTDEP, 1987).

REGULATORY INADEQUACIES AND POSSIBLE SOLUTIONS

Guzewich and Morse (1986) discussed a number of factors contributing to outbreaks of shellfish-borne disease which remain important today:

1. Pollution of coastal waters with human sewage and the consumers desire to eat shellfish raw.

   Many coastal embayments and estuaries are polluted by sewage from treatment plants, septic tank failures and other inadequate treatment of human sewage. This pollution may be chronic or periodic (after storms).

2. Illegal harvest of shellfish from closed waters.

   Enforcement agencies do not have adequate staff to fully police all closed shellfish beds, and the shellfish industry does not admit that illegal harvesting is a problem. The penalties levied on violators are usually inadequate to deter future illegal harvesting, and in some areas diggers are treated as folk heroes.

3. Improper classification of shellfish waters.

   Periodic flushing of pathogens into harvesting areas is more difficult to detect than chronic contamination and may have escaped detection by the monitoring effort. Some beds which are closed after storms may be opened too soon, particularly where viruses are present.

   The absence of coliform bacteria is not necessarily a reliable indication of contamination with viruses. Viruses are not deactivated by sewage treatment and are retained in the shellfish intestine more tenaciously than bacteria.

Several actions should contribute to reducing the incidence of shellfish-borne diseases.

1. Reduce contamination of the shellfishery.

   Improved sewage treatment, particularly of combined sewage overflows and on boats, would reduce the level of contamination, but may not be universally effective. Treatment systems will need to attenuate viruses as well as bacteria to be fully effective.

2. Enhance enforcement and/or impose more severe penalties on violators.

   Overall, the shellfish industry suffers when the consumer loses confidence in the safety of the product. However, in the short-term the individual digger can often derive significant benefit at limited risk by harvesting from illegal beds. Severe penalties and enhanced enforcement increase the risk to the individual digger. The financial costs of implementing this option would not be as great as the social cost of relying more heavily on policing restrictive regulations.

3. Advise the public against consumption of raw or partially cooked shellfish.

This approach will be effective only if people are aware of the advice and believe it. Enhanced reporting of disease incidents and greater public awareness of the risks of eating raw shellfish are needed.

Encourage aquaculture of shellfish in controlled, clean environments.

Shellfish can be cultured in re-circulating seawater. Pathogens and other contaminants can be controlled to produce a high-quality product. However, this recommendation should not be considered as a substitute for continued efforts to reduce contamination of the Harbor-Sound-Bight environment by pathogens and toxic chemicals.

PCBs are by far the most ubiquitous and significant chemical contaminant of fish and shellfish in the Harbor-Sound-Bight system. Major industrial point sources of PCBs to the Hudson and Housatonic Rivers were identified and controlled by the late-1970's (Horn, *et al*, 1979). However, contaminated sediments in these rivers undoubtedly still contribute to PCB contamination of the marine fisheries. And non-point runoff and miscellaneous point sources in the various urban centers in the region cannot be ignored.

Until the 1960's an industrial point source of cadmium existed on the lower Hudson River near Cold Spring, NY. Sediments in the cove north of Constitution Island have been designated a Superfund site. These sediments may be contributing cadmium to the Harbor-Sound-Bight system, but non-point runoff and miscellaneous point sources in the various urban centers in the region are probably more important.

Until environmental discharges of these chemicals are significantly reduced and sediments removed or buried, fish and shellfish will remain contaminated. Health advisories will continue to be necessary. Without the requirement for a fishing license, State agencies may need to consider how to inform anglers about the advisories. In limited areas where dioxin contamination is most severe, New Jersey has posted signs in English and Spanish to warn anglers not to eat fish or crabs from these waters. Such an effort would be more difficult where the advisory is less restrictive, more complex and applicable to waters at some distance from the point of posting. The author also believes that posting should be reserved for areas of contamination where the risks are highest (e.g. shellfish beds potentially contaminated by pathogens and the most extreme levels of chemical contamination.

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SEAFOOD SAFETY: AN INDUSTRY PERSPECTIVE

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Last week at the 1990 Food Policy Conference entitled "Safe and Healthy Eating" held in Washington, DC, the Secretary of Health and Human Services, Dr. Louis Sullivan, reiterated the position often stated by the U.S. Food and Drug Administration in recent months that seafood consumption in the United States is extremely safe, in fact much less likely to cause illness than consumption of meat or poultry. This statement apparently was based on rather in-depth analysis conducted by the FDA in conjunction with Center for Disease Control which included not only reported outbreaks of foodborne illness, but also results of other surveys. In contrast to the statement by one of the top health authorities in the United States, we have all seen rather contradictory charges made by various groups which give the impression that seafood is a very unsafe product. In fact, "Russian roulette" was the way it was characterized by one organization.

The commercial seafood industry is caught in-between these two points of views. We know that seafood in general is very safe. It is one of the best foods for human consumption in that its nutritional characteristics are very beneficial, especially in the maintenance of a low-fat, low-cholesterol diet with its attendant benefits to a healthy cardiovascular system. The industry also recognizes, however, that certain products can carry a risk of illness that is beyond acceptable limits in today's society. I am particularly talking about raw molluscan shellfish which has been harvested from polluted waters, and in extreme cases, products which contain chemical residues that exceed tolerances determined by health authorities. The present regulatory system is intended to keep such products from the marketplace, but the system is in need of improvement.

The Conference organizers have posed a series of questions to the presenters. Some of these I am not qualified to address, especially those that relate to existing levels of toxics in the water, sediment, in the Sound-Harbor-Bight system. Our organization also lacks specific data that would enable us to issue blanket statements regarding level of risk that may exist from consuming fish from this area. But I would like to comment generally on these two points, then devote the bulk of this presentation to a discussion of existing regulatory mechanisms and standards and the changes anticipated that would improve the situation.

TOXINS AND RISK ASSESSMENT

As various analysts have considered levels of toxics in water sediment and their relationship to human health the seafood industry has very often suffered because information reflected the toxins present in whole animals or in edible portions of the animals as opposed to that which may exist in the flesh which would be the normal part consumed. Experience has shown a tendency to throw around numbers reflecting high levels of toxins without pointing out that they do not reflect the level in edible parts of the fish or shellfish. As management measures are considered or information released to the public, it is critical that the numbers be accurate and have a relationship to consumption as opposed to impact on the resource or the ecosystem.

As for the present human health risk from consuming fish and shellfish from the system, one must separate risk into two considerations. The first is the risk of rather immediate illness that can come from eating food, and the other would be impact on health over a longer term. Considering first the immediate risk, it would appear that consumption of a cooked seafood product from U.S. waters including the systems being discussed typically poses little or no risk of illness, a fact supported by the comments of the Secretary of Health and Human Services that I mentioned earlier. On a pound per pound basis, cooked seafood products are among the safest, or the very safest of the animal proteins. Raw shellfish, however, can pose a greater risk with that risk being considerably increased if the product is taken from areas that are closed due to pollution. There are some who would believe that consumption of any raw shellfish is an unacceptable risk. We disagree and maintain that product harvested from waters certified to meet current standards of the National Shellfish Sanitation Program fall within the bounds of acceptable risk for healthy individuals. However, consumption of raw animal proteins is an individual judgmental call which falls in the same category as making a choice to consume any number of foods such as raw eggs, raw milk or steak tartar.

Moving from the risk of immediate illness to long-term impact due to presence of toxins of one kind or another in the flesh of fish and shellfish is a major step. For years, the health authorities have set tolerances or action levels to keep from the marketplace those products which were deemed to pose an unacceptable risk to health over the longer term. It is common knowledge that the methodology to determine these action levels or tolerances is now under significant debate with many suggesting that risk from carcinogens or reproductive toxins has been understated in the past. We are not qualified in toxicology so I will not make a specific comment on appropriate methodology. There are numerous scientists of national repute who argue that overstating risk from chemical presences in the food supply appears to be more likely the case than understating them in that epidimiological evidence does not seem to support any contention that current methods are understating the risk. I have not seen any evidence that would link rates of cancer to consumption of fish and shellfish, but on the contrary, have seen research results which suggest that lower fat diets may reduce cancer incidence.

CURRENT REGULATORY MECHANISMS AND STANDARDS

Regardless of risk, however, the present regulatory system which governs the movement of the fish to the marketplace is not adequate for today's needs and those of the future. It is for that reason that the seafood industry has been working for the past several years to establish a more effective regulatory program which includes some form of mandatory seafood inspection. The work on this system was actually begun in 1985 when the industry asked Congress to direct the National Marine Fisheries Service, which is an agency of the U.S. Department of Commerce, to investigate and design an improved seafood inspection system. Monies were appropriated for this purpose and that agency has been working on this design since 1987.

A preliminary report of the study has now been submitted to Congress which is in the process of considering a number of legislative proposals, which would establish a mandatory seafood inspection program. The industry supports enactment of such legislation and has very specific ideas as to what is needed to provide assurance to the consumers now and in the future that the seafood supply is indeed safe.

In order to provide this assurance, of course, the legislation must address any real problems that may exist and also provide a means of anticipating possible problems in the future. The program envisioned by the industry would contain a number of elements with the centerpiece being a relatively new concept in food safety surveillance called the HACCP system. HACCP stands for Hazard Analysis Critical Control Point concept and it is an approach that calls for monitoring of those points in a process which have the potential for causing a health hazard. The food processor is charged under regulation with maintaining a monitoring system of these control points, and to maintain records which would be available to the inspection authorities to provide assurance that there is a continual monitoring of the operation and that unsafe food did not reach the marketplace.

The HACCP system is presently employed in the low-acid canned food business, but implementing it across an entire industry as diverse as seafood is a rather mammoth undertaking. This explains the lengthy amount of time that has been engaged over the past few years to develop the technicalities of the system itself. The HACCP system by itself will not provide the assurances that are necessary when one is dealing with possible problems resulting from pollution even though it does have the provision for establishing control points to provide greater assurance that product moving into trade has not been harvested from closed areas. It would also provide a means of regularly requiring laboratory analysis of product to assure that the levels of residues are within standards.

But, in addition to these provisions of the HACCP program, however, we would anticipate that a new regulatory system would provide more concentrated attention to such questions as molluscan shellfish regulation and enforcement. It would set the stage for development of additional standards for toxic substance presence in fish products. The current regulations of the Food and Drug Administration do cover a dozen or so chemical residues that have been found in fish and set up action levels or tolerances for them. We would expect that with the onset of a new regulatory program additional substances now being detected in seafood products would become subject to a regulatory level.

As for raw molluscan shellfish production, it would be our wish that greater resources be devoted to this area of the seafood industry, especially in the form of monies for more comprehensive and persistent state monitoring and enforcement activities. In concept, the present regulatory mechanism of monitoring growing waters is realistic, but in various parts of the country the inability to prevent bootlegging from closed areas and the inability to monitor as often or as thoroughly as necessary, has created some questions over the effectiveness of the system. In a new program funding should be provided to correct these deficiencies. In addition, there should be additional federal authority available to make it easier for the federal government to back up states efforts in this area.

Also needed is an infusion of research funding to provide a more sophisticated and accurate method of monitoring growing waters. The industry has been lobbying Congress for such funds and has been successful in getting a project started. The work will be rather involved and long-term, but at least the effort has begun.

One of the new concepts of legislation that is being considered is a program that would regularly monitor fishery resources for toxic substances, providing an early warning system. Should problems be detected, compliance to standards would be built into the HACCP control program or the body of water, or select species from it would be declared off limits. The concept is an extension of the present molluscan shellfish monitoring system in finfish production areas.

The industry believes that the new regulatory inspection legislation will provide new mechanisms and assurances that the seafood supply remains safe for human consumption.

SEAFOOD SAFETY: A SPORT FISHERMAN'S PERSPECTIVE

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- - - PAPER NOT AVAILABLE - - -

TOXICS IN FISH PRODUCTS -- A PRACTICAL ENVIRONMENTAL PERSPECTIVE

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Hudson River Foundation
Long Island Sound Task Force

I am a rational environmentalist who has struggled for the past 25 years on the restoration of both the Hudson River and Long Island Sound. These efforts have been quite successful. I am also an active sportfisherman, clammer, and lobsterman consuming much of what I harvest. I've carefully followed the toxic and pathogenic trends in these species in relation to the perceived and actual effects on humans who consume them. As vice-chairman of the upper Hudson River PCBs reclamation project for more than 14 years, I know a little bit about PCB movement in the Hudson River, New York Bight, and Long Island Sound and their effects, if any, on human beings and fish life throughout the area. The really tragic toxic story is that PCB loadings in the Hudson River, Housatonic River, and New Bedford Harbor are still in place and continue to infect the coastal fisheries, and there are no remedial solutions in sight.

When we talk about toxics in fisheries products that might be detrimental to human health we are looking at the chlorinated hydrocarbons, PCBs, DDT, dieldrin and the heavy concentrate in shellfish flesh. All of the chemical toxics have been steadily decreasing during the past decade as both state and federal pollution control laws have been tightened and the enforcement efforts against polluters have become more efficient and effective. A lot of these toxic chemicals and pesticides have been banned or outlawed by the regulatory agencies. Shellfish poisoning in humans has also decreased because of increased monitoring of shellfish waters and the industry's self-regulated quality program.

There is a lot of madness out there concerning toxics in fish flesh. The leaders in this toxiphobic parade are the large, publicly supported environmental organizations that compete against each other for funds. Doomsday scenarios of toxic poisoning are produced in a steady stream of books, advertising, semi-scientific studies and TV programs by these organizations, each trying to out-doom the other. All of these scare tactics product a snowstorm of donations from a public terrified by sensational news stories, TV bits, and magazine articles that have little basis in reality. To amplify this hysteria is the modern miracle of analytical chemistry, which now allows us to validly test samples down to parts per billion, parts per trillion, and even parts per quadrillion. At these levels, we are no longer talking about chemical substances but molecules of matter. To exacerbate the problems, the public's perception is that parts per billion is more than parts per million because the numbers are larger. I did some back-of-the-envelope scratching one day and came up with the interesting notion that if all the fish flesh consumed in this country during one year contained 1 ppb of PCBs, the total amount, if aggregated, might fill two 5-gallon buckets. The federal government, through its many public health and environmental protection agencies, sets maximum levels for toxics in fish flesh that moves through interstate commerce. The states seem to tag along with these protocols. Extensive sampling and testing show that heavy metals in fish flesh rarely even come close to these conservative federal action levels. Heavy metals rarely dissolve in the water column; rather, they consolidate in the bottom sediments. Even the fate of DDT, banned for almost twenty years, is in the bottom sediments. So, it is the new political pollutant, PCBs, which catches all the action in fish toxics exposes.

The FDA has set a 2-ppm limit on PCBs found in fish flesh, but this is the whole fish -- guts, skin, and all. But we humans tend only to consume boneless fillets, which contain less than a third of the total body burden of PCBs. Where PCBs in fish are a problem, each state has an active public education campaign as well as fish advisories outlining which segment of the populace might be most susceptible along with guidelines for cleaning and cooking suspected species to decrease the levels of PCBs.

The fish flesh toxic alarmists always harp back to the Japanese Yushu incident, where cooking oil and PCBs became mixed and were ingested by hundreds of people. No one died; there were some examples of chloracne and minimal birth defects, but the real culprits were the dibenzofurans in the PCBs. Dibenzofurans are closely allied to dioxin, a known carcinogenic chemical. Yet, none of the aroclors of PCBs produced by Monsato (the only U.S. PCB manufacturer) ever contained any dibenzofurans.

What we have created in the United States is a totally chemophobic society without any understanding of the many chemicals we ingest into our bodies each day through normal food and water consumption. As an example of how far this silliness can go, during the media blitz of "syringes on beaches" that occurred 2 years ago, we received calls from frantic women saying, "My husband just brought home some bluefish he caught. Can I get AIDS from eating bluefish?"

I've been following Bruce Ames, the world-renowned biochemist, during the past years, and I have been fascinated by his flip-flop from a carcinogenic doomsayer into a sponsor of chemical rationality. As such, he has now become the pariah of the environmental rightists. I, too, have come to realize that the plant world, our chief source of food material, has evolved into its present state by turning its waste products into natural pesticides and fungicides that humans consume with minimal or no effects. Indeed, a whole new field of science called "allelopathy," based on naturally occurring insecticides and pesticides produced by plants, is now developing.

There is a great deal of talk these days of human excrement being dumped into inshore waters from boats bypassing their septic holding tanks. The result is that dockside pumpout station facilities are becoming more common, yet -- ironically -- seldom used. As a followup to this -- I don't know of anyone who has tried to do a mass balance study of naturally produced fish feces loadings versus the boaters' human product.

Then there is the whole matter of bottom paints. These paints are loaded with heavy metal biocides to prevent bottom fouling of pleasure boats jammed into marinas, which seldom venture out into the open water. Only Tributyltin (TBT) paint has been banned. Yet all the rest slowly slough off, as they are supposed to do, dumping toxic metals into the water column and bottom sediments, and -- since marinas are in protected areas -- flushing is minimal.

As a matter of interest, after the whole Hudson River PCB problem was exposed more than fifteen years ago and General Electric settled with New York State for four million dollars matched by the state's three million dollars for dredging, we of the PCBs Advisory Committee had funds to do a lot of studies, including extensive epidemiological work. We studied the G.E. workers, who practically walked in excess PCB fluids from transformers and capacitors, as well as their wives. We did pediatrician lead work with pregnant women and lactating mothers along Lake Ontario, as well as extensive blood sampling among individuals who consumed high amounts of fish along Lake Michigan. As would be expected, we did find that the more PCB-laced fish these people consumed, the higher the levels of PCBs in their blood. But as to chronic health effects, we could find none against the common background noise of smoking and drinking.

The groups clamoring about the environment like to base their arguments of total toxic disaster on a methodology called "toxic risk assessment," which is a statistical exercise based on a lot of assumptions and models that have not been truly tested in the real world. The positive metabolic effects of fish consumption are not factored into the equation, nor is the undeniable truth that hundreds of lives have been saved over the decades of PCB use as a dielectric in transformers and capacitors that didn't overheat, catch fire, and burn people to death, as was the case when mineral oils were used.

Although the recent spat of fish consumption scares has put a damper on the economics of sportfishing and of the fish stores closest to the coasts, 10 miles inland, the same fish products are purchased with no hesitation as if they came from a different ocean. There is also the fact that since commercial fishing for striped bass has been banned in the Hudson River since 1976 because of the river's PCB loading, the population of these fish has exploded to an all-time high (even to the point that it is ruining the traditional spring shad-netting fishery, since so may of the forbidden striped bass are clogging the shadman's nets). The excess of striped bass has poured into Long Island Sound to the amazement of local draggers and lobstermen who are finding lively small stripers in their nets and pots this winter, something that has never occurred before.

Heavy metals, PCBs, and PAHs are supposedly the cause of fin rot and skin lesions in finfish, and they could well be. But preliminary testing done by the Connecticut DEP on the microalgae Champia parvula, and sea urchin Arbacia punctulata sperm cell tests done in Bridgeport's Black Rock Harbor, one of the most nefarious toxic-loaded harbors on Long Island Sound, "only indicate some mild toxic effects." Supposedly, the dumping of New York City's sewage sludge at the 106-mile site in the New York Bight was causing the decimation of all aquatic life. But followup cruises by NOAA during the summer of 1989 using submersibles found a thriving ecosystem. Can anyone here tell me why 98% of 2-year-old Hudson River tomcod have gross lesions on their livers but outwardly appear to be strong and healthy? Yet we have been funding studies of this phenomenon through the Hudson River Foundation for years.

Even the penned aquaculture fisheries of salmonoids along the Northeast, Puget Sound, and the Scandinavian countries, once believed to be the sacra sancta answer to the toxic-loaded ocean fishery, are now being attacked as excessive feces producers loaded with viral diseases and prophylactic sulfa drugs, much like our domestic poultry and cattle industries.

There is also the idiocy of past toxic scares that were blown all out of proportion to the true relative dangers, and the eventual reversals of supposed facts that never made the front pages but were hidden in obscure paragraphs. Remember the mercury scare in swordfish a decade ago? Or the recent astounding pronouncement that leaving sequestered asbestos intact in schools and buildings is safer than tearing it out? How about the turnaround from the fuel crisis of the 1970s, where every house and building should be made as air-tight as possible to conserve oil -- now we are plagued with indoor pollutants and radon.

In light of all this -- No, I don't believe we need any more fish testing and toxic regulations at this time. Each state, guided by federal standards, is doing an adequate job of protecting public health in this, the last hunter/gatherer food industry in the United States. Federal inspection of fishes, similar to our domestic beef and poultry inspections, would only create more problems than it would solve. Fish come and go freely, and very few have detectable toxics in them. We should look to other countries that have seafood inspection programs in place to discover what works and what doesn't before starting anything here. After all, scrombroid poisoning is more prevalent in our area than any toxic-caused sickness, yet no one even talks about it. We should stop trying to count the number of toxic angels that can dance on the head of a pin and enjoy eating fish.

As a rational environmentalist who is also an active sportfisherman, I feel that the existing state and federal toxic standards for shellfish and finfish taken out of the New York Bight area and Long Island Sound are adequate. Over the past decade, I have carefully studied the toxic trends in these seafoods as well as the relationship between the perceived and actual effects on humans who consume them. I feel that any human risk is minimal, if indeed there is any health risk at all, since no statistically significant epidemiological study has shown any adverse effects. Connecticut, New Jersey, and New York have extensive sampling and testing procedures in place, fashioned after federal protocols, that continue to show only extremely low levels of environmental toxics and pathogens. Unlike federal beef and poultry inspection practices that deal with captive populations of animals, seafish roam freely. When and if isolated fish are found with higher body burdens of a chemical, these instances are sensationalized all out of proportion to the total universe of fish taken, which scares the public and creates havoc in the whole fishing industry.

WORKSHOP SESSIONS ON THE PRIMARY FACTORS CAUSING USE IMPAIRMENTS AND OTHER ADVERSE ECOSYSTEM IMPACTS

OCEAN DISPOSAL

DREDGED MATERIAL DISPOSAL: A REGULATORY PERSPECTIVE

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and

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To meet the requirements of modern shipping and transportation, the channels, slips and berthing areas of the Port of New York and New Jersey require periodic dredging. Managing the dredging operations and disposal of material dredged from the shipping channels is a major responsibility of the New York District Corps of Engineers.

The Port of New York and New Jersey handles more general and containerized cargo than any other port in the United States. The Port is comprised of 750 miles of waterfront and 2600 acres of marine facilities, supported by 240 miles of federally maintained channels. Since the harbor is not a naturally deep port, the maintenance of ocean commerce within the Port depends upon a regular program of dredging. Annual volumes of material dredged from federal channels and private facilities of the Port between 1970 and 1986 vary widely, ranging from 2.3 million cubic yards (1981) to 19.5 million cubic yards (1971).

Proper management of dredged material disposal activities is necessary to limit adverse impacts on marine biota and ecosystems in the New York Bight. It is the responsibility of the Corps of Engineers, under several authorities, to evaluate and regulate the disposal of dredged material.

WHAT IS DREDGED MATERIAL?

Before addressing regulatory issues, we need to define terms. Dredged material is sediment (mud and sand) that must be moved out of the navigation channels. It is a product of natural erosion and transport of sediment. New York Harbor is an estuary, which is defined as a semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water. Estuaries usually have high sedimentation rates, especially for fine grained material.

Typical sediment from the New York Harbor area is approximately 50-65% water, as compared to typical upland soils which are 30-40% water. Most dredged material is less than 30% sand; it is comprised mainly of silt and clay. It naturally contains trace metals such as copper, iron, mercury and cadmium. Sediment contains contaminants and organic materials to a greater or lesser degree because of human influences. Outfalls, storm drains and spills all contribute to contamination. The result is a naturally occurring, mostly inorganic material, which is influenced by the quality of the water it flows through, and which needs to be relocated in order to provide channels for ships.

It is important to remember that dredged material is not comparable to sewage sludge or chemical wastes which are products of processing a human derived product. Sediment cannot be considered a "waste" product in that sense, since sedimentation is a natural process. Even if there was no population present, there would still be sedimentation in New York Harbor. However, if there was no need for shipping, there would be no dredged material. The desire for a port turns this sediment into dredged material, while people and businesses located at the water's edge can cause contamination of the sediment.

Most of the dredged material from the Port of New York-New Jersey poses no toxic threat to the ecosystem and organisms of the New York Bight. However, since this is a highly urbanized and industrialized area, some 2 to 5% of the material dredged each year may accumulate sufficiently high concentrations of organic or metallic contaminants that they may adversely impact the survival or function of marine organisms that come in direct contact with the sediment.

WHY OCEAN DUMPING?

At this point I would like to dispel a common myth, namely, that ocean disposal is the "cheap solution" to the problem of dredged material disposal. Actually, ocean disposal usually costs between $5 and $12 per cubic yard, depending on the distance that the material needs to be transported. By comparison note that sidecasting, which is commonly done in the Gulf Coast states, costs on the order of $.50 per cubic yard. Since a typical dredging project involves tens or hundreds of thousands of cubic yards of dredged material, the difference in cost amounts to tens of millions of dollars. Ocean disposal of dredged material is not done in order to save money; it is done out of necessity.

In the past, upland disposal was the most common form of disposal in New York Harbor; upland areas, near shore areas and wetlands were routinely filled in. By the late nineteenth century, the population had grown significantly and the limited waterfront property available became very valuable to use in water related or port related activities. This severely limited the number of available upland and near shore sites. At the same time, ships got bigger and needed deeper channels. Passenger liners, oil tankers and containerships need up to 45 foot depths to enter the harbor and New York Harbor is naturally less than 20 feet deep on average. The increased need for dredging, combined with fewer upland disposal sites, resulted in increased use of offshore disposal. Since World War I, approximately 90% of New York Harbor dredged material has been ocean disposed in the general vicinity of the Mud Dump Site which is located 6 miles east of Sandy Hook, New Jersey.

WHAT IS THE REGULATORY PROCESS? HOW IS DREDGED MATERIAL EVALUATED?

The Marine Protection, Research and Sanctuaries Act of 1972, commonly known as the Ocean Dumping Act, is the law that governs all materials proposed for ocean disposal. The law is derived from the international agreement known as the London Dumping Convention which outlines ocean disposal policies for almost 100 signatory nations.

Section 103 of the Ocean Dumping Act specifically covers dredged material. It gives the Secretary of the Army the authority to regulate the transportation of dredged material to ocean waters for the purpose of disposal. The Corps of Engineers is required to use technical guidelines set up by the U.S. Environmental Protection Agency, in consultation with the Corps, in evaluating ocean disposal applications. To the maximum extent practicable, disposal sites designated by USEPA are to be used. The regulations which set up technical and procedural guidelines are contained in the Code of Federal Regulations (40 CFR parts 220-229 and 33 CFR part 324).

There are three important aspects to consider when dredged material is proposed for disposal in the ocean:

a. A need for the particular dredging and disposal project must be demonstrated. This is generally a straightforward analysis, and is usually not controversial for port related activities.

b. All disposal alternatives must be fully explored on a project by project basis when an applicant proposes disposal in the ocean. The Ocean Dumping Act states that all other alternatives are considered available and preferable to ocean disposal, even if they involve a "reasonable incremental cost" above the cost of ocean disposal. This incremental cost has never been defined precisely. An exception to the rule that the ocean is the alternative of last resort is any situation where the alternative can be shown to damage the environment more than ocean disposal would.

In addition to project by project analyses, the Corps has evaluated in depth several regional alternatives to ocean disposal. They will be discussed in greater detail in Section IV of this paper.

c. Dredged material being considered for disposal cannot cause unacceptable ecological impacts to the ocean environment. These impacts are measured through the EPA/Corps rigorous testing program.

Since the Ocean Disposal Act and accompanying regulations stress the ecological aspects of ocean disposal, the EPA/Corps testing guidelines reflect this by emphasizing biological testing. The testing program utilizes evaluative techniques such as bioassays and bioaccumulation testing, which provide relatively direct estimates of the potential for unacceptable environmental impact. It should be emphasized that testing prior to ocean disposal is very stringent, more so than for either disposal on land or in an estuary. Recent proposed revisions could make the testing requirements even more stringent. These changes have been incorporated into the national testing guidance manual ("Green Manual") for ocean disposal of dredged material which has been released for public comment. Changes include lengthening the time required for bioaccumulation tests from 10 to 28 days for organic compounds, and encouraging the use of a tiered or hierarchical approach to testing and evaluation.

Unfortunately, there is a public perception that the dredged material testing program is too lax. This frequent criticism is based upon reading of the Public Notices in which it appears obvious that "everything passes." There is a simple explanation for this misconception: the Corps does not publish Public Notices proposing ocean disposal in those limited cases when the criteria is not met. Therefore the public does not see the testing problems, or the projects with a questionable need: these have all been eliminated. Either the project was modified to comply with the regulations, another disposal alternative was sought, or the project was withdrawn.

When a project satisfies all three aspects of ocean disposal criteria, the Corps is still required to minimize possible adverse impacts to the environment. This is done through continuous monitoring and management of the disposal site during and after disposal. The management goal for dredged material disposal in the New York Bight is to locate a site where currents or waves will not disperse the sediment. Then, through the use of pinpoint dumping, disposal effects are limited to the smallest possible area of the bottom. Finally, the site is bathymetrically and biologically surveyed to ensure that this has been controlled. The management goal for other materials that are disposed in the ocean, such as sewage sludge, is to allow the material to disperse and dilute in the ocean. Dredged material is one of the few types of material that are kept contained. The Corps performs this management and monitoring, in coordination with USEPA.

WHAT ABOUT ALTERNATIVES TO THE OCEAN?

In 1978, the National Wildlife Federation and the Environmental Defense Fund filed a lawsuit contending that the Corps of Engineers failed to comply with ocean dumping requirements. A 1980 decision upheld one of their charges, that in addition to considering alternatives for individual ocean dumping projects separately, the Corps had a responsibility to evaluate possible regional alternatives to ocean disposal. In accordance with the findings of the Court, the Corps issued a comprehensive programmatic Environmental Impact Statement in 1983, and began to systematically study possible alternatives under the Dredged Material Disposal Management Program.

On the basis of years of study and site selection screening, many alternatives have been considered. The study concludes that:

a. There is no single alternative or combination of alternatives that could replace ocean disposal for more than a few years. The volumes are too huge and disposal space is too limited.

b. However, ocean disposal can be managed in an environmentally responsible way through disposal management techniques such as capping, which have already been implemented, and which minimize the impacts of ocean dumping significantly. Material that contains low levels of pollutants, but does not pose an environmental threat, is disposed in the ocean and covered with a thick cap of clean dredged material which has been shown to effectively protect the marine environment.

c. The most necessary alternatives to ocean disposal are those that could receive contaminated dredged material which is not disposed of in the ocean because it is considered too polluted. This material is suitable for disposal in confined facilities. Confined facilities could also receive dredged material that is currently capped in the ocean, if it is considered more desirable to place the dredged material there.

d. There are two promising alternatives for contaminated dredged material that are being considered. Borrow pits are underwater pits left from previous sand mining operations. Dredged material could be disposed in either existing or newly constructed borrow pits, since extensive studies have shown that this is feasible. This alternative could be implemented relatively quickly with limited additional expense. A longer term alternative would be the creation of a large containment island similar to ones used in Baltimore and Norfolk. An island could give as much as 50 years of disposal capacity, if reserved for dredged material that is not suitable or marginally suitable for ocean disposal.

e. Other alternatives can be implemented in special cases. For example, the New York City Department of Sanitation is currently using dredged material as sanitary landfill cover at their Fresh Kills Landfill. Beneficial uses of dredged sand such as beach nourishment and construction materials are also being done. In addition, wetlands creation with clean material could be a promising alternative, if funds are available.

These points are discussed in detail in a recently published technical summary report conducted by New York University's Institute of Environmental Medicine entitled "Managing Dredged Material." The report is an evaluation of disposal alternatives for dredged material in the New York and New Jersey metropolitan regions. The utility of individual alternatives was evaluated based upon the quality of the sediments, the quantity of the sediments, and the practicality of implementing any given disposal option. Regarding quality, some alternatives are only feasible for clean dredged material, while contaminated material may be disposed utilizing other alternatives. Regarding quantity, large volumes of dredged material require large-capacity disposal options. For example, only the ocean is capable of handling the entire volume of clean material. Finally, the environmental, engineering and economic aspects of individual options will affect which are ultimately chosen for implementation.

RESPONSES OF HABITATS AND BIOTA OF THE INNER NEW YORK BIGHT TO ABATEMENT OF SEWAGE SLUDGE DUMPING - PROGRESS REPORT

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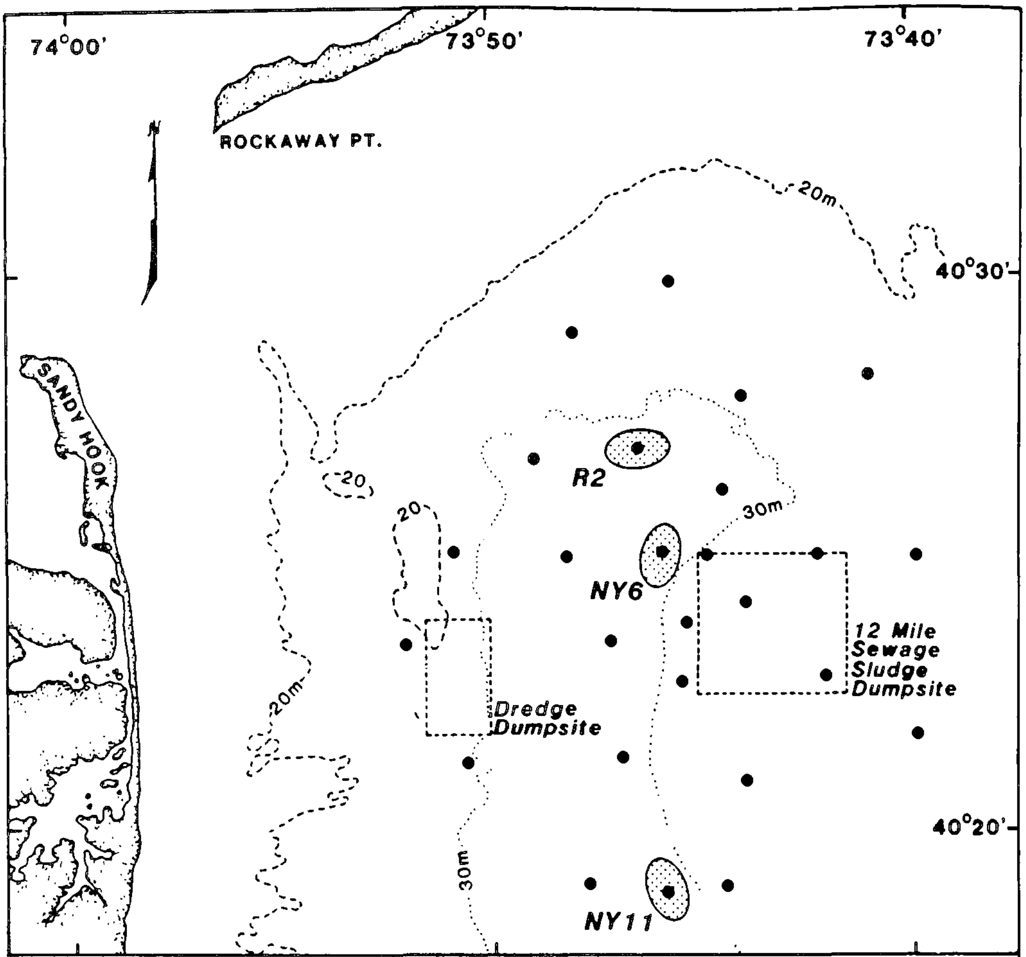
INTRODUCTION

From 1924 through 1987, sewage sludge was dumped at a site 22.2 km (12 nautical miles) off Sandy Hook in the inner New York Bight (Fig. 1). No records of amounts dumped were kept before 1960. More recently, there was a general increase in dumping amounts, to a maximum of 7.6 million metric tons (8.3 million wet tons) in 1983. Inputs in the early 1980s were at the time the largest ever to any oceanic sludge dumpsite (Norton and Champ, 1989). However, the New York City Department of Environmental Protection (1983) stated that recent increases in sludge volume had been due mostly to increased water content, that sludge solids dumped increased only 5% from 1973 to 1981, and that the mass loadings of most sludge contaminants decreased over that period. A comparison of 1973 and 1987 sludge loadings (HydroQual, Inc., 1988) indicated decreases, some quite large, in loadings of sludge solids, biochemical oxygen demand and heavy metals, although nutrient inputs increased; for organic contaminants, no 1973 data were available for comparison.

The sewage sludge dumpsite is in 23.8 - 25.3 m (78 - 83 ft) water depths. Sediments in the dumpsite are sandy and are scoured by storms. During dumping, dumpsite sediments contained somewhat elevated concentrations of carbon and contaminants, but there was no long-term buildup of sludge materials at the site (Norton and Champ, 1989). Contaminant accumulation and effects were most apparent in the deeper waters (30 - 40 m) (98 - 131 ft) of the Christiaensen Basin to the west, especially just west of the dumpsite's northwest corner (where most dumping had been)



	1986		1987-1988				1989		
	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS
Replicate (ringed ●)	x x x	x	x x	x	x x x	x	x x	x	x x x
Broadscale ●	x	x x	x	x x	x	x x	x	x x	x
Seabed metabolism	x x	x x x	x x x	x x x	x x x	x x x	x x x	x x x	x x x
Hydrographic surveys (with EPA)				x				x	
Seabed and water column rates, hydrographic surveys with EPA, NJ DEP, and others					x				x

Figure 1. Sampling locations and schedules.

(Environmental Processes Division, Northeast Fisheries Center [hereafter EPD], 1988). It was, in general, not possible to distinguish completely the fates and effects of sewage sludge from those of other inputs (sludge ranked only third behind dredged material disposal and the Hudson-Raritan outflow as a source of most contaminants to the inner Bight) (Stanford and Young, 1988). Some impacts wholly or partly attributed to sewage sludge were:

1. Accumulation of heavy metals and toxic organic compounds in bottom sediments and in organisms, including resource species (Reid et al., 1987);
2. Introduction of viral, bacterial, fungal and protozoan pathogens and pathogen indicators into the inner Bight (Cabelli and Pederson, 1982; Robohm et al., 1979; Sawyer, 1980);
3. Development of bacterial strains resistant to toxic metals and antibiotics (Timoney and Port, 1982);
4. Closure of shellfish beds due to elevated levels of microbial indicators of pathogens (Stanford et al., 1981);
5. Elevated rates of seabed oxygen consumption, and lowered sediment oxidation-reduction potentials (EPD, 1989);
6. Reduced bottom dissolved oxygen levels (Segar and Berberian, 1976);
7. Bottom macro-invertebrate community severely altered over approximately 10 - 15 km^2 (3.9 - 5.8 mi^2) to the west of the sludge dumpsite, and total macroinvertebrate biomass elevated and crustacean populations (especially the pericarids) reduced over most of the Christiaensen Basin and upper Hudson Shelf Valley (Boesch, 1982; Steimle et al., 1982);
8. Increased incidences of fin rot in bottom fish (Murchelano and Ziskowski, 1976), and "black gill" and shell disease in crabs and lobsters (Sawyer, 1982);
9. Reduced catches of fishes (Waste Management Institute, State University of New York at Stony Brook, 1989) and lobsters, in part due to fishermen avoiding areas where trawls and pots would be fouled by sewage sludge; and
10. Reduced demand for fish and shellfish from the Bight (Waste Management Institute, 1989).

The phaseout of sludge disposal in the inner Bight between March 1986 and December 1987 provided an opportunity, by studying responses of habitats and biota, to clarify past fates and effects of the sludge. Findings of the study will increase understanding of effects of ocean dumping, and will add to the limited information available on recovery of former dumpsites.

METHODS

Sampling consisted of two complementary surveys, conducted in alternate months except in August when both were conducted to focus on the stressful conditions (e. g., high temperature, low dissolved oxygen) likely at that time. On "replicate" surveys, eight samples were taken for each of numerous variables at three stations at similar depths and for which historical data exist, but with different levels of presumed sludge accumulation and effects (EPD, 1988). Station NY6 was located approximately 1.6 km (0.9 nautical mile) west of the dumpsite's northwest corner (Fig. 1); NY6 was thought to be the area of greatest sludge accumulation and effects. Station R2 (Fig. 1) was about 3.4 km (1.8 n. mi.) north of NY6, with a benthic community that is not highly altered but has elevated biomass, presumably due to carbon inputs from sludge and other sources. Station NY11 (Fig. 1) was 11.3 km (6.1 n. mi.) south of NY6 on the eastern shoulder of the Hudson Shelf Valley, and is considered the least polluted of the three sites. At each replicate station, three samples of all variables were taken at a central point and another five samples were taken at the edges of an ellipse about the central point.

On "broadscale" surveys, single samples were taken for slightly fewer variables at 25 stations covering most of the inner Bight and including all major habitat types. All station locations and sampling schedules are shown in Fig. 1. Variables sampled in each survey are listed in Table 1, which also indicates sampling done independently of the replicate and broadscale surveys.

Bottom water samples were taken using Niskin bottles. Dissolved oxygen was determined by Winkler titration. Smith-McIntyre grabs were used for sampling sediments and benthos. Sediment redox potentials were measured by inserting a platinum electrode in the grab, for comparison with a reference electrode. Samples for sediment metals were taken from the grabs with plastic coring tubes, and were analysed by flame atomic absorption after an aqua regia leach. After subsampling the grabs, remaining sediments were rinsed through 0.5 mm mesh sieves for analysis of benthic macrofauna communities. Fish, crabs and lobsters were collected with 15 - minute tows of an otter trawl having an 11.0 m (36 ft) footrope and 9.8 m (32 ft) headrope, with 51 mm (2 inch) mesh net in the cod end and 76 mm (3 inch) mesh elsewhere. Pots were used to supplement lobster catches. Seabed oxygen consumption was surveyed on separate monthly cruises, by deploying a Pamatmat multiple corer and measuring rates of consumption in cores incubated at ambient temperature. A special survey of fecal coliform bacteria in bottom waters of the inner Bight was made by the U.S. Food and Drug Administration (FDA) in October 1989; samples were taken from the bottom water overlying the sediments in the grab sampler, and coliform counts were determined using the five-tube MPN (most probable number) technique.

Detailed discussions of station characteristics, methods and rationales are given in a Plan for Study (EPD, 1988).

RESULTS AND DISCUSSION

OBSERVATIONS REPORTED BELOW ARE PRELIMINARY, AND MAY CHANGE WITH FURTHER DATA ANALYSIS. See EPD (1989) for more complete descriptions of data through mid-1988. EPD intends to issue final data reports for each discipline beginning in late 1990, with an overall final report scheduled for 1991.

Table 1. Variables measured during the 12-mile dumpsite study

Habitat		Biota
Water	**Sediments**	
Bottom Water	Chemistry	Resource species
Dissolved oxygen (R,B)[1]	Heavy metals (R,B)	Distribution/abundance (R,B)
Temperature (R,B)	Organic contaminants (R,B)	Diet (R)
Salinity (R,B)	Sulfide, pH profiles (R)	Winter flounder
pH (R,B)	Redox potential (R,B)	Red hake
Sulfide (R,B)	Sediment BOD (R)	Silver hake
Nutrients (R,B)	Chlorophyll pigments (R,B)	Lobster
Turbidity (R,B)	Total organic carbon (R,B)	Gross pathology (R)
		Winter flounder
Water Column	Characteristics	Lobster
Temperature	Grain size (R,B)	Tissue organics (R)
Salinity (CTD)	Erodibility	Winter flounder
Oxygen		Lobster
Current measurements	Rates	Migration (tagging) (B)
(moored meters)	Seabed oxygen consumption	Winter flounder
	Sedimentation	Lobster
		Benthos
		Macrofauna abundance/diversity (R,B)
		Meiofauna abundance/diversity (R,B)
		Bacteria - sediments
		Fecal and total coliform (R)
		C. perfringens (R)
		Vibrio spp. (R)
		Total count (R)
		Bacteria - shellfish

[1]R = Replicate survey
B = Broadscale survey

Sediment Heavy Metals

Metal concentrations in the top 1 cm of sediments at NY6 in 1936 and 1987 appear to have remained at levels similar to those found during peak dumping in the early 1980s (see Fig. 2 for concentrations of Zn at the three replicate stations; patterns for Cr, Ni, Pb and Cu were similar). With cessation of dumping, levels in the top 1 cm appear to have dropped toward those found 5 cm deep in NY6 sediments. The values at 5 cm depths were similar to those elsewhere in the Christiaensen Basin, e. g., at R2 (Fig. 2) (EPD, 1989). Analysis of during- vs. post-dumping data for all seasons will be required to confirm these trends.

Seabed Oxygen Consumption (SOC)

SOC, which is related to organic loading of the sediments, had been elevated at and near the dumpsite while dumping was ongoing. SOC rates declined rapidly toward background with phaseout (EPD, 1989). Fig. 3 shows annual rates at a six-station transect across the top of the dumpsite and extending to the east and west. Statistical significance of any trends in these annual rates has not yet been tested. Station 30, 2.0 km (1.1 n. mi.) east of the dumpsite, had always had values typical of relatively clean Bight sands, and rates did not change with cessation of dumping. Station 31 was in the northeast corner of the dumpsite, where only Nassau County (NY) had dumped, and only through June 1986. There the annual average SOC rate dropped appreciably from 1985 to 1986 and then had only a slight further decrease through summer 1988. Most dumping had been in the site's northwest corner (Station 32), where rates dropped precipitously after phaseout began and leveled off to background rates as dumping ceased. Just west of the dumpsite in the eastern Christiaensen Basin (Station 33, = NY6), rates apparently responded to the initial reduction in dumping with a 20% lower annual average SOC in 1986 versus 1985, and then decreased again to background levels as dumping ceased. Station 34, in the center of the Basin, probably received organic materials with a smaller, less labile sewage sludge component and proportionally more refractory material from the estuary; this may explain why little or no change in SOC rates was seen at 34. Station 35 was just northeast of the dredged material dumpsite, and the drop in rates between 1985 and 1986 may be related to a 75% decrease in dredged material disposal over that period.

Sediment Redox Potential

Sediment oxidation-reduction or redox potential is also influenced by organic inputs. Areas of sludge accumulation (e. g., NY6 in Fig. 4) had been characterized by reducing sediments (low redox potentials). Potentials at NY6 have generally increased since the beginning of the phaseout, and the amplitude of seasonal redox cycles has diminished. There appears to be a convergence of values between NY6, R2 and NY11 (EPD, 1989).

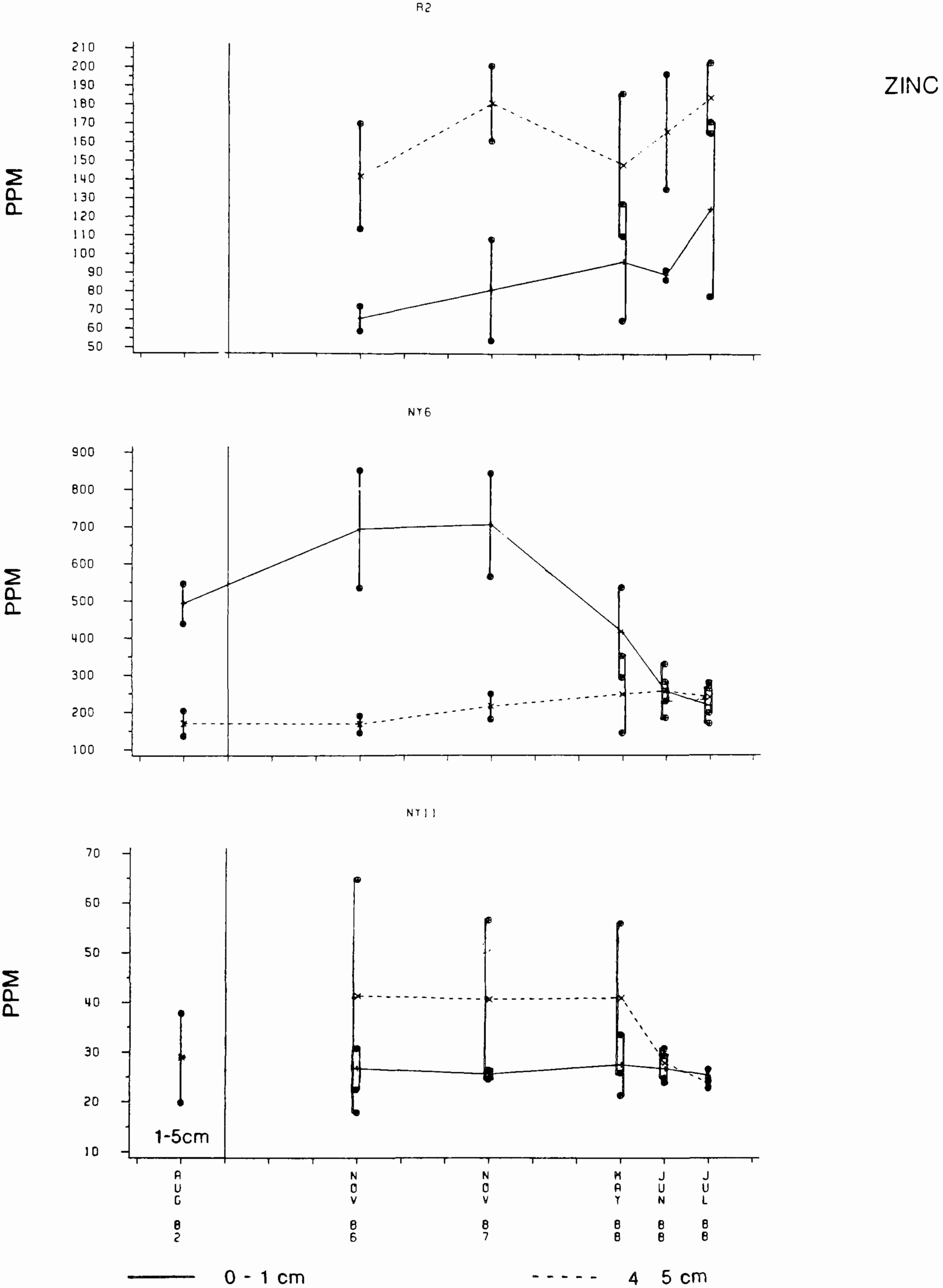
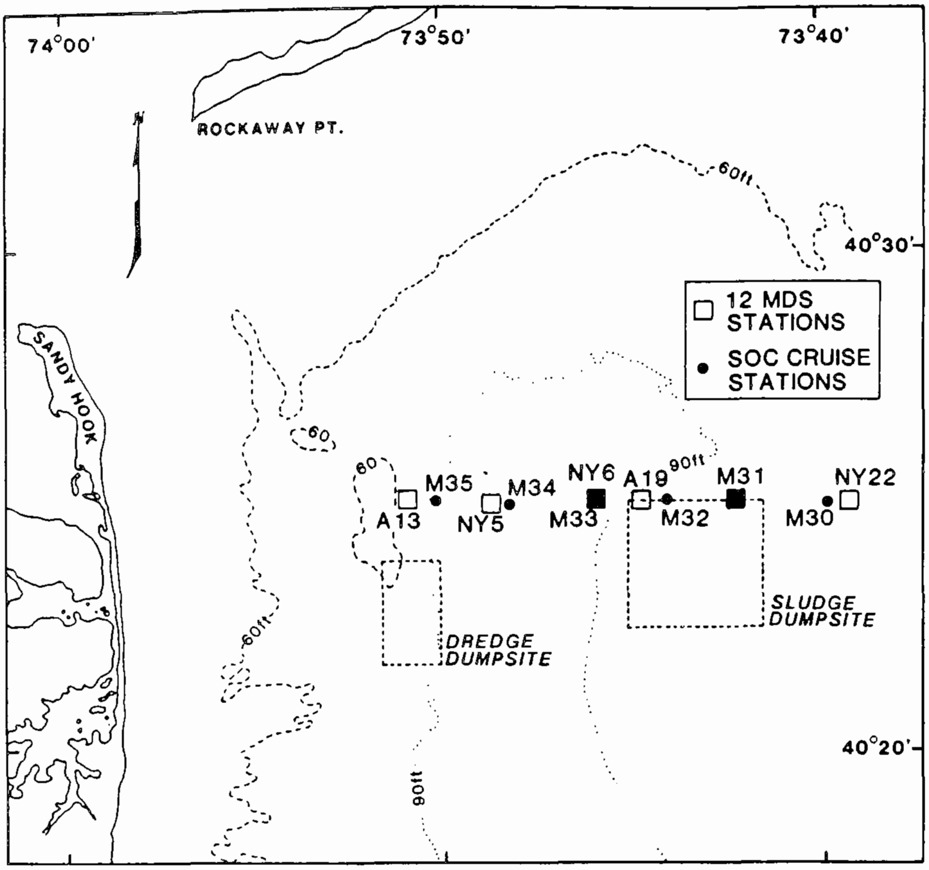


Figure 2. Mean (n=3) concentration of zinc (± one standard deviation) in layers 1 and 5 at replicate stations.



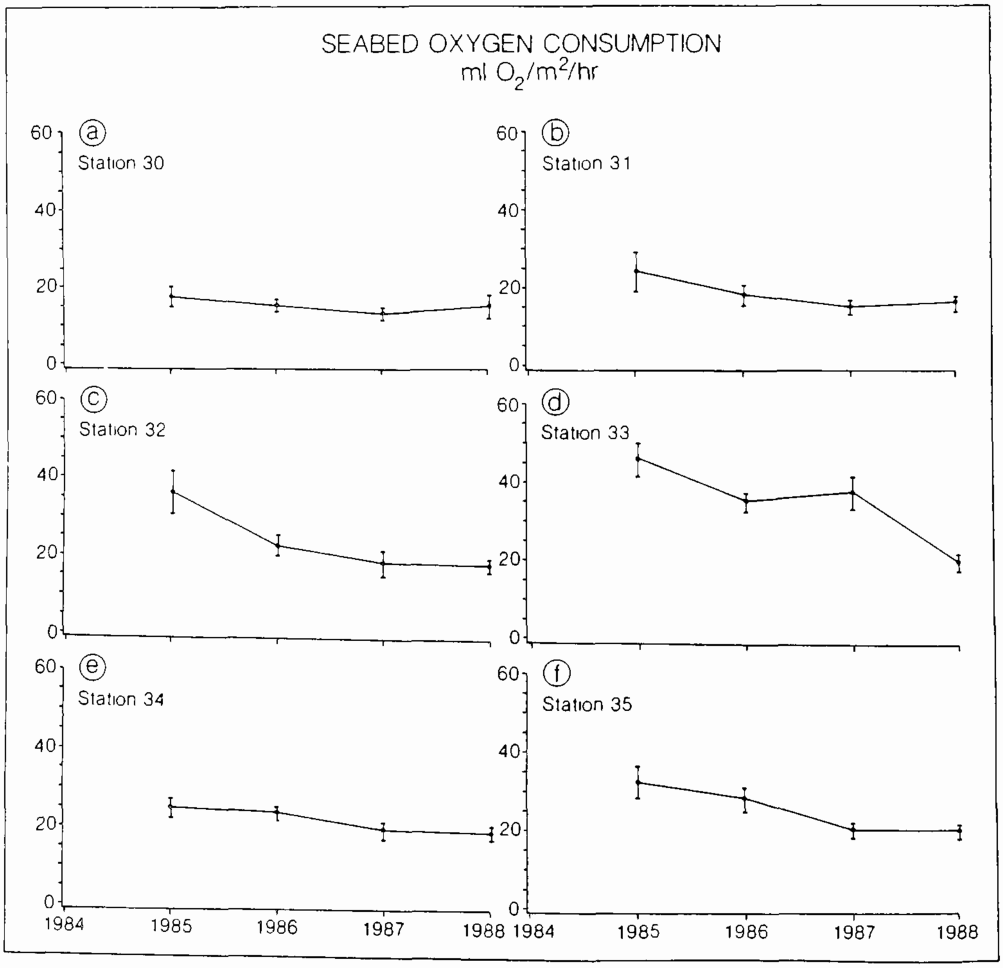


Figure 3. Station locations and seabed oxygen consumption rates.........

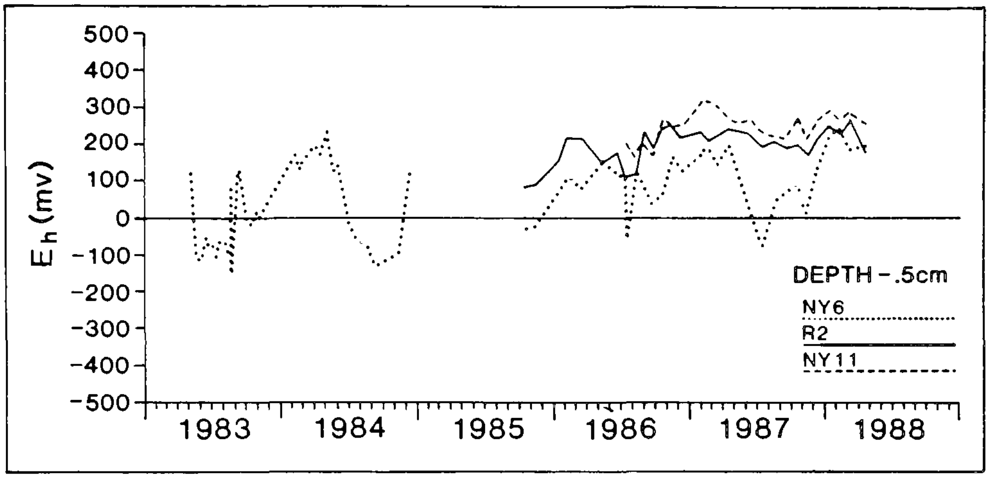


Figure 4. Redox potentials at 0.5 cm in sediment at replicate stations over time.

Dissolved Oxygen in Bottom Waters

From the beginning of the sludge phaseout in March 1986 through summer 1989, dissolved oxygen concentrations of less than 2.5 mg/l were not measured in bottom waters at NY6. Before the reduction in sludge input, values less than 0.5 mg/l were observed in summer months (Andrew Draxler, NOAA, Sandy Hook Laboratory, Highlands, NJ 07732, pers. comm., February 1990).

Fecal Coliform Bacteria in Bottom Waters

Of 30 stations sampled in an October 1989 survey of the inner Bight, 28 had fecal coliform counts below the detection limit used (MPN of 9/100 ml water), one station had an MPN of 9, and one station in deep water between the sewage sludge and dredged material dumpsites had a count of 139. The counts in general were noted to be well below those observed during dumping, and lower than counts found in many estuaries where shellfish are currently harvested. It was therefore thought that it should be possible to reopen most or all of the shellfish closure area. However, the inner Bight is considered a unique situation, and the standard guidelines for shellfish closures are not used. FDA must also evaluate toxic and pathogenic contamination of clam tissues, and perhaps other factors, in making its determination (Jack Gaines, U.S. Food and Drug Administration, Bldg. S-26, Construction Battalion Center, North Kingstown, RI 02852, pers. comm., November 1989).

The reduction in fecal coliform counts cannot be attributed exclusively to the cessation of sludge dumping. It has been estimated (New York City Department of Environmental Protection, 1983) that the Hudson-Raritan outflow added at least 500 times the numbers of coliforms to the inner Bight as sludge did when dumping was ongoing. Much of the reduction in coliforms must be due to the year-round (as opposed to warmer months only) chlorination of municipal wastewaters in the estuary, beginning in 1986. The year-round chlorination is probably the main factor enabling a three month extension of the seasonal certification of surf clam beds off the Rockaways (western Long Island) for harvesting for human consumption in 1987; in December 1988 the area became certified year-round (Interstate Sanitation Commission, 1989).

Benthic Macrofauna

The polychaete worm, <u>Capitella</u> sp., widely used as an indicator of organic pollution, had often been extremely abundant (>10,000 per m^2) at NY6 during dumping. No densities >100 per m^2 were found in the three summer 1988 surveys. No clear responses of species richness or other community variables were seen through summer 1988 (EPD, 1989).

Fish, Crab and Lobster Distribution/Abundance

From July 1986 through December 1987, biomass of trawl catches at all three replicate stations was dominated by little skate, winter flounder, ocean pout, spiny dogfish and rock crabs. During the phaseout of dumping, total biomass decreased, the proportion of fish to invertebrates increased, and differences among the three stations diminished (EPD, 1989). Interviews with lobstermen have indicated some reduction in fouling of pots and nets by sludge-like materials, though lobstering in the highly altered area has not increased much (Clyde MacKenzie, NOAA, Sandy Hook Laboratory, Highlands, NJ 07732, pers. comm., February 1990). Some fishermen still report that their nets are fouled with "manmade fibers" while trawling in the inner Bight, and that conditions have not changed since dumping stopped (William Phoel, NOAA, Sandy Hook Laboratory, Highlands, NJ 07732, pers. comm., February 1990).

Fish and Lobster Food Habits

Early results indicated principal prey items to be generally similar for the three replicate stations while dumping was ongoing. One exception was the occurrence of *Capitella* sp. in guts of winter flounder at NY6, reflecting the dominance of this polychaete there (EPD, 1989).

Fish and Lobster Pathology

The degree to which sewage sludge has contributed to pathology in the inner Bight, and the response to phaseout, have been unclear. O'Connor et al. (1987) chose fin rot in winter flounder as an appropriate pathology and species for an index of pollutant-induced disease. In 1973, the first year of systematic observations, a very high 13.4% of flounder examined from the inner Bight had fin rot (Table 2), compared to 2.1 % from "control" areas (Murchelano and Ziskowski, 1976). However, the incidence decreased thereafter, perhaps due to increased resistance among flounder populations, and there were several years in which little or no disease was observed. Data through 1983 are from the inner Bight in general; it is not known how many fish were from the sludge-affected area. The 1986-89 data are from the sludge phaseout study (Anthony Pacheco, NOAA, Sandy Hook Laboratory, Highlands, NJ 07732, pers. comm., February 1990), and are broken down into incidences at stations NY6, R2 and NY11. The decrease in fin rot at NY6 over that period could be taken as a response to the phaseout, but decreases were also seen at R2 and NY11, and the latter "reference" station had the highest incidence in the first year of the study. Effects of sludge are thus difficult to evaluate.

TABLE 2. INCIDENCE OF FIN ROT IN WINTER FLOUNDER FROM THE INNER NEW YORK BIGHT. DATA FOR 1973 - 1983 ARE FROM O'CONNOR ET AL., 1987; 1986 - 1989 DATA ARE FROM PACHECO, UNPUBLISHED.

Year	Incidence of fin rot (%)		n
1973		13.4	1943
1974		6.1	570
1975		1.6	1637
1976		0.7	667
1977		3.2	1159
1978		2.0	2561
1979		-	-
1980		0.0	102
1981		1.6	314
1982		1.7	357
1983		0.4	241
1986	NY6	2.2	85
	R2	1.8	169
	NY11	3.9	64
1987	NY6	0.7	356
	R2	0.3	417
	NY11	1.1	153
1988	NY6	0.6	577
	R2	0.3	816
	NY11	0.0	233
1989	NY6	0.1	585
	R2	0.0	286
	NY11	0.0	178

SUMMARY

Preliminary data from a study of responses to sludge phaseout in the inner New York Bight possibly indicate improvement in several variables: sediment trace metals and redox potentials, seabed oxygen consumption, and bottom water dissolved oxygen and fecal coliform concentrations. Responses are mixed or not yet seen for bottom invertebrate communities and for fish, crab and lobster distribution/abundance, food habits and pathology. No firm conclusions about responses can be made until a rigorous interdisciplinary data analysis has been completed.

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SEWAGE SLUDGE DISPOSAL: A REGULATORY PERSPECTIVE

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USEPA-Region II

Ocean dumping is regulated under the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, 33 U.S.C. 1401-1444. This Act requires that a special permit be obtained from the U.S. Environmental Protection Agency (EPA) for the transport and disposal of municipal sewage sludge into ocean waters. EPA has been issuing permits for this activity since April 1973.

Municipal sewage sludge has been dumped in the ocean since the 1920s. There are currently nine municipal sewage sludge generators, six in New Jersey and three in New York. Collectively, these dumpers annually dispose of approximately 8.7 million wet tons of sludge. This paper provides a brief overview of sewage sludge disposal and addresses the four related management conference questions as follows:

- What are the current and planned practices for sewage sludge disposal at the 106-mile site?
- What are the current plans for implementation of land-based alternatives?
- What do we know about the adverse environmental impacts of this activity?
- What further monitoring and analysis is planned to improve our understanding of these impacts?

EXISTING DISPOSAL PRACTICE

Dumping has occurred at the site design-by EPA, The Deepwater Municipal Sludge Dump Site (DMSDS, also known as the 106-Mile Site), since March 17, 1986. Dumping municipal sewage sludge at sea is restricted to this site, which is located approximately 115 nautical miles from the nearest point on the coastline; Atlantic City, New Jersey. Previous ocean dumping permits, allowing disposal at the 12-Mile Site, expired on January 9, 1981. The dumpers shifted their disposal operations to the designated site in accordance with amended judicial decrees entered into subsequent to the 1982 final judgment in the Case of City of New York vs EPA, 543 F. Supp. 1084 (1981).

EPA received complete applications from the following nine New Jersey and New York sewage sludge generators: Bergen County Utilities Authority (BCUA), Joint Meeting of Essex and Union Counties (JMEUC), Linden Roselle Sewerage Authority (LRSA), Middlesex County Utilities Authority (MCUA), Passaic Valley Sewerage Commissioners (PVSC), Rahway Valley Sewerage Authority (RVSA), Nassau County Department of Public Works (NCDPW), New York City Department of Environmental Protection (NYCDEP), and Westchester County Department of Environmental Facilities (WCDEF) for issuance of special permits to transport and dispose of sewage sludge. In conjunction with preparing permit conditions for a term ending on March 17, 1991, EPA drafted Agreements to implementation of alternative disposal methods as required by the Ocean Dumping Ban Act of 1988 (ODBA). The ocean dumpers accepted the Agreements, and EPA and the respective State accepted their cessation schedules. The Agreements were signed by all parties in August 1989.

The new ocean dumping permits contain numerous new conditions to minimize the adverse environmental impacts and to ensure a more controlled dumping operation. The major key provisions include:

- Reduced discharge rates based on individual permittee sludge toxicity. The previous rate was 15,500 gal. per minute (gpm) at minimum speed of 3 knots for all dumpers. Reduced rates now range from 15,500 to 292 gpm at a vessel speed of 6 knots.
- Monitoring requirements include monthly sampling (sludge characterization) and deployment of probes and drifters from barges to measure current shear at the site and farfield transport of sludge away from the site.
- Vessels are to follow tracklines and allow 2 hours (or 12 miles at 6 knots) between vessels.
- Manifest system to track the sludge from its origin until its ultimate disposal at the DMSDS. Seals must be placed on all vessel dump and transfer valves. Inspectors check the condition of the seals and observe all sludge loadings and transfers while the vessels are in port.
- Shipriders are required on all vessels going to the DMSDS to monitor dumping operation at the DMSDS.

LAND BASED ALTERNATIVES

The Ocean Dumping Ban Act (ODBA) states that an ocean dumping authority, the State in which it is based, and EPA shall enter into a compliance or an enforcement agreement as a condition of issuing a permit for the ocean dumping of industrial waste or sewage sludge. Section 104B(c)(2) of ODBA requires a compliance agreement that includes a negotiated plan for an ocean dumper to terminate its ocean dumping by December 31, 1991, through the design, construction, and full implementation of an alternative system for management of the waste or sludge.

If an ocean dumper does not propose to implement long-term land-based waste or sludge management by December 31, 1991, the parties must enter into an enforcement agreement. A judicial consent decree and enforcement agreement was successfully negotiated with each ocean dumper; each of the agreements was signed by the parties on or before August 4, 1989.

New Jersey's six ocean dumping sewerage agencies identified their choices of interim and long-term land-based sludge management alternatives in their sludge management plans submitted to the New Jersey Department of Environmental Protection (NJDEP) in April 1989. Interim proposals include landfilling and chemical fixation as a landfill cover material. Long-term proposals include incineration and chemical fixation as a landfill cover material. New Jersey sludge and solid waste management regulations require that long-term plans be implemented within the county where the sludge or solid waste is generated unless an interdistrict (or equivalent) agreement is developed and signed.

New York's three ocean dumpers have indicated that each is evaluating the feasibility and environmental acceptability of the entire range of sludge management options. New York State General Municipal Law 120(w) provides for a process to solicit proposals from the private sector to furnish solid waste management facilities. This request for proposals (RFP) technique is being used by the New York ocean dumpers to seek interim alternatives to ocean disposal. If this process yields alternatives that can meet long-term land-based needs, the dumpers may enter into a 25-year agreement with the proposer under this law. At the same time, the dumpers are continuing to evaluate their long-term alternatives. The specific dates and plans identified for all the dumpers are as follows:

New Jersey	Interim Plan	Long Term Plan
Bergen County	Dewater at PVSC 3/17/91	incineration 1/01/96
Joint Meeting	Out-of-state disposal 3/17/91	incineration, 2/10/98
Linden Roselle	Out-of-state disposal, 3/17/91	incineration, 1/01/96
Middlesex County	Dewater and chemical fixation to in-state landfill as cover, 3/17/91	Same 3/17/91
Passaic Valley	Dewater and out-of state disposal, 3/17/91	incineration, 12/31/96

Rahway Valley	Dewater and out-of state disposal, 3/17/91	incineration at Jt. Meeting 2/10/98
Nassau County	Private Venture*, 50% 6/30/91 100% 12/31/91	Under Study 12/31/94
New York City	Private Venture** 20% 12/31/91 100% 6/30/92	Under Study 50% 12/31/95, 100% 6/30/98
Westchester	Private Venture*, 12/31/91	Under Study 9/15/95

* Being Sought Through Joint RFP Process

** Being Sought Through RFP Process

MONITORING IMPACTS

From 1984 through early 1986, EPA developed and implemented, as directed by the Ocean Dumping Regulations, a monitoring plan designed to determine whether adverse impacts result from disposal of sewage sludge at the 106-Mile Site. The monitoring plan is consistent with the general approach for tiered monitoring . The plan considered characteristics of the site and the sludge to predict possible impacts of sludge disposal and formulate the null hypotheses tat these predictions suggest. The following impact categories itemized in the ocean dumping regulations were used to develop predictions of possible impacts:

- Impingement of sludge onto shorelines,
- Movement of sludge into marine sanctuaries or shellfishery or fishery areas,
- Effects of sludge on commercial fisheries,
- Accumulation of sludge constituents in biota,
- Progressive changes in sediment composition related to sludge disposal,
- Impacts on pollution-sensitive species or life-cycle stages as a result of sludge disposal,
- Impacts on endangered species as a result of sludge disposal and,
- Progressive changes in pelagic,demersal, or benthic biological communities as a result of sludge disposal.

A tiered approach organized the null hypotheses into a hierarchy, whereby data collected in each tier were used as the foundation for he design and extent of monitoring activities in the next tier. Such an approach ensured that only information needed for making decisions would be collected.

The four tiers included in the 106-Mile Site monitoring program are as follows:

- o Tier 1-Sludge Characteristics and Disposal Operations
- o Tier 2-Nearfield Fate and Short-Term Effects
- Tier 3-Farfield Fate
- o Tier 4-Long-Term Effects

The objectives of Tier 1 are to assess sludge characteristics and disposal operations in order to determine whether the assumptions made in setting permit conditions continued to be true throughout the period that the 106-Mile Site is used. Monitoring and surveillance of sludge characteristics and disposal operation were necessary for assessing the characteristics of individual sludge plumes and total loading of sludge to the site.

Because of uncertainty in the reliability of available data from the sewerage authorities, EPA independently sampled and characterized sludge from the nine authorities. Parameters measured included toxicity to representative marine species (Menidia beryllina and Mysidopsis bahia), organic priority pollutants, metals (copper, lead, cadmium, and mercury), and other characteristics--settleable matter,total suspended solids, total solids, wet-to-dry-weight ratio, density of solid matter, and specific gravity. Although data from this independent study did not provide a statistical representation of the characteristics of sludges through time, they were used to evaluate the representativeness and accuracy of data submitted by the sewerage authorities. Data generated by the EPA study were generally comparable to those provided by the sewerage authorities. The information was subsequently used in calculating allowable rates for dumping.

The overall objective of Tier 2 monitoring was to assess the short-term behavior, transport, and impact of sludge within the 106-Mile Site and in the immediate area surrounding the site. Short-term effects were defined as those effect were occurring within 1 day of sludge disposal. Measurements of nearfield fate of sludge disposed at the site have focused on issues related to compliance with permit conditions and possible effects from sludge disposal. In 1987 EPA began studying the short-term, nearfield fate of sludges disposed at the site. Activities included direct studies of sludge plumes under varied oceanographic and meteorological conditions. Specifically, Tier 2 activities include:

- o Measuring sludge constituents in the water column in and near the 106-Mile Site to determine fate of sludge constituents with respect to permit conditions and ambient conditions,
- o Conducting sludge-plume observations to define dilution characteristics of the sludge and any seasonal patterns of sludge dispersion at the 106-Mile Site,
- o Studying rapid settling of sludge particles from plumes and,
- o Measuring surface currents and water-column structure to estimate sludge dispersion.

Measurements of the concentration of selected sludge tracers in the barges discharging sludge during surveys conducted plus time series measurements of the concentration of these tracers in the plumes have been used to develop an emperical formulation that allows the calculation of disposal rates for each municipality. Based on this formulation and acute biossay results from the sludge characterization study, EPA developed a nomograph which relates the regulatory driven Limiting Permissible Concentration to allowable dumping rates. This nomograph (Figure 1) forms the basis for settling discharge rates for the permits issued in August 1989 and will be used to adjust dumping rates at the 106-Mile Site on a quarterly basis.

Before a comprehensive estimate of long-term effects of sludge dumping at the 106-Mile Site can be made, it is necessary to estimate where the sludge goes, the area of the seafloor that may be influenced by sludge particles, and the cumulative concentrations that may be expected in the water column and sediments after years of dumping. Therefore, Tier 3 of the monitoring program was designed to estimate the transport and fate of the sludge dumped at the 106-Mile Site in the long term and the farfield.

Farfield fate of sludge dumped at the 106-Mile Site depends upon dispersion of sludge plumes in several space and time scales. The principal components of estimating fate of sludges are (1) advection, (2) mixing, and (3) sinking and coagulation. Advection is the transport of sludge particles by the movement of water, that is, in a current field. All but the largest sludge particles are expected to spend weeks to months in the water column. They are likely to encounter many current fields and travel long distances, up to 100 - 1000 km, before deposition on the bottom. Mixing is the dilution of sludge particles in a parcel of water by small-scale turbulent processes that depend on the density and velocity of the water. Turbulent energy due to wind and surface waves, vertical current shear, and density profiles of the water mass affect mixing. Sinking is dependent on particle size and denisty. Coagulation, the sticking together of sludge particles, may alter the distribution of particle sizes in a sludge plume and affect sinking.

Thus, several types of measurements are required to estimate the possible results of all the physical processes acting on the sludge. Specifically, Tier 3 activities include:

- o Studying water-mass movement from the 106-Mile Site,
- o Studying surface currents and water structure in the areas expected to be impacted by dumping,
- o Using remote-sensing information to evaluate large-scale water movements and structure,
- o Measuring settling of sludge particles in the field and,
- o Using appropriate models to estimate fate of sludge constituents and to identify possible depositional areas.

The study of water-mass movements was initiated through the release of satellite-tracked drifters during October 1988 (4 drifters), and most recently in October 1989 (4 drifters). Additional releases have occurred and will continue weekly by the dumping authorities beginning in March, 1990. Trajectories of these releases, illustrated in Figure 2 indicate that the water mass being tracked from the site has not moved on to the continental shelf; movement from the site has been in a southwesterly direction, continuing until entrainment in the Gulf Stream.

During 1988 and 1989, EPA monitored water-mass structure and particle concentrations at distances up to 40 nmi from the site. These measurements were not associated with specific plumes, so they effectively bridged nearfield and farfield monitoring. Vertical profiles were made to determine the depth of the particle maximum, and water samples were collected and analyzed for sludge tracers: trace metals, selected organic compounds, Clostridium perfringens spores, Salmonella spp., other pathogens, chlorophyll a, and xylem tracheids. Preliminary results suggested that sludge tracers could be identified at many stations downcurrent from the site and that further farfield studies were warrented.

Results of farfield fate studies conducted to date suggest that:

- o The seasonal pycnocline, where particles concentrate naturally, is a region of the water column where sludge particles may also concentrate,
- o Sludge constituents are unlikely to concentrate in any location on the seafloor within or to the southwest of the site. If sludge were transported onto the continental shelf, sludge constituents could reach the seafloor,
- o Warm-core eddies are a viable but poorly understood mechanism for potential northward transport of sludge constituents to the edge of the continental shelf,
- o On average, sludge particles are likely to remain in the water column, become entrained in the Gulf Stream, and be subject to great dispersion, which would not result in identifiable impacts to the environment and,

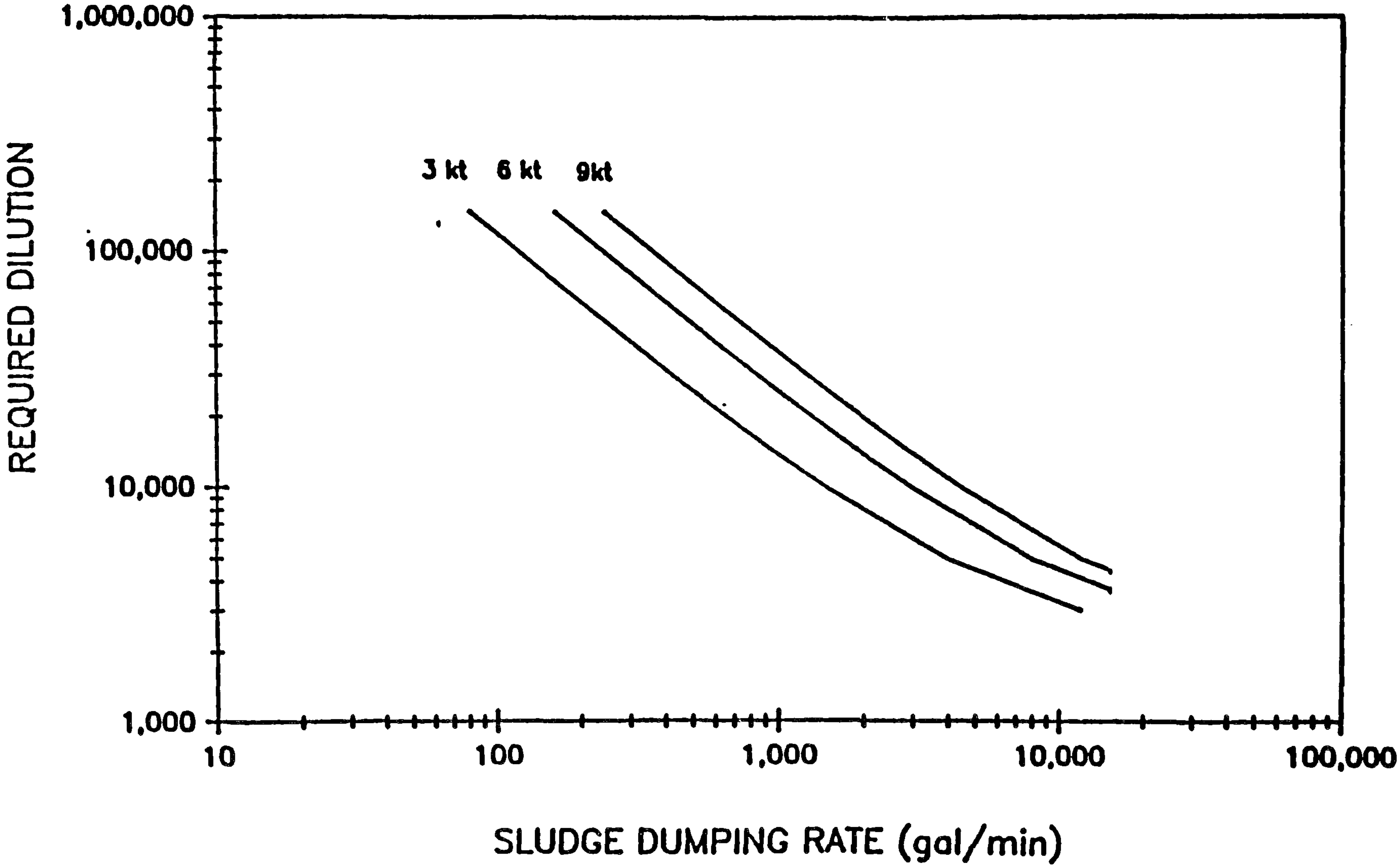
- o Under some oceanographic conditions, sludge may be recirculated through the site.

The objective of Tier 4 studies is to assess whether there are long-term impacts from sludge disposal at the 106-Mile Site. Tier 4 includes plans for studies of impacts on fisheries species, biological communities that are prey for fisheries species, and other marine resources.

Long-term effects may occur within or outside the site. Long-term effects in the site can occur if, for example, there is a progressive decline in water quality--although such a decline has not been observed or nor is it predicted--or if significant quantities of sludge particles settle to the seafloor within the site. Effects outside the site, such as bioaccumulation of sludge constituents, may occur if sludge particles are regularly transported in the direction of marine resource areas.

Long-term effects, Tier 4, studies were initiated in 1989 and will continue for the duration of the program. Effects on endangered species have been assessed since dumping began and will continue throughout the life of the program. During 1989, NOAA and EPA conducted preliminary studies of contaminants in lantern and hatched fishes. Other bioaccumulation studies, studies of chitinoclasia, benthic studies, assessment of ichthyoplankton, and measurements of pathogens in sediments will proceed during 1990 and 1991.

FIGURE 1. NOMOGRAPH FOR DISCHARGE RATES



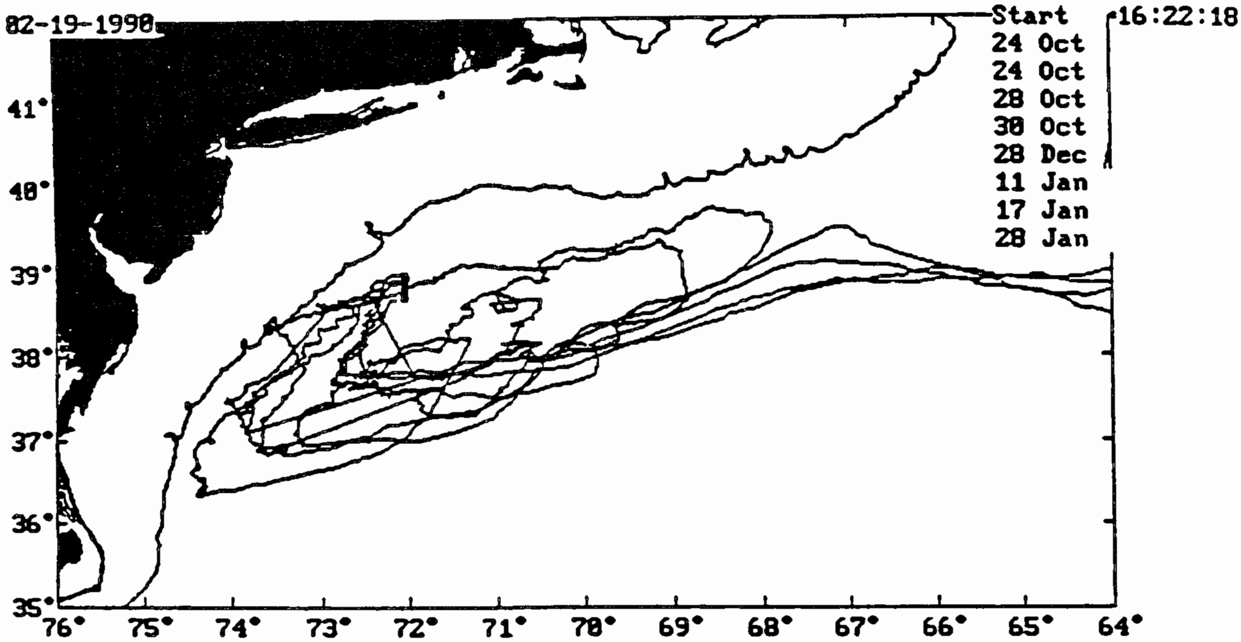


FIGURE 2- TRAGECTORIES OF DRIFTERS RELEASED AT THE SITE

ENVIRONMENTAL RISKS OF OCEAN DISPOSAL

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Introduction of anthropogenic wastes into the marine environment often results in adverse impacts on ecological systems. The intensity and scale of impact is dependent upon several factors, including the physical and chemical attributes of the waste material, the amount of material and its release rate, and the existence and susceptibility of biological systems exposed to the wastes. The challenge for environmental scientists is to describe and predict potential impact in sufficient detail to permit effective management of waste disposal.

During the 1970s and early 1980s, dredged sediment, sewage sludge, and industrial byproducts made up the bulk of wastes released into U.S. waters (Burroughs, 1988). Historically, these same wastes have caused the greatest concern for the New York-New Jersey-Connecticut region. Added to this list are cellar dirt, acid wastes, construction wastes, and the products of activities such as at-sea wood and liquid waste incineration. Within each of these categories of waste material, large variation exists in the concentrations and bioavailability of constituent contaminants. This variation requires that the potential impacts of waste disposal be examined on a case-by-case basis.

Both shallow nearshore and deep water offshore sites have routinely been used for disposal activities. In selecting a site, a general tradeoff is made between the economic uses of an area and the perceived hazards of the wastes to be disposed. The rationale behind this approach involves consideration of the proximity of human activity, but also the degree of dispersion (and therefore dilution) expected at these sites. The distributions of obvious natural resources and the timing of their greatest susceptibility are also considered. Whereas the environmental impact of ocean disposal can be modulated to some degree through judicious placement of disposal sites, very few areas of the ocean are devoid of organisms and ecological systems susceptible to impact. Such impacts can occur at all levels of biological organization, from effects on subcellular and genetic systems to modification of the form and function of whole ecosystems.

The highly complex relationships between the waste material, disposal site characteristics, and biological systems are neither easily understood nor well described. The U.S. Environmental Protection Agency's Environmental Research Laboratory in Narragansett, Rhode Island (ERLN), has strived over the past decade to develop a logically sound, scientifically defensible approach to addressing questions of the ecological impacts of ocean disposal (Bierman *et al.*, 1986; Gentile *et al.*, 1989). This strategy, centered around the risk assessment paradigm, employs several information-gathering, modeling, experimental, and synthesis activities in the quantification of potential impact. As summarized in Figure 1, information concerning the physical and chemical attributes of the source waste material (Source Characterization), the physical and biological characteristics of the disposal site (Site Characterization), the spatial and temporal distributions of the waste material and constituent contaminants during and following disposal (Exposure Assessment), and the responses of appropriate biological endpoints over the range of relevant exposure concentrations (Hazard Assessment) is synthesized into qualitative and quantitative statements of risk (Risk Characterization). Properly formulated estimates of ecological risk can be used to make rational disposal decisions. Ideally, monitoring programs are implemented to confirm or deny the validity of the risk predictions (Phelps and Beck, 1984). Although originally developed as a predictive tool for use prior to initiation of disposal activities, modified versions of this approach have proven valuable in the examination of impacts in aquatic systems associated with in-place hazardous wastes (*e.g.*, Johnston *et al.*, 1990).

The remainder of this paper describes the range of adverse impacts associated with ocean disposal of anthropogenic waste through the presentation of case studies and projects conducted by ERLN. Evidence from these studies is supplemented where appropriate with salient information obtained from other investigations performed mainly in the New York-New Jersey-Connecticut region. The primary intent of this discourse is

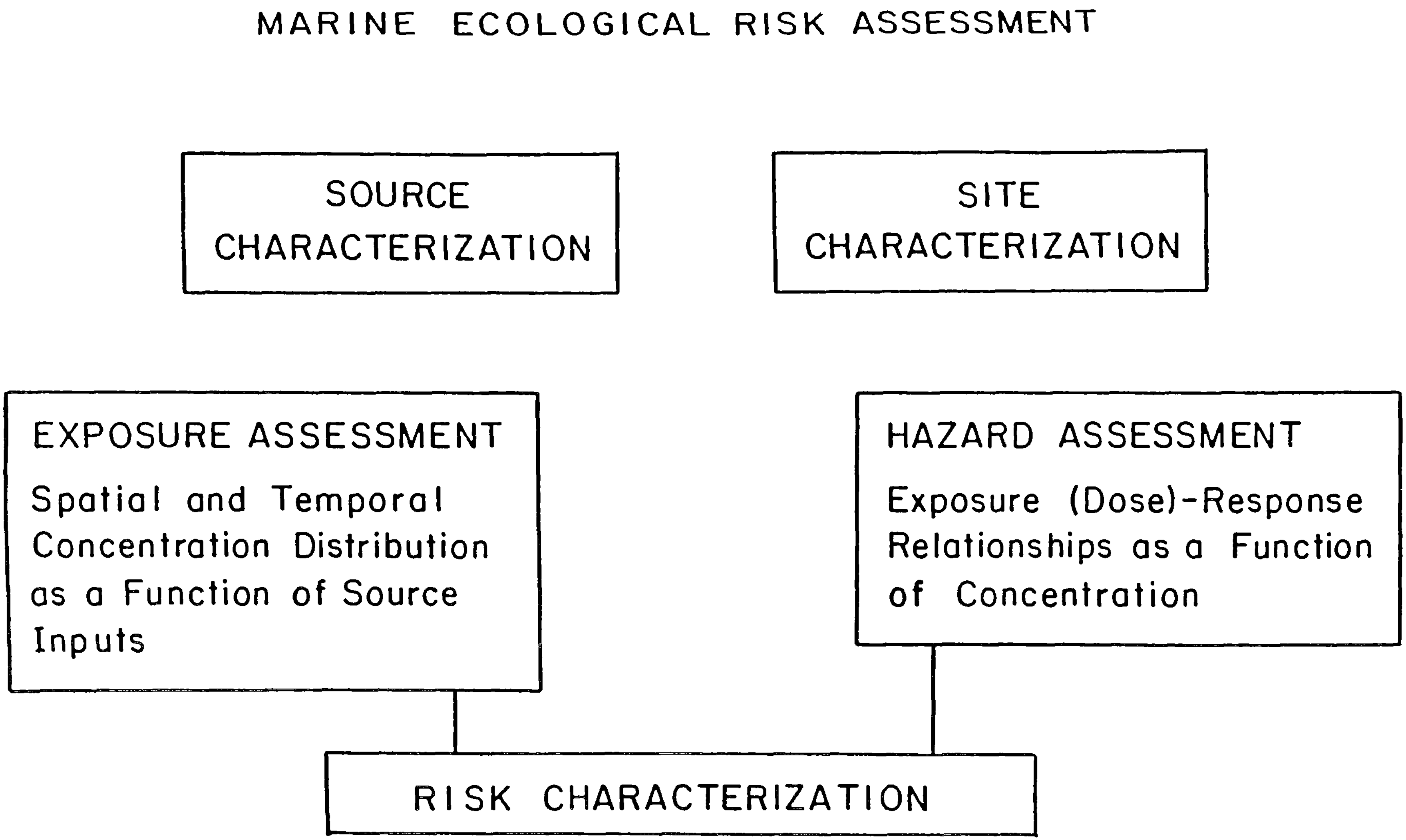

Figure 1. ERLN's Marine Ecological Risk Assessment Strategy.

not to catalogue all known impacts associated with ocean disposal, but rather to provide scientific insight into the identification and resolution of waste disposal management issues.

IMPACTS OF DREDGING AND OCEAN DISPOSAL OF DREDGED SEDIMENTS

Adverse impacts associated with dredging and ocean disposal of dredged sediments can result from the physical disturbances associated with the actual dredging and disposal activities, and from the release of constituent contaminants and their subsequent exposure to biota. Physical disturbance of benthic communities at the dredging and disposal sites is assumed to occur as an obvious and unavoidable byproduct of the dredging operation. Although such disturbances are clearly important to management decisions, more pervasive are the impacts associated with the release of contaminants. The ultimate fate of these contaminants, and therefore their potential ecological impact, is dependent upon the transport mechanisms existing at the dredging and disposal sites (Figure 2). In energetic systems, contaminants in dissolved and particulate form may be distributed over large areas, increasing the risk of environmental impact. Fortunately, the harbors and waterways most often requiring dredging are typically depositional areas with relatively quiescent current regimes. However, it is these same areas which tend to accumulate fine grained sediments. Because fine grained sediments are likely to display higher levels of contamination and are also more easily transported by water currents, these materials can potentially cause the greatest problem when disposed in the ocean.

Case Study 1 – The New Bedford Harbor Pilot Project

In conjunction with EPA Region I, the U.S. Army Corps of Engineers (COE), and the State of Massachusetts, ERLN participated in the New Bedford Harbor Pilot Project by monitoring the potential adverse impacts associated with different options of dredging and in-harbor disposal (Nelson, 1989). The upper reaches of New Bedford Harbor (NBH), which is located on Buzzards Bay in Massachusetts (Figure 3), contain fine grained sediments which are highly contaminated with polychlorinated biphenyls (PCBs) and heavy metals. These sediments are also acutely toxic to marine life. Up to 100% of test animals died in laboratory assays involving benthic amphipods. Additionally, ambient water column concentrations of several contaminants exceed EPA's Water Quality Criteria in the upper harbor, presumably as a result of contaminant migration from the bottom substrate. The site was added to EPA's National Priorities List of hazardous waste sites in 1982, and targeted for mitigation. The Pilot Project was designed to provide input to the decision process addressing mitigation options.

The approach used by ERLN to quantify impacts associated with the various

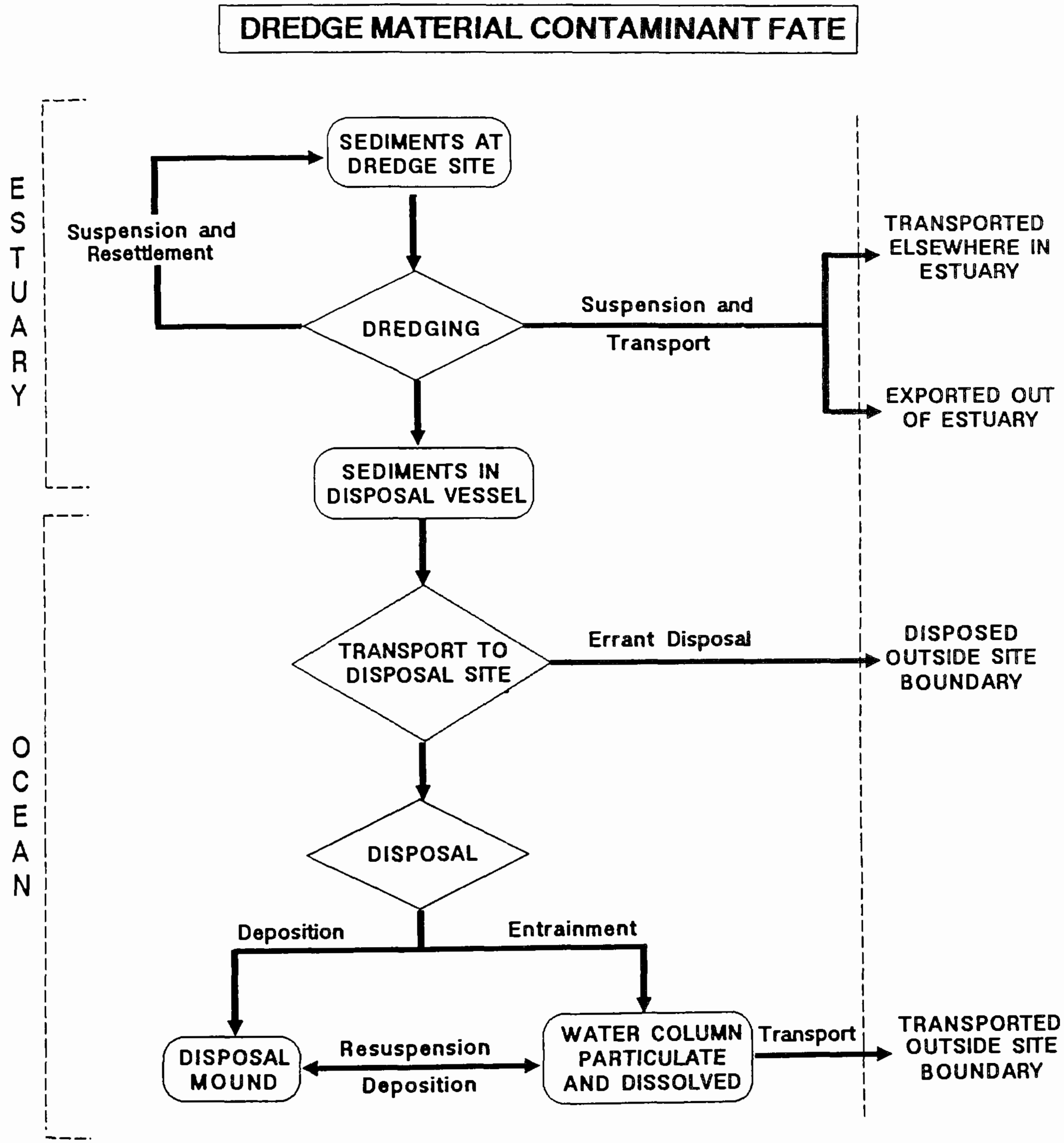

Figure 2. Fate of dredged material released during dredging and disposal operations.

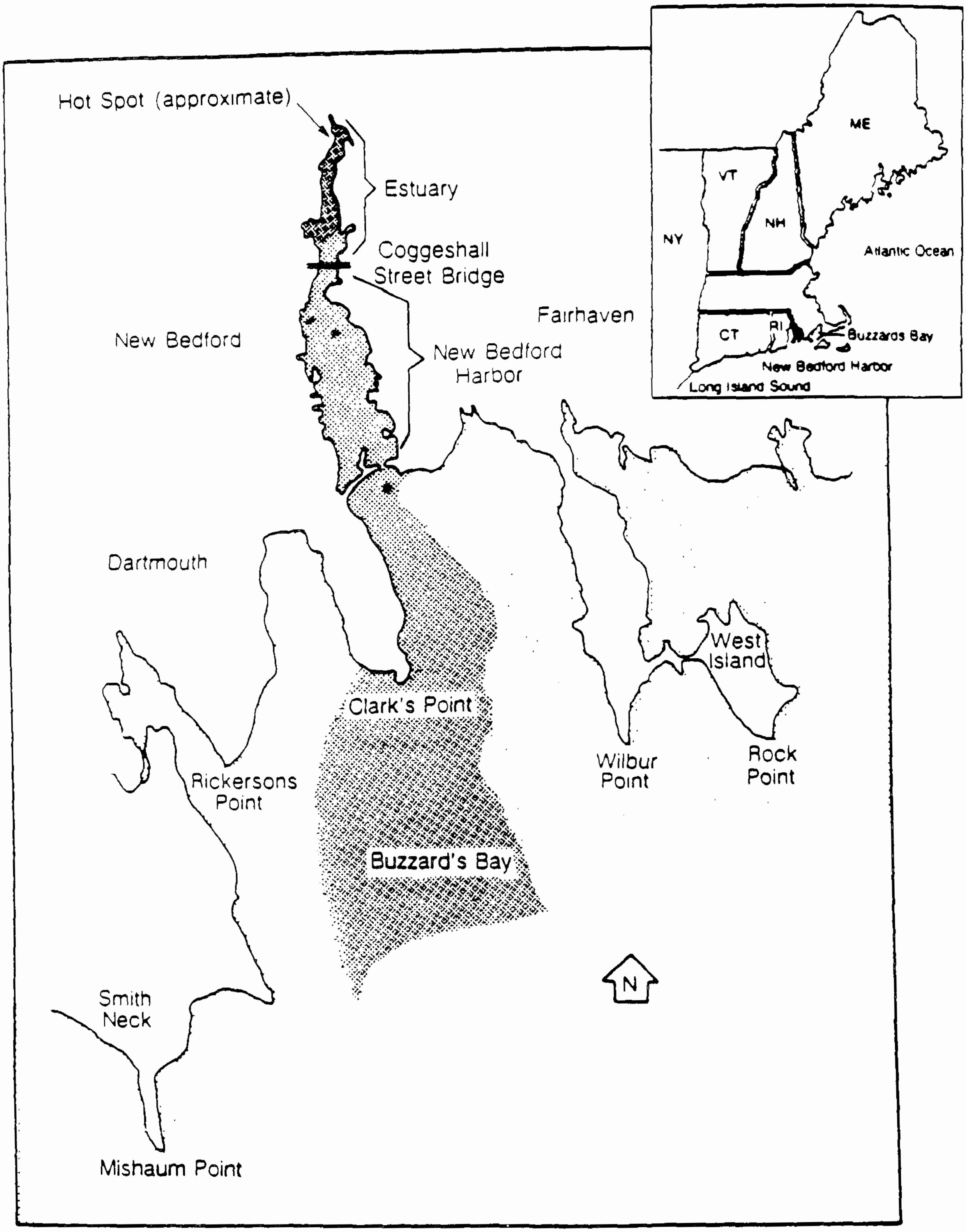

Figure 3. Location of New Bedford Harbor (modified from Nelson, 1989).

dredging and disposal options involved the use of real-time environmental monitoring. Exposure and hazard assessments were performed utilizing physical (suspended particulates), chemical (water column concentrations of PCBs, cadmium, copper, and lead, and PCB bioaccumulation in mussels), and biological (acute and chronic toxicity assays involving fish, mysids, algae, and sea urchin reproductive cells and field deployments of caged mussels) endpoints. Rapid turn-around of chemical and toxicity results permitted daily decisions to be made which mitigated the potential risks associated with specific dredging and disposal activities.

Due in large part to the extreme precautions taken during sediment handling operations (*e.g.*, installation of silt curtains, and minimization of the release of particulates during dredging and disposal), no unacceptable biological impacts were observed during this study (Nelson, 1989). Operation-related elevations above prespecified levels in water column PCB concentration were observed on a few occasions, but these rapidly returned to lower levels following corrective action. A final conclusion drawn in this project was that no adverse environmental impact was observed.

The New Bedford Harbor Pilot Project was unusual in that every effort was made to minimize the transport, and therefore potential impacts, of released contaminants. This project demonstrates that dredging and in-harbor disposal operations can be conducted safely (at least on a small scale), and should be used as a model for future dredging projects. A review is given by Morton (1977) of existing studies conducted through the mid-1970s which address the ecological impacts of dredging and disposal. During the decision process, the ecological risks of dredging clearly need to be weighed against the ecological and economic risks of leaving the sediments undisturbed.

Case Study 2 -- The Field Verification Program

In 1982, COE and EPA initiated the 6-year Field Verification Program (FVP) to investigate three options for the disposal of dredged material (Gentile *et al.*, 1988a; Peddicord, 1988). Two of these options, upland disposal and the creation of new wetlands, were examined by COE's Waterways Experiment Station (Folsom , 1988; Simmers *et al.*, in preparation). The third option, aquatic disposal in coastal marine waters, was investigated by ERLN (Gentile *et al.*, 1988b). Black Rock Harbor (BRH), located near Bridgeport, Connecticut (Figure 4), was selected as the source of dredged material for this case study. Approximately 55,000 cubic meters of BRH sediment, an anoxic, fine grained material containing high levels of organic and inorganic contaminants (Rogerson *et al.*, 1985; Munns *et al.*, 1988), were disposed in the northeast corner of the Central Long Island Sound (CLIS) Disposal Site (see Figure 4). This operation produced a relatively small (circa 1.5 m in height) disposal mound in a location removed from other existing disposal mounds. Physical isolation of the mound, in conjunction with

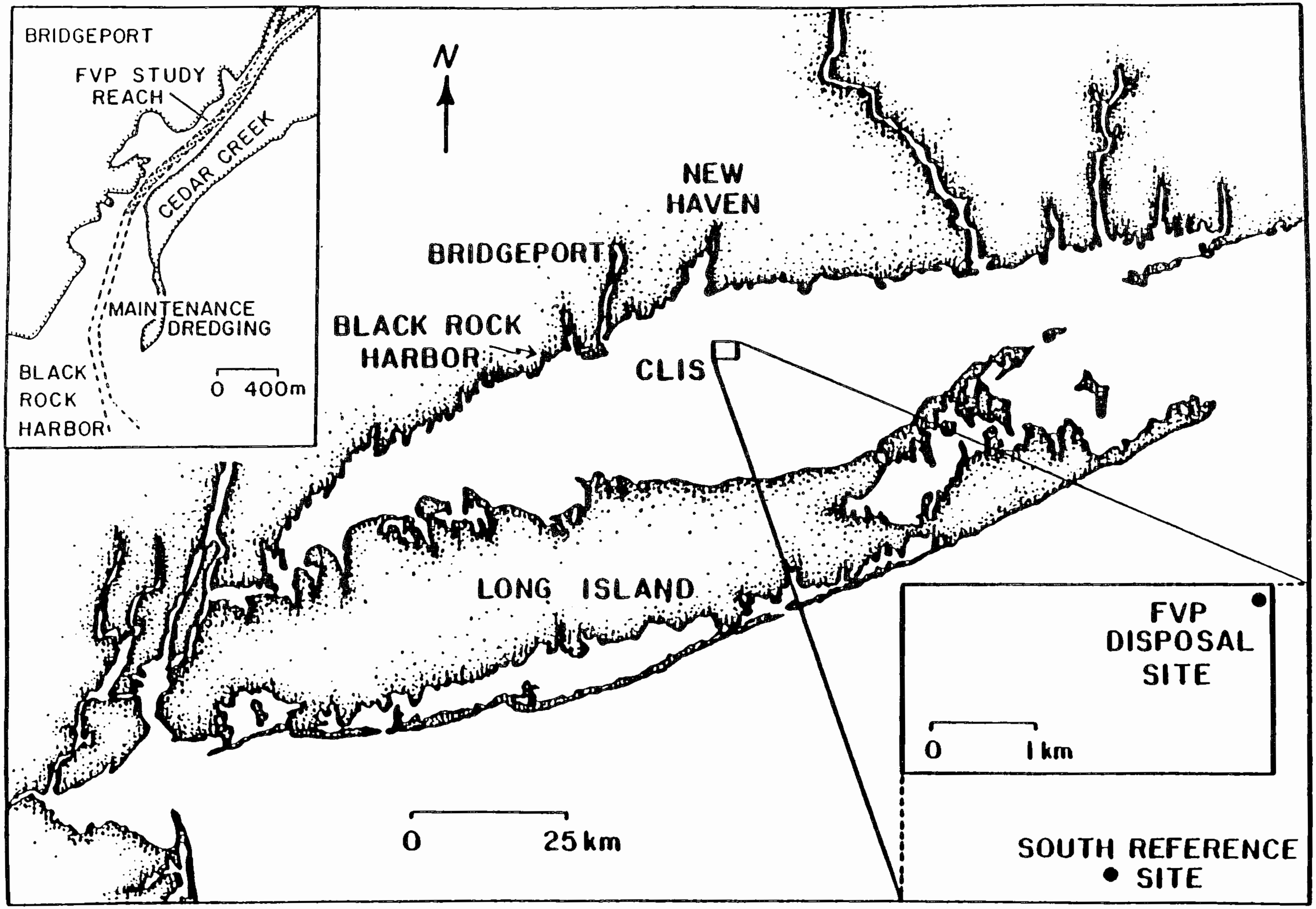

Figure 4. Locations of Black Rock Harbor, CLIS, and the FVP disposal site.

predisposal site characterization and monitoring activities, permitted some degree of separation of the impacts of the BRH material from those resulting from other disposal activities.

Following the ecological risk assessment approach, ERLN collected information concerning the dredged material, the exposure fields resulting from disposal, and the effects of the material on several ecologically relevant endpoints, to develop an understanding of the potential impacts associated with such disposal operations. Individual studies were conducted simultaneously in the laboratory and in CLIS to verify assay-based predictions of risk. These studies involved suspended and bedded exposures of BRH sediment to a large number of marine species representing several phyla. Hazard measurements were made on genetic, physiological, histological, organismal, population, and community level endpoints.

BRH sediment proved to be hazardous to a variety of biological functions and endpoints in agreement with the levels of its constituent contaminants (Gentile *et al.*, 1988b). In the laboratory, both water column and benthic effects were observed. Most significantly, the physiology of mussels and polychaetes, and the survival and fecundity of mysids and amphipods, were adversely impacted. Behavioral changes and contaminant bioaccumulation were also observed. The magnitude of impact was typically correlated with the level of BRH exposure. Similar responses occurred at the disposal site, and good agreement was seen between the responses experienced in laboratory and field studies for comparable exposure conditions. Most of the effects measured were short-term in nature, and confined to the near field. It is notable that the benthic community which developed on the dredged material mound had not yet completely converged with that of either the predisposal or the surrounding background community some 2.5 years following disposal.

Two important conclusions can be drawn from the FVP. The first is that the risks of adverse impact associated with ocean disposal of contaminated dredged material are both real and potentially large. These impacts can involve both water column and benthic species. The second conclusion is that laboratory assays generally provide appropriate predictions of field responses when exposure conditions are similar. Although the first conclusion is disconcerting (albeit not wholly unexpected), the second is satisfying in that it provides justification for the laboratory assay approach to predicting environmental impact. This approach is outlined in the current revisions to the EPA/COE implementation manual (EPA/COE, 1977).

Where adverse impacts are indicated, mitigating measures such as capping or confined disposal can be initiated. These procedures have been successfully employed by the COE New England District in its dredging program (Morton, 1989). For those cases in which in-water mitigation cannot be accomplished, it may be prudent to evaluate and compare the risks of ocean disposal with those of wetland and upland disposal options, or with those of keeping the sediments in place.

IMPACTS OF SEWAGE SLUDGE DISPOSAL AT OFFSHORE SITES

The impacts associated with offshore disposal of municipal sewage sludge are not well established. Evidence from such disposal at nearshore sites suggests that the effects may be varied, and not always negative. Most obviously, nutrient enrichment and perhaps enhanced phytoplankton growth may occur as organically rich sludge is introduced into nutrient poor waters. If enriched too far, however, noxious phytoplankton blooms can occur, and shallow ocean basins and areas of impaired circulation can experience hypoxia and anoxia as organic mater is decomposed. These situations are not uncommon in the New York-New Jersey-Connecticut region (Swanson and Sindermann, 1979; Welsh, 1988). Other types of impact found in shallow systems include the release of pathogens and chemical contaminants, including heavy metals and organic compounds (Duedall *et al.*, 1983). These insults can lead to long-term modification of benthic community structure and function (*e.g.*, Pearson, 1987). As with dredged materials, the extent and magnitude of environmental impact associated with sludge disposal are dependent upon the quantities disposed, their level of contamination, the potential for transport, and the proximity of susceptible biota.

Case Study 3 – Sewage Sludge Disposal at the 106-Mile Dump Site

With the closure of the 12-Mile Site in the New York Bight impending, municipalities in New York and New Jersey began disposing their sewage sludge at the Deepwater Municipal Sludge Dump Site (a section of the 106-Mile Site; Figure 5) in 1986. Located off New Jersey at the edge of the continental shelf, the 106-Mile Site displays highly dispersive characteristics thought to result in rapid dilution of released wastes. Sewage sludge is currently being introduced to the site at a rate of some 7-8 millon wet tons per year (EPA, 1988).

ERLN's risk assessment activities associated with the 106-Mile Site have centered primarily around modeling exercises of contaminant exposure and biological effects (Paul, 1988), and laboratory measurements of the toxicity of the sludges (Miller *et al.*, 1988). Initial modeling efforts were directed towards description of sludge transport and the resulting long-term pattern of waste and constituent contaminant concentration (Paul *et al.*, 1989; Walker *et al.*, 1987). These studies suggested long-term elevations in contaminant concentration, but no real adverse environmental impact in the water column. Subsequent simulations of sludge accumulation in the bottom sediments, and the resultant bioaccumulation of contaminants by biota, again suggested little impact associated with existing sludge loading rates to the 106-Mile Site (Nocito *et al.*, 1988).

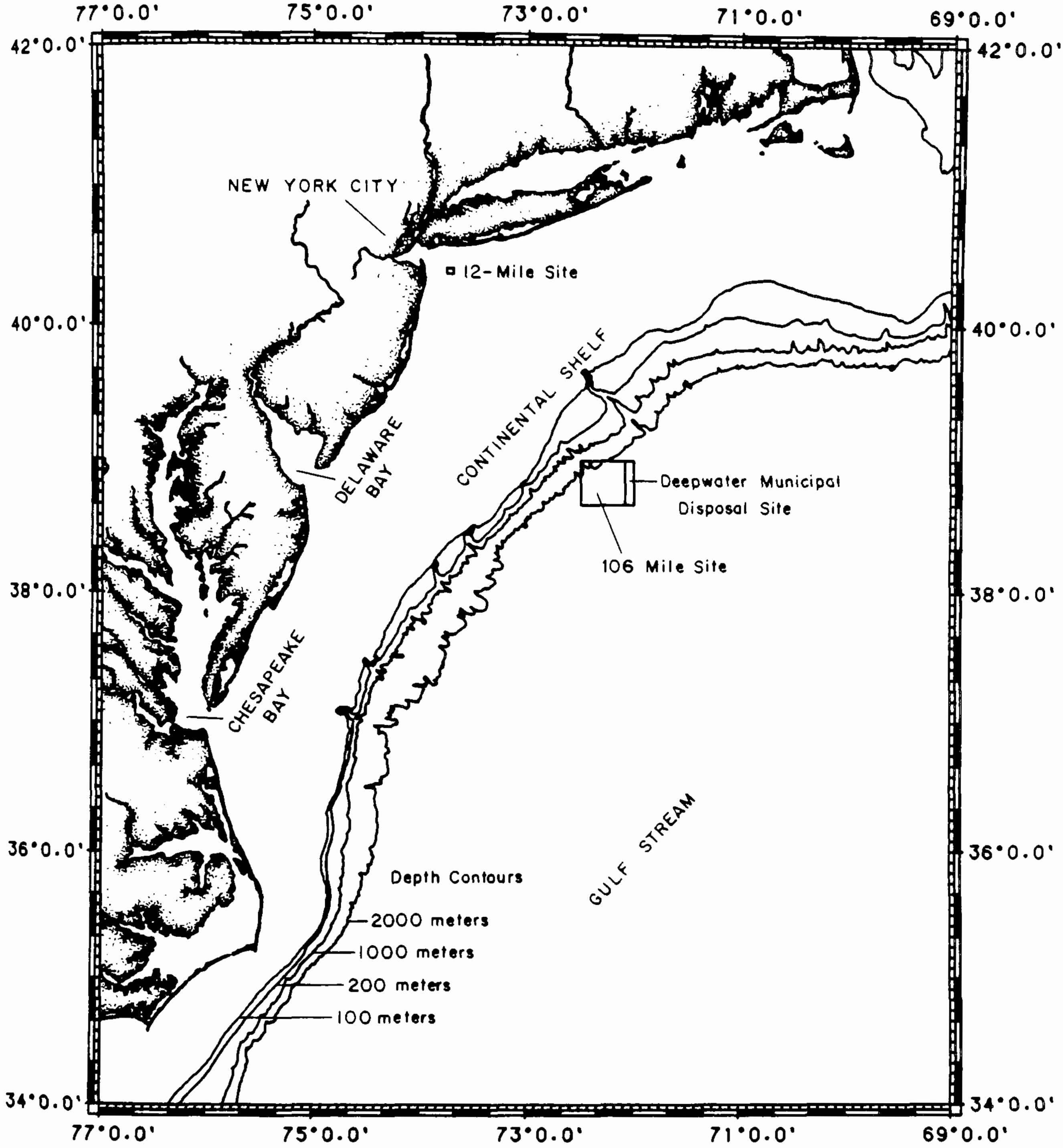

Figure 5. Locations of the 12-Mile Site and the 106-Mile Site (modified from Walker *et al.*, 1987).

In a final exercise, impacts on the short-term population dynamics of zooplankton were indicated to be minimal at existing loading rates, although they became more significant with an increased mass loading rate (Munns *et al.*, 1989). The low toxicity of these sludges, in conjunction with the highly dispersive character of a deepwater site, results in an expectation of little to no adverse environmental impact associated with sludge disposal at the 106-Mile Site.

To date, limited monitoring of sludge disposal impacts in the vicinity of the 106-Mile Site has occurred. Early monitoring efforts focused on waste characteristics and near field fate and effects. ERLN's assessments of ecological risk therefore have not been validated. Although EPA is formulating a more comprehensive monitoring plan for implementation in the near future (EPA, 1990), recent legislation (The Ocean Dumping Ban Act of 1988) has dictated cessation of municipal sludge disposal at this and all other oceanic sites by the end of 1991. It is therefore unlikely that our long-term predictions will be tested.

IMPACTS OF DISPOSAL OF OTHER ANTHROPOGENIC WASTES

A multitude of anthropogenic wastes other than dredged material and sewage sludge have been introduced in marine systems (Ketchum *et al.*, 1981). Of these, combustion products of at-sea incineration activities, acid wastes and other industrial byproducts, and radioactive wastes, might reasonably be considered the most noxious. Studies conducted at ERLN and elsewhere have demonstrated the potential for adverse impacts associated with the release of such wastes. Again, the impact realized in the environment is determined in large part by the quantity and rate at which the material is released and the physical characteristics of the site. In the case of liquid wastes, rapid initial dilution following disposal typically limits the extent of adverse impact associated with even relatively toxic wastes. Some examples will serve to illustrate these points.

An investigation of at-sea incineration of driftwood and other wooden debris was conducted to determine the potential for toxicity and bioaccumulation of contaminants associated with the ash effluent produced as a result of post-burn wet-down activities (Schimmel and Pruell, 1989). Samples of this effluent, and of the receiving waters around the incineration vessel, were the subject of acute toxicity assays and 10-day bioaccumulation tests utilizing mysids, fish, algae, and sea urchin reproductive cells. Of the samples tested, only the wet-down effluent itself displayed significant toxicity. No bioaccumulation of the several organic and inorganic contaminants examined was observed. These results indicate that although this incineration waste has the potential to produce adverse impact, rapid mitigation of this potential occurs as a result of initial dilution upon entering the ocean. Similar conclusions were drawn from a study of the combustion byproducts of PCB-contaminated fuel oil (Strobel *et al.*, 1988). Little toxicity was observed using a variety of test species and endpoints in assays simulating introduction of stack gasses into marine waters. Thus, when the wastes are sufficiently diluted or exhibit low toxicity, no adverse impact are expected.

The potential exists, however, for long-term buildup of waste materials in bottom sediments when sedimentation of these materials is sufficient to impact the bottom. The depth of the disposal site and the lateral transport experienced by the waste as it descends become important in these cases. For instance, modeling efforts and experiments conducted by Bonner *et al.* (1986) indicated that a high degree of dispersion could be expected for low-level radioactive soils released at the edge of the continental shelf. On the other hand, solid wastes can accumulate on the bottom of shallow systems in a fashion similar to dredged material accumulation. The adverse impacts of this buildup can include modification of bottom sedimentology, affecting the suitability of the site for benthic recolonization, contaminant bioaccumulation, and perhaps acute and chronic toxicity (Harvey, 1989).

CLOSING REMARKS

Impacts associated with ocean disposal of waste materials are the result of complex interactions between physical, chemical, and biological processes. Thus, the risks associated with disposal of each type of waste need to be examined and defined individually in the context of the characteristics of the disposal site and potentially impacted biota. In regions receiving input of multiple wastes, however, management by waste load allocation appears most appropriate. Individual disposal decisions would then be made in the context of the total waste stream entering the region, perhaps with some consideration of the assimilative capacity (*sensu* Cairns, 1977) of that region. Evidence is accumulating which suggests that many of the nearshore environments in the New York-New Jersey-Connecticut region may be close to reaching that capacity.

Despite their inherent complexity, disposal impacts are measurable, and through application of a risk assessment strategy, subject to prediction. Sound technical bases for the delineation of environmental (and human health) risks associated with other disposal options also exist, or are being developed (see Norton *et al.*, 1988). It should therefore be possible for the environmental manager to evaluate and compare the risks of each disposal option, and then select the one which yields the optimal solution with respect to potential environmental impact, cost, esthetics, or any other criterion important in the disposal decision. Environmental studies will continue to provide valuable insight to this decision process.

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Remarks of Lillian C. Liburdi
"Cleaning Up Our Coastal Waters:
An Unfinished Agenda"
March 13, 1990

Ocean Disposal: A Commercial Perspective

Good morning. My name is Lillian Liburdi, and I am the Director of the Port Department of the Port Authority of New York and New Jersey. It is a pleasure to be here today, and to be given the chance to speak on the economic issues of dredged material disposal. Before I address the questions provided, I would like to give you some background on the Port Authority and Port of New York and New Jersey.

The Port Authority was created in 1921 by compact between the states of New York and New Jersey as their joint and common agency to plan, develop and operate a bi-state network of land, sea, and air transportation facilities and other facilities of commerce that contribute to the promotion and development of the economy of the New York/New Jersey Metropolitan Region.

Our Port facilities are unquestionably a vital component of the bi-state region's economic base. The Port generates more than $14.0 billion annually in economic activity, $4.2 billion in wages and salaries, $2.3 billion in business income and $.4 billion in state and city income taxes and sales tax.

The direct impacts represent a significant contribution to the regional economy, accounting for approximately three percent of regional employment.

Commodities of all kinds are brought by ship to pass through our marine terminals, ranging from orange juice to automobiles, lumber to wine. Some shippers move their cargo through the NY/NJ port largely out of geographic convenience - this region has a large consuming population. However, you must be aware that, as a result of the massive changes in the transportation industry such as deregulation and intermodalism, we cannot count on business, even those in the region, to ship through the Port. Unlike years ago, when the Port was clearly the nation's gateway, we must now compete not only with ports on this coast, but ports around the nation. Rail and truck services have become important players in the competition for cargo. It may be cheaper for a shipper to bring cargo into a port that may be farther from the cargo's ultimate destination, only to move it by rail or truck the rest of the way.

Competition in this industry is fierce. All aspects of the industry are brought into play. Costs, service, labor - all are factored in, including the physical ability of a ship to enter port and navigational safety. Dredging is one of these competitive components.

The Port of New York and New Jersey has no choice but to dredge. The natural depth of the harbor - about 18 feet - could not accommodate today's deeper draft vessels requiring 35 or more feet. Approximately 8 - 12 million cubic yards of sediment is relocated from the Port's navigation channels and berths each year. All decisions on dredging and dredged material disposal impact the commercial viability of this port. Legislation of regulation that is not sensitive to the need to balance environmental needs with realistic economic considerations, can affect, possibly severely, a port's competitive position and the regional and national benefits derived from port activities.

Presently, total federal maintenance channel dredging costs in the port are more than $20 million annually. It is conceivable that more stringent regulations could raise the cost of dredging and disposal significantly. There are many scenarios with attendant costs I could share with you. One dramatic example is the use of a containment island. Using Corps of Engineers planning estimates, and assuming that project costs would be recouped, dredging, transportation and disposal costs could escalate between $60 and $215 per cubic yard of material. That would drive the annual dredging cost up to anywhere between $71 to $243 million. Again, I submit that we all must balance human economic needs with environmental protection.

In considering the issues and impact on the commercial viability of the Port of New York - New Jersey, with regard to alternatives to woodburning at sea, we must discuss navigation safety and pollution. Again, some background information. Most of the wood burned at sea is generated by the New York Harbor Removal of Drift Program. The project was conceived as the most effective way to rid the waterfront of decrepit piers and structures that ar hazardous sources of drift. Drift can be, and is, a navigational hazard to commercial and recreational shipping. It can rupture the hull of a vessel. In addition, the project offers the prospect of waterfront land reuse, with further benefits of aesthetic and environmental enhancements, as well as fire and health hazard reduction. The Corps has estimated that collisions with drift causes $53 million in damage to recreational and commercial vessels each year. There is an indirect cost in dollars and public perception to this port when a vessel is damaged in the harbor. Safe navigation is very important to the Port Authority and the vessels that navigate our harbor.

As to the last question that I am to address in this forum - "Would the Port Authority serve as a sponsor for innovative programs for dredged material disposal?" - it can be read in many ways. We are involved in many of the ongoing efforts to address the environmental issues that are now being examined in our harbor, especially those that seek to examine dredging and the placement of dredged material as part of their agenda. We have been members of the Corps of Engineers Public Involvement Coordination Group, assisting to hammer out a workable long term plan for the management of dredged material along with 500 other participants. We are actively involved in the London Dumping Convention, which examines the issue of ocean dumping on an international level, through our membership in the International Association of Ports and Harbors. We sponsored the kickoff meeting of the New York/New Jersey Harbor Estuary Program and have been attending committee meetings ever since. The Port Authority also sponsored a seminar on Dredged Material Management in 1988 - many of you were there.

The Port Authority would most certainly join with state, local and the federal government and agencies to explore and sponsor innovative, cost effective solutions to the placement of dredged material. This issue will not be solved by on authority of agency. It will take a joint effort of all the stakeholders of our harbor and our region. We are willing to help.

Thank you for allowing me to express the Port Authority's views on these issues. We look forward to working however we can with you to balance those issues in a way that addresses sound environmental and economic policy.

AN INTEGRATED AGENDA FOR CLEANING UP OUR COASTAL WATERS

AN INTEGRATED AGENDA FOR CLEANING UP OUR COASTAL WATERS

Albert F. Appleton, Commissioner

New York City Department of Environmental Protection

March 13, 1990

To begin with, I would observe that the only successful agenda for cleaning up the coastal waters of the New York metropolitan region will be an integrated one. We will either recognize that shared natural resources are the concern of all, or we will bog down in jurisdictional squabbles and struggles over power, prestige and responsibility, or more likely the avoidance of it, and our shared hopes for environmental restoration will remain unrealized. Governments must learn to work together and they are going to have to accelerate their efforts to do so, for public expectations are growing at a very rapid pace.

The Dinkins Administration is an environmental administration and it has a keen interest in the status of our local waterways and land-water connections. Our swift and aggressive response to the Exxon spill in Arthur Kill, our commitment to work towards tighter regulation of the petroleum industry, is one example of this dedication to clean coastal waters. Another example is our commitment to preserving and, where possible, restoring the City's wetlands. We believe in no net loss of wetlands and we have been disappointed in the Bush Administration's retreat from it in the fine print of recent wetlands policy documents.

To combat coastal pollution effectively, government must first establish sanction severe enough to take the profit out of pollution. But at the same time, it must also offer partnership and assistance to the private sector, and make it easier for businesses to meet environmental standards. New tools for this partnership include technical assistance programs, better preventive measures, impartial, scientific intensive monitoring of pollution control efforts, full assessments of natural resource damages, prompt and definite regulatory guidance, an understanding that time is money, the commitment of sufficient resources to regulatory management and the creation of genuine tools of self-regulation such as environmental auditing.

Second, government must put its own house in order. Since the 1930's, and particularly since the early 1970's when Federal aid became available, New York City has invested heavily in water pollution control programs. The programs started since the Clean Water Act have already yielded major gains in water quality, and the City is committed to achieving even more improvements as the work continues and new programs are added.

Government control of its own pollution demands a comprehensive set of programs. Since the Clean Water Act, over $2.5 billion has been spent to build two new sewage treatment plants for the large parts of Brooklyn and Manhattan that never before had plants, plus pumping stations to link other unserved areas to existing plants. The new Red Hook plant was completed last year. The new North River plant began advanced preliminary treatment in 1986 and will be completed this year. Upgrading work has already been completed on nine of our twelve older plants. Work is still underway on the Coney Island and Owls Head plants, and design work is beginning on the Newtown Creek plant. The total cost of these last three upgrades is estimated at over $2 billion.

New York City generates about 1.7 billion gallons of sewage daily. As a result of expanding our treatment plant network, DEP has reduced the City's routine raw sewage discharge into coastal waters from 425 million gallons per day in 1973 to less than 1 million gallons today. Intermittent raw discharges, caused by construction related bypasses, accidents or malfunctions, have been reduced from an average of 200 million gallons per day in 1973 to about 4 million gallons today. Recent improvements were gained through our regulator improvement program, budgeted in Fiscal 1990 at $3.1 million, which has substantially eliminated dry weather leakage from faulty regulators.

The only remaining routine raw discharge comes from five outfalls at the southern tip of Staten Island. Work is underway on an interceptor sewer and pumping stations that will halt this last discharge by 1993, at a cost of over $200 million. In addition, lateral connections to the interceptor sewer will eliminate the aging septic tanks and privately operated "package" plants that have poorly served southern Staten Island.

As a result of our investments in new treatment plants and our sewer system over the past 15 years, the City's annual survey of Harbor water quality shows a significant drop in coliform bacteria counts, and a significant increase in dissolved oxygen. Total coliforms harborwide averaged 11,800 per 100 ml in 1974. They dropped 86%, to 1,600 per ml, by 1989. Fecal coliforms dropped 87%. Average dissolved oxygen levels rose 34%, from 3.8 mg per liter in 1974 to 5.1 mg in 1989. Our surveys show that these basic water quality indicators are finally returning to turn-of-the-century levels.

With raw sewage discharges under control, the City's $1.5 billion Combined Sewer Overflow Program is the next major step toward better water quality. Our initial ten-year program is focusing on the City's largest combined sewer outfalls. The benefits will be major gains in dissolved oxygen and coliform bacteria levels, as well as a reduction in floatable trash in our waters. The first two projects will begin land use review this spring and all eight projects in our initial program will be in the facility planning stage by the middle of next year. Our first two projects are for the Paerdegat Basin and Flushing Bay coastal inlets, which are severely impacted by storm runoff. Their target completion dates are 1995-1996.

The Combined Sewer Overflow Program incorporates both traditionally-oriented projects, like the retention facilities planned for our largest outfalls, and experimental approaches like our test of a pontoon-based system in Fresh Creek. This system, called the Flow Balance Method, has been used successfully to abate storm runoff into freshwater lakes in Sweden. Fresh Creek is the first location in the world to test the system's ability to deal with combined sewer overflows into saline waters. So far the results are highly encouraging. A Federal grant paid half the $750,000 cost of the original installation, and are in the process of obtaining similar monies for a $1 million project to reconfigure and improve the facility.

After combined sewer overflows come floatables. Following the summer of 1988 DEP, along with State and Federal agencies, developed a program to keep water borne trash from polluting our beaches. Last year the City started a $2.7 million study that will lead to permanent measures to keep trash out of the water. We are scrutinizing every possible source of floatable trash in the New York Harbor, from storm and combined sewer overflows to decaying piers, solid waste transportation and recreational activities. We are also looking at the transmission of floatables in, around, and out of our local waters. We expect this study to yield significant data we can use to create a systematic program for reducing floatables from sources in New York City. We are also hopeful that the regional information-gathering in the study will help other regional localities focus their clean-up efforts.

After combined sewer overflows, we turn to toxic metals. Regrettably, since we first began monitoring heavy metals in Harbor waters in 1974 we have detected no significant long term improvements, with the exception of a decrease in lead primarily due to federally mandated cutbacks in leaded gasoline. On the other hand we have seen a highly desirable result of our aggressive enforcement of federal industrial pre-treatment regulations, in a significant reduction of metals in our sewage sludge. The staff of our Industrial Pretreatment Program has grown from an initial twelve to 39, and we are trying to find the resources to bolster the program staff again, to 58. We are also looking to add additional staff to our water testing laboratory.

We are now concentrating on ways to reduce metals that leach into our water from plumbing, beginning with copper. Success on this front should yield gains in both sludge and Harbor water quality.

After toxic metals, we must safely dispose of our sludge. New York City halted the disposal of sludge at the 12-Mile Site at the end of 1987, in compliance with Federal law that now requires ocean disposal at the 106-Mile Site pending ocean disposal phase-out by 1992. Whether these new measures improve coastal water quality remains to be seen.

New York City has begun to invest tremendous sums in land-based alternatives for sludge disposal. Last fall the City placed an order for 53 sludge dewatering centrifuges, at a cost of $44 million, which we plan to install on the grounds of eight existing sewage treatment plants. Total costs for the dewatering facilities alone are estimated at $694 million. We are working with the private sector to find both interim and permanen' land-based sludge management alternatives that make beneficial reuse of its organic qualities. That goal is going to be difficult to obtain. We will need the help of those who so fervently argued that sludge should be taken out of the ocean. It is hardly good coastal policy to save the water at the price of inflicting far worse damage on the land or air.

For New York City, another element of coastal water preservation is taking all possible steps to avoid resorting to the Lower Hudson for drinking water. The reduction of flows into our treatment plants is an important secondary gain from water conservation, saving major infrastructure costs. We've coordinated a $25 million Infiltration and Inflow study of the sewers with electronic leak detection of the water supply system to abate groundwater infiltration from leaking water mains, we are implementing the citywide Metering Program on a priority area basis, and we are conducting door-to-door leak inspections in buildings in those areas as well. By spring we hope to have a program, at an estimated $1 million cost, to conduct free leak and waste audits for homeowners citywide. This program will also include installing free low-flow showerheads and aerators.

A keystone of our City-wide water conservation projects is our $290 million, 10-year program to install water meters in all 630,000 residential buildings that have never been metered. We are also replacing 170,000 existing meters. So far the program is running ahead of schedule, at a rate of approximately 1500 installations weekly.

The City has also mandated the installation of low flow fixtures in new or renovated buildings. The City law adopted the ultra-low 1.6 gallon per flush standard for toilets, for which the law takes effect in 1992. We are working successfully with the plumbing industry and other city agencies to have the ultra-low flow toilets installed voluntarily even before the 1992 deadline. Every year an estimated 200,000 toilets are replaced in New York City.

To encourage property owners to retrofit their buildings with low-flow fixtures, DEP has a pilot retrofit program underway, using city-owned apartment buildings and low-flow fixtures donated through the New York Plumbing Foundation. So far the comparison of retrofitted buildings with the control group shows a 30-40% drop in water consumption.

Public education about water conservation has become a permanent DEP program since the 1985 drought emergency. In Fiscal 1990 we allocated $600,000 for water conservation programs, including videos, brochures for adults, educational material for schoolchildren, and an exhibit opening Thursday at the Con Edison Conservation Center.

In addition to seeking more funds for building on these existing programs, the City plans to implement additional pollution abatement and wetland protection projects. These include Harbor System Modeling, a Greenhouse Effect evaluation, the Staten Island Bluebelt program, the Harbor Herons Nature Refuge Complex, the Buffer the Bay program for Jamaica Bay, the Bronx River and Udalls Cove programs, and a variety of wetland restorations in various city coastal parks. We are moving towards a permit with the Department of Environmental Conservation on cleanup of hazardous waste sites and control of discharges from Fresh Kills. New York City is also participating in studies of the Long Island Sound, the New York Bight, the Hudson River estuary and the New York-New Jersey Harbor estuary to help devise plans for future regional water quality improvements. As part of the Long Island Sound Study, we have volunteered our Tallman Island sewage treatment plant in Queens and budgeted over $300,000 to test methods there for reducing nutrients in plant effluent.

I believe this represents reasonable progress by New York City towards our goal of comprehensively putting our own house in order.

The third component of an integrated strategy is inter-governmental cooperation. Frankly, it is my limited experience that we can do much better. However cordial and collegial relationships are on the personal level, it is difficult to see much evidence of an integrated approach to Clean Water. State and Federal bureaucracies are understaffed and too divorced from operational responsibilities to have any clear sense of time urgency in the short term and time reality in the long term. Moreover they suffer from their own internal divisions of responsibility between regional officials and distant capitols, and are in the position that no theorist of democratic government regards as desirable, of having power without responsibility, particularly the power to require actions from subordinate levels of government that they refuse to accept responsibility for either paying for or dealing with the obstacles to their implementation that no local government has the power to remove.

A similar list of sins besets local and regional governments. They have let themselves be consumed by short term local interests, political, economic and budgetary, to the absence of any long term strategy of environmental improvement. They have been far too willing to blame higher levels of government for their own environmental failures and far too unwilling to enter the national environmental political debate on the broad scale of carrying forward national environmental policy, as opposed to short term and immediately expedient pursuits of parochial local interests.

Above all, an integrated inter-governmental approach would be asking two questions: what planning is being done, and does the current institutional division of labor make sense. I have some strong concerns on both issues. It is difficult to see any orderly thinking about environmental policy in the debates over the Clean Air Act, on federal energy policy, and on a dozen other topics, starting with water policy. Some legislation is resource focused, other is pollutant focused, some use command and control measures, some is incentive driven, some performance standard driven, some discretionary regulations. We have sludge legislation making draconian demands that we get sludge out of the ocean in an impossibly short time without the slightest proof that the alternatives are environmentally more beneficial standing side by side with federal toxics cleanup and pesticides regulation programs that in very fundamental ways are more environmental gesture than environmental regulation. We have more models for citizen participation than you can shake a stick at, and we have steadily more dissatisfied citizen groups. And when it comes to preemption, the concept of consistency seems to vanish from the English language.

Last, but certainly not least, there is the ominous political and moral inconsistency bordering on the predatory different jurisdictions often manifest towards each other. New Jersey bemoans New York sludge and then moves forward towards ringing the harbor with sludge incinerators that will send her sludge products New York bound. New York State bemoans New Jersey air emissions while ignoring the need to prevent development in Sterling Forest from filling northern New Jersey reservoirs with sewage. The Midwest bemoans shipments of northeast garbage while blithely sending acid rain precursors all over the northeast to save a few percentage points on utility rates. Until there is a realization that political boundaries do not relieve governmental jurisdictions of their responsibilities to their fellow Americans these practices, and all they mean for coastal waters, will continue.

If this conference accomplishes anything, it will be to suggest not that there are answers to the question of an integrated approach, but some major massive questions that we should no longer delay discussing.

Fifth, an integrated approach means a national approach, and a national approach means one thing, national money. I'm new on the block, I realize the Revolving Fund was meant to close out the Federal Clean Water Funding responsibility question, but let's unclose it. My biggest three combined sewer overflow plants will cost less than one B-2 bomber. Which will do the country more good? Reprogramming 1% of the current defense budget would double the funding for EPA. Which would do the country more good?

The lament out of Washington the last ten years is that we cannot afford domestic investment in our infrastructure. Not only is that statement astonishingly myopic, but it represents an approach to the management of our Federal resources so egregiously misguided that it cries out for challenge. It was pointed out not too long ago that the main difference between the Federal Budget in 1980 and today is that somewhat over $100 billion has been cut from domestic programs and somewhat over $100 billion has been added in interest on the national debt. Senator Moynihan has pointed out that the 1980's was not a tax cut decade, merely a time when we slashed income taxes on our wealthiest citizens and offset them with social security tax increases on hard working blue collar and middle class taxpayers. The Federal government has made massive increases in off-book loan guarantees and is now bailing out the Savings and Loan industry to the tune of $200 billion plus. Under those circumstances, any claim that the Federal government cannot afford to spend some necessary billions a year on Clean Water infrastructure is laughable. And it is time to say so. There is a peace dividend coming that has to be reinvested in the country's pressing social and environmental problems. It is time we stopped impoverishing ourselves, neglecting and degrading our basic natural resources.

The sixth component of an integrated coastal policy is an integrated approach to the environment. It is time we stopped pushing pollutants out of one media into another. Sludge is one notorious example, but there are many others such as solid waste, acid rain and toxic substances. This means it is time to end the era of pollution control and begin a new era of pollution prevention. There will be no cleaner coastal waters without it. Here in the New York - New Jersey harbor region we are admirably positioned to turn what is a necessity, a multi-media approach to pollution control, into a major opportunity for national leadership.

Lastly, I must add that there has to be an integrated philosophy of environmental protection. I think the two concepts we must ground this on are equity and creativity. Equity here means equal access to public resources. Let me illustrate with a non-water example, the current Clean Air Act debate. The Bush Administration costs its own Clean Air proposals at $19 million, and they claim those of Clean Air advocates would total $41 million. Assuming (and it's an assumption only) for a moment that both these numbers are correct, what the Bush Administration is arguing is that industry should get to cut down $22 billion worth of Clean Air from the public resource treasury. By what right? We have to stop using the environment as a free resource to subsidize the economic gains of a select few.

As for creativity, I hope the concept needs no introduction but what does it mean in practice? It means rejecting the pat solution, the standard orthodoxy and finding ways to craft win-win solutions for all concerned. It is impossible to overstate how much we will need this. There are no more easy environmental victories in the years ahead. And without new ideas, new approaches, a new era of integrated thinking and integrated regional action, we will have no environmental victories at all.

In closing let me just suggest this: We all have immediate and legitimate institutional needs, immediate and legitimate bureaucratic and political authorities we must report to. But if we cannot find a way to reconcile whatever differences these produce to face the larger problem of coastal pollution, then the environmental prognosis for the future is grim indeed. As Benjamin Franklin once observed, we must all hang together, or we will hang separately.

EXISTING AND PLANNED ENVIRONMENTAL PROGRAMS:

A NORWALK PERSPECTIVE

By: Dominick M. Di Gangi, P.E.
City of Norwalk
Director of Public Works

INTRODUCTION

Much of what you have heard yesterday and this morning concerns the importance of controlling the discharge of nutrients -- more specifically nitrogen -- into Long Island Sound. The preliminary data available from the Long Island Sound Study suggest that we can no longer be content with removing only 5-day biochemical oxygen demand and suspended solids. The environment appears to warrant that we do more. Algal blooms and resulting limited light penetration are related to nutrient enrichment -- some of which comes from municipal treatment plant effluents as well as non-point sources such as urban runoff and agricultural runoff. We at Norwalk have opted to do something about the contribution of total nitrogen our treatment plant makes to Norwalk Harbor and to Long Island Sound. Working with the Connecticut Department of Environmental Protection and our consulting engineers, Malcolm Pirnie, we have developed an aggressive program to determine what method of biological treatment is best suited to solving the nutrient removal issue at Norwalk. More importantly, the program is geared toward developing processes that will have general applicability to all secondary facilities discharging to the Sound, both in New York and in Connecticut.

Long Island Sound is a vital resource. More locally, Norwalk Harbor is extremely important to the economy of the City of Norwalk and Fairfield County. The City recognizes this and has embarked on an ambitious program to meet the problem head on and solve it. Today, I will describe several elements concerning our work:

- The general history of the City's environmental programs
- A bit about our current process performance
- The nature of the nutrient problem facing Norwalk Harbor
- Our current program for biological nutrient removal.

With respect to nutrient removal, the City of Norwalk is Taking Action!!!

SOME BASIC HISTORY

The original Norwalk wastewater treatment plant was constructed by the City in 1931. At that time, the facility consisted of the present primary settling tanks and a chlorine contact tank for disinfection. Although a primitive treatment works by today's advanced standards, the facility provided a marked improvement over the many raw discharges and grit tank that characterized waste treatment in Norwalk prior to its construction. At best, the old primary plant removed suspended matter from the waste and provided a measure of disinfection for the protection of the public health.

As residuals management become a problem owing to the competition for space in an urban area, the plant was modified in the mid-1960's to include a coil-type vacuum filter for the dewatering of primary sludge and a fluid bed incinerator to combust the dewatered sludge and reduce its ultimate volume to ash.

For over 40 years, the Norwalk plant existed as a primary facility until, in 1974, an activated sludge biological treatment process was added to comply with state and federal water quality objectives. The secondary addition included several conventional unit processes including aeration tanks, final clarifiers and additional chlorine contact facilities, as well as dissolved air flotation thickeners, centrifuges and an additional fluid bed incinerator for solids handling.

The 1980's brought more change for Norwalk. Early in the decade, a supplemental treatment facility -- the only one of its kind in the State of Connecticut -- was constructed to primarily to treat storm water. A new headworks was built, including new bar screens, grit chambers and Parshall flumes. However, the major element in the supplemental facilities were six rotating drum microstrainers designed to treat stormwater in a flow stream parallel with the secondary treatment facilities. The last major addition to the facility came with the construction of a second fluid bed incinerator and the replacement of the centrifuges with belt filter presses for the dewatering of combined primary and secondary sludge. The original fluid bed incinerator was abandoned with the start-up of the new unit.

Today, the Norwalk plant can provide effective biological treatment for a wastewater flow of 15 million gallons per day.
As you will see, permit limitations are consistently met with performance being far better than required. Also, the plant provides treatment for up to an additional 75 million gallons per day of stormwater in its supplemental treatment facility. This is where we are in 1990. However, we anticipate that the next five years may radically change the face of the Norwalk wastewater treatment facility. The issue is nutrients.... here is why.

The Harbor

Norwalk Harbor is an estuary formed by the confluence of the Norwalk River with Long Island Sound. In an engineering report entitled "Norwalk Harbor Demonstration Project for Hypoxia Control", the Connecticut Department of Environmental Protection presented documentation concerning the need to mitigate severe low dissolved oxygen conditions in the Harbor.

The estuary is characterized as having an "outer harbor" known as Sheffield Island Harbor and an "inner harbor" essentially comprised of the tidal reaches of the Norwalk River. The harbor has many prominent environmental features including the Stewart B. McKinney Wildlife Refuge which supports the third largest wading bird colony in the northeast as well as the largest nesting and feeding heron colony on Long Island Sound. Also, the harbor supports very significant commercial and recreational activities, including:

- Two public beaches
- Twenty-two marinas
- Twelve yacht clubs
- Thirty commercial fishing vessels
- Two thousand acres of shell fish beds
- Seventy percent of all seed bed oysters sold in Connecticut

All of this contributes to an annual revenue of about 20 million dollars in activity directly related to the Harbor. Clearly, the vitality of Norwalk Harbor is extremely important to maintain from both environmental and economic perspectives.

THE PROBLEM

Before I present the current action plan for the harbor and its implication for the Sound, let's set the stage by briefly discussing the problem.

Research conducted by Connecticut DEP has determined that Norwalk Harbor has water quality problems including extremely low levels of dissolved oxygen. Sampling and mathematical modelling have attributed these hypoxic conditions to excessive algal growth and resulting eutrophication. The preliminary conclusion reached by DEP is that the conditions of hypoxia are largely a result of the presence of the nutrient, nitrogen. Nitrogen is present in the effluent from the Norwalk plant -- as is the case in most secondary plants not designed to remove nitrogen forms. The implication here is that the nitrogen in the Norwalk effluent contributes to the water quality difficulties in the Harbor. Clearly, there are other sources of nitrogen, such as urban and agricultural runoff to the river. However, these non-point sources are believed to be present in much smaller quantities and are more difficult to control and quantify than a municipal plant outfall.

As a result of the study work to date, it was concluded by DEP that the control of nitrogen from the Norwalk plant could have a beneficial impact on the Harbor. Moreover, since the harbor resembles the Sound itself in many ways -- for example, both water bodies exhibit localized hypoxic conditions in a marine environment -- I believe what we learn in Norwalk will have wide ranging benefit to many communities in both Connecticut and New York. The Norwalk program is a key element in the overall Long Island Sound Management plan. Now, I'll tell you about the program and how we got there.

THE NORWALK DEMONSTRATION PROGRAM

In March of 1989, the City advertised a Request for Proposal to develop a facility plan to address the advanced waste treatment needs of the Norwalk plant. After a review of proposals, the City selected based on qualifications and experience the consulting engineering firm of Malcolm Pirnie, Inc. of White Plains, New York to prepare the facility plan and develop the Norwalk Harbor Demonstration Project. (As a side note, Pirnie's Vice President responsible for the project, Joe Lauria, is a graduate of Manhattan's sanitary engineering program.)

The approach to solving the nitrogen removal problem had to be flexible; several criteria were established:

- Up to 90% removal of total nitrogen might be required
- The City preferred a non-proprietary process, if possible
- Re-use of existing tankage was desireable
- Site constraints were considerable.

In consideration of the other plants which potentially could be affected by nitrogen removal policy, I believe these criteria have relatively universal applicability. We all have tight sites and would like to get maximum utility out of existing facilities. With these thoughts in mind, the Norwalk Demonstration Pilot Project was developed and funded two-thirds by a planning grant obtained form Connecticut DEP.

To satisfy the study objectives, three separate pilot systems treating up to a total of 9,000 gallons per day were designed and constructed on-site at the Norwalk plant. Each pilot was designed as a biological nutrient removal facility using a different process.

The first pilot was constructed with basic design criteria similar to the existing secondary treatment processes. Our intent with this system is to see just how far we can "push" nitrogen removal in a model of a conventional secondary plant by doing "simple" things such as cycling on and off the diffused aeration system, installing fixed baffles in the aeration basins, modifying mixed liquor concentrations and varying recycle rates. Successes here will be translated to full plant trials and also could be tried at other municipal plants designed along the same conventional mid-1970's criteria as were the Norwalk secondary facilities.

A second pilot system was constructed with specific aerated, mixed and anaerobic zones with tankage and internal recycles established so as not to infringe on existing patents for three-stage biological nutrient removal processes. We believe this system may achieve levels of total nitrogen removal approaching 90 percent.

A third pilot system was constructed using a modification of the 5-stage Bardenpho process. The system contains two aerated zones and three zones of very low dissolved oxygen designed to achieve up to 90 percent removal of total nitrogen forms.

All three pilot systems are being operated simultaneously and are treating primary effluent from the existing treatment plant. A mechanical chiller is in-place and is capable of reducing the 9,000 gallons per day of primary effluent to a temperature of about 5 to 7 degrees centigrade. This will be used to asses the impact of cold weather on process performance. Currently, we plan to operate all three systems for at least six months.

BENEFITS

There is much to be gained from the Norwalk Biological Nutrient Removal Demonstration Pilot Program:

> Pilot scale evaluation of three alternate biological nutrient removal technologies will determine the best approach to year-round nutrient removal, not only for Norwalk, but for all plants discharging to the Sound. The data available from cold weather operation of the biological nutrient processes will be of

significant benefit to all designers of wastewater treatment facilities.

- More accurate cost estimates for the design, construction and operation of advanced facilities of this type can be determined through pilot plant scale-up.

- Subsequent to construction, the opportunity to study post-treatment water quality improvements in Norwalk Harbor will provide unique and useful data pertinent to understanding the problems encountered in Long Island Sound itself.

- Subsequent to construction, the Norwalk facility would be the first of its kind in Connecticut and could serve as an instruction center for municipal staff involved with treatment plant operations and maintenance.

SUMMARY

To summarize briefly, I've discussed some of the history of the Norwalk facilities and described the problems facing Norwalk Harbor. The existing environmental programs and their performance have been described; the existing plant is doing quite well.

Nutrient removal is the next step. Our program is ambitious and currently is being implemented. The benefits that will be derived for the Norwalk Demonstration Pilot Project will advance significantly our understanding of the most appropriate biological nutrient removal technology for this climate and will have broad implications for Sound-wide water quality improvements.

The City is proud to be among the leaders in contributing to the nutrient removal solution for Long Island Sound.

Thank you.

EXISTING AND PLANNED ENVIRONMENTAL PROGRAMS: AN INDUSTRY PERSPECTIVE

by

Geraldine V. Cox, Ph.D.
Vice President Technical Director
Chemical Manufacturers Association

ABSTRACT

The chemical industry initiated several programs that reduce its contribution of contaminants to the estuary system. For ten years we have operated waste reduction programs to lower the volume of wastes we generate, and to increase the treatment levels of the wastes that are must be disposed. This program has been superseded by the Responsible Care Initiative which is a broader program that includes waste reduction and other elements. Responsible Care is an obligation of membership in the Association.

Responsible Care has management practice codes that address various operational elements of the chemical industry. The most relevant code to the New York Bight is the Waste and Release Reduction, WARR, Code. This code will be adopted shortly by the industry and focuses on reducing waste at the point of generation.

BACKGROUND

When I first worked on the New York Bight in 1970, I can remember the gross pollution that came from just about every source imaginable. The industrial effluents had some control, but not that much. Sewage treatment of municipal wastes was primary — if at all. Combined sewer overflows carried raw sewage, industrial wastes and runoff from the streets that was laden with heavy metals, salts and other wastes. The majority of the heavy metals, 96%, entering the New York Bight came from the Hudson and its tributaries (NOAA, 1975). The practice of dumping garbage from New York stopped at least a decade before, but disposal of primary sewage sludge and construction rubble continued. While ocean dumping of industrial and municipal wastes was a common practice at that time, this practice has contributed little contamination relative to the total loading to the New York Bight.

When I drove through New Jersey toward New York I can remember air pollution so severe that my eyes swelled shut and I could not see. I remember driving along open trash heaps in the tidal marshes north of the Newark Airport. The swarms of sea gulls that fed on the dumps became a hazard for the airplanes landing at the airport. Fallout from air pollution and seepage from improperly managed waste disposal operation contributed significant levels of contamination to the New York Estuary and Bight.

Fortunately that picture of the past is becoming more of a memory.

Many things have changed in the intervening twenty years. State and Federal legislation and regulation and voluntary industry actions have reduced industrial inputs to the Bight. Ocean dumping of industrial wastes is no longer practiced in the New York Bight. Industry has significantly reduced the levels of organics and toxic materials in its effluent. Industry has reduced the volume of the wastes it generates and has significant recycling and reuse programs. The quantity of airborne contamination is a small fraction of what it was in the 1970s. This airborne reduction reduces the quantity of materials that enter the waterways by atmospheric fallout and non-point source reduction. The practices of waste disposal have changed in that same period. Industry is under severe restrictions for its disposal of wastes.

Unfortunately other things have not changed soon enough. The treatment of municipal wastes — both waterborne and solid — lag well behind industrial counterparts. Ocean disposal of industrial wastes is a thing of the past. New York is finally ceasing its ocean disposal of sewage sludge. New York City's slow movement to secondary treatment and the continued problems with municipal solid waste disposal force me to give the New York Estuary and Bight a mixed report card for the past twenty-year period.

INDUSTRY RESPONSES TO ENVIRONMENTAL RESPONSIBILITY

Responsible Care

The chemical industry has accepted its role to protect the environment and the communities surrounding our operations. We believe that we have an obligation to go beyond legal requirements. This commitment has its roots deep in the history of the industry and currently is manifested in our Responsible Care management code.

The Responsible Care initiative has five key elements:

1. Guiding Principles — The Guiding Principles of Responsible Care are statements regarding health, safety and environmental quality upon which management practice codes are based. The Principles recognize both public concerns and the industry's desire for self-improvement.

2. Codes of Management Practice — Responsible Care is defined through a series of management practice codes. Each code clearly states its purpose and the management practices it is intended to foster. Each code also states the intended results and defines, in a qualitative way, what is expected of member companies. All codes will be accompanied by implementation resource materials that identify ways a company can improve its performance. Codes aim to encourage companies to stretch themselves to achieve higher levels of performance. Codes are reviewed by a Public Advisory Panel and member companies before final approval.

3. Public Advisory Panel — Fundamental to Responsible Care is the Public Advisory Panel. This panel is composed of informed citizens and environmental and community leaders from across the country. It helps ensure that the public's concerns are understood and that actions are taken to respond to those concerns. The Panel reviews all proposed Codes of Management Practices and will provide early warning on issues of public concern.

4. Member Self-Evaluation — Each management practice code requires a member company to conduct an annual self-evaluation of its progress on implementing each element of that code. This assists company management to determine whether a change in implementation is necessary. The self-evaluations also will assist CMA to gauge overall industry progress and to identify areas where additional resource materials are needed.

5. Executive Leadership Groups — Executive Leadership Groups are regional meetings of Chief Executive Officers (CEO) and other senior industry executives that provide an opportunity for companies to meet and discuss their progress and share experiences with Responsible Care implementation. Each group is chaired by a CEO or other senior executives and each region contains approximately thirty companies. Group members discuss individual progress on overall implementation, identify areas where individual companies need assistance and suggest adjustment to the program.

6. Obligation of Membership — Obligation of membership includes: 1) signing the Guiding Principles; 2) commitment within the company; and 3) to participate in code drafting and good faith effort to implement the code.

Guiding Principles

CMA developed the Guiding Principles of Responsible Care from a position statement adopted in 1983 by CMA's Board of Directors. The statement acknowledged public concern about the impact of chemicals and hazardous waste on human health and the environment. In the statement, CMA endorsed principles regarding health and safety and environmental quality and urged its members and all chemical manufacturers to adopt them. CMA expanded upon this statement, using the Canadian Responsible Care Principles along with guidance from member company Executive Contacts, to prepare the Guiding Principles.

Responsible Care begins with each member company's Executive Contact signing the principles, Table 1, as evidence of the company's commitment to support fully an effort to continuously improve the industry's responsible management of chemicals. Table 2 provides management code development dates.

TABLE 1. GUIDING PRINCIPLES FOR RESPONSIBLE CARE A PUBLIC COMMITMENT

As a member of the Chemical Manufacturers Association, this company is committed to support a continuing effort to improve the industry's responsible management of chemicals. We pledge to manage our business according to these principles:

- To recognize and respond to community concerns about chemicals and our operations.

TABLE 1. (cont.)

- To develop and produce chemicals that can be manufactured, transported, used and disposed of safely.
- To make health, safety and environmental considerations a priority in our planning for all existing and new products and processes.
- To report promptly to officials, employees, customers and the public, information on chemical-related health or environmental hazards and to recommend protective measures.
- To counsel customers on the safe use, transportation and disposal of chemical products.
- To operate our plants and facilities in a manner that protects the environment and the health and safety of our employees and the public.
- To extend knowledge by conducting or supporting research on the health, safety and environmental effects of our products, processes and waste materials.
- To work with others to resolve problems created by past handling and disposal of hazardous substances.
- To participate with government and others in creating responsible laws, regulations and standards to safeguard the community, workplace and environment.
- To promote the principles and practices of Responsible Care by sharing experiences and offering assistance to others who produce, handle use, transport or dispose of chemicals.

TABLE 2. RESPONSIBLE CARE IMPLEMENTATION

Code of Management Practices

- Community Awareness and Emergency Response Approved November 1989
- Waste and Release Reduction Will be presented for approval in April 1990
- Process Safety Will be presented for approval in June 1990
- Distribution Will be presented for approval in November 1990
- Waste Management Will be presented for approval in April 1991

TABLE 2. (cont.)

- Product Stewardship Will be presented for approval in Winter 1991
- Worker Health and Safety Will be presented for approval in Spring of 1991

Responsible Care is a program of the present and the future. The chemical industry has reduced its contributions to the general contamination of the New York Bight through other programs that will be incorporated into the Responsible Care Codes of Management Practice.

Hazardous Waste Management

The Chemical Manufacturers Association has conducted numerous seminars and produced materials to help its members reduce the volume of wastes it generates and to provide better treatment for those wastes that must be handled. This effort has paid off (Tischler/ Kocurek, 1989).

Wastewater

- Between 1981 and 1987, the participants have reduced wastewater generation by 18.6%.
- The quantity of waste treated in NPDES facilities decreased by 12.7% from 1981 to 1987.
- Discharge to a POTW decreased 65.8% from 1981 to 1987.
- Wastewater treatment by means other than in NPDES facilities or by discharge to a POTW decreased by 84.6% from 1981 to 1987.
- Underground injection decreased by 9% between 1981 and 1987.

Solid Waste

- Solid waste generation increased 27.1% from 1981 to 1987 — mainly from recycled wastes. Without including recycled wastes, solid waste generation actually decreased 41.5% from 1981 to 1987.
- Incineration increased 50.2% from 1981 to 1987.
- Solid waste treatment by means other than incineration decreased by 69.8% from 1981 to 1987.
- Landfill disposal decreased by 13.6% from 1981 to 1987.
- Incineration increased from 14.7% in 1981 to 44.9% in 1987.

- Landfill disposal increased from 13.3% in 1981 to 30.5% in 1984. Since 1984, there has been a steady decrease to 23.4% in 1987.

In 1987, of the hazardous solid waste that the chemical industry generated, 77.2% was recycled. Recycling includes material reclamation/reuse/recovery and energy recovery.

Rather than belabor the point, the chemical industry is generating far less waste than it did a decade ago, and it is managing that waste in a far more rigorous manner than it did even five years ago. The net result is that the wastes from our operations have significantly less impact on the New York Bight.

Fugitive Emissions

Another program of the Chemical Manufacturers Association is Fugitive Emissions. In 1989, the Chemical Manufacturers published Improving Air Quality: Guidance for Estimating Fugitive Emissions from Equipment. This manual helps the member companies to identify the sources of fugitive emissions from operating equipment so that the sources can be controlled. We worked with the Environmental Protection Agency to assure that the manual conformed to the Agency's methodology. This has helped many members to reduce the emissions from previously unmonitored sources. The manual is supported with three video tapes and a computer program, Plant Organizational Software System for Emissions from Equipment, POSSEE. POSSEE supports the organization, entry and analysis of plant data and field measurements of fugitive emissions. It allows entry of screening and bagging data too.

Airborne contaminations are a concern in the New York Bight, and with such programs the chemical industry is reducing its contribution of contamination to the watershed.

SUMMARY

The chemical industry has made significant improvements in its operations in the New York Bight area. The environmental protection programs instituted by the industry and by the federal and state governments make it much less significant as a source of contamination in the region. The industry is committed to improving its performance even more. Contamination from the chemical industry is no longer a significant threat to the Bight. Nationwide, the contribution of pollution to waters is less than 11% from all industrial sources (CEQ, 1987).

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SETTING PRIORITIES: A NATIONAL PERSPECTIVE

David A. Fierra
Water Management Division, U.S. EPA Region I

Thank you, Rich. I guess I'm supposed to be talking about priorities from EPA's perspective in six minutes. Maybe I'll try to do it in one minute by saying that as everyone here expects, EPA considers everything a high priority and everything should be done tomorrow. That's my short speech. But I guess I've got to go through at least six minutes.

I've been with EPA since the beginning and I've seen it evolve. In the beginning years, EPA dealt largely and continues to deal largely with point source problems, at least in the water program. They got very used to running programs, very specific programs, permitting programs, enforcement programs, things that were easily quantifiable. I guess that those are the things that are more easily dealt with from a budget perspective. Congress likes to know how many permits are going to get issued for how many people and how many enforcement actions. Unfortunately, that has driven EPA to be very program specific. I know that it is true in some of the other programs, although I'm not as familiar with them. We've tended over the last 20 years or so to be very, very program specific -- a lot of it because of legislation, the need to deal with what may be called the most obvious problems, and because that is where we can best get our budget. I think in the early 1980's we realized that we really hadn't accomplished, and were not going to be able to accomplish, what Congress intended us to accomplish back when the Clean Water Act was passed in 1972. I think through experiences such as what was going on in the Great Lakes, the Chesapeake Bay, and other areas, we realized that we were not accomplishing the goal of a healthy ecosystem and a healthy environment.

One example I would like to use to further emphasize that problem is Cape Cod, Massachusetts, where there are no point source discharges because there is a state Ocean Sanctuaries Act, but where we continue to have nutrification problems, and more shellfish beds are closed every year. Obviously you can't turn around and point at the pipes coming out of New York City or Boston or anywhere else as the problem -- not even CSOs. So really we have to start looking at things differently. We've got to start looking at things that we haven't looked at -- some of the nonpoint source issues.

What Administrator Reilly asked the Agency to do over the last year is to try and start dealing with some of these broader issues. I think he's frustrated by the way some of our laws are very parallel, they don't integrate activities. I think that because of that, he's asked the Agency to embark on a strategic planning process.

I can talk a little bit about what we are doing in the water program, and particularly in my region. We're one of three regions in the country that have been asked to pilot a strategic plan, and I'll try to talk about the national environmental priorities we are trying to deal with in a strategic sense. The Office of Water Strategic Plan -- the Office of Water Program with its strategic plan -- has come to recognize the Chesapeake Bays, the Long Island Sounds, and the New York Bight, by saying that we need to emphasize some of these ecosystems but we also need to continue some of the activities that we have had ongoing for the last 20 years. Basically we have taken the position that we must maintain the environmental gains that have been made and at the same time start solving some of the ecosystem problems. With limited resources, that is going to prove to be a real challenge.

I'd like to talk a little bit about my perspective on how these issues fit together and what they mean. To maintain environmental gains, as Administrator Reilly mentioned yesterday, requires continued enforcement, in fact, increased enforcement. He mentioned something to the effect that he would be out the door if the numbers didn't go up. I certainly took that as a message that I'd probably go out the door before he would, if the numbers didn't go up. I do see an emphasis on enforcement. I think we can take that emphasis and put it where it's going to make a bigger difference, maybe in some areas that are more important than others. I think looking at toxics and the enforcement of toxics regulations in the coastal zone is certainly something that we could and should do more of. In another area -- the wetlands issue -- I think we should have more aggressive enforcement, particularly in some of the sensitive areas. I hope enforcement is not going to just be number driven but it's going to have an impact.

I think we need to do more pretreatment and we need to do more regarding point source discharges. Again, I think we have to target some of these activities because of limited resources and implement them where they are going to do the most good. I think a lot of people here feel that the coastal areas would be one of those target areas.

The no net loss policy -- I personally think that habitat protection is vital to the survival of any coastal system and we need to do more than just enforce regulations against violators. We need to look at more preservation. We need to be more proactive. There are habitat wetland areas in the coastal areas that have been degraded but have the potential to be restored. I think we need to seek out and restore them, not just implement the no net loss policy, i.e., trade off one for another. I think we've got to start getting a leg up on that, at least in the sensitive areas.

Another new program is the nonpoint source program as a national priority. I think this is something that is particularly important in sensitive areas. Actually, when a lot of people talk about nonpoint source problems they equate them almost totally with agricultural issues. I think it certainly is a major issue and a big problem. I also think that there are a lot of other nonpoint source kinds of activities that are critical to the coastal areas and to the Northeast and we need to do a better job of lobbying in terms of their importance.

I think another principle that both Administrator Reilly and LaJuana Wilcher have emphasized is the whole area of pollution prevention. I think it is particularly critical and should be interwoven into whatever priorities we set. As I mentioned yesterday, I would encourage people to not limit their thinking about pollution prevention to waste minimization but, rather, to look at it in its broadest sense in terms of resource protection and what needs to be done in areas such as land use management. There are certain things we need to limit -- the loading zone -- and the most important one in the marine environment is nutrients.

What criteria should be used to establish priorities? Well, for one thing, we need to maintain the quality of the environment that we have already attained. And that's a tricky job. In my region, for strategic planning, we have decided, for better or for worse, that we are going to pay somewhat less attention to point source discharges in freshwater areas, particularly large streams that have a lot of dilution and probably don't need as much attention. That doesn't mean that those permits aren't going to be enforced -- they are going to be enforced. They are in effect. But we are considering not reissuing them as rapidly as we have in the past. That's a small thing, but we are also looking at inspections to see where they make a big difference, in terms of risk and knowing that we have got to do more inspections in sensitive areas with a set level of resources. We're trying to identify areas where, even if we have a minor violation from time to time, we're not going to have a water quality problem.

I think preservation of habitat in the coastal area is something that, in the short term, we should decide to do, seek out, and take a proactive approach. I was happy to see this morning that it was ranked high across the board. Obviously, all levels of government can play a role in that as well as citizens.

We should, in the short term, make a commitment to looking at all ways of changing our lifestyles, and preventing pollution. I think we could all do something and it needs to be done collectively. We need to establish that as an effort.

I think the other problems that we've heard talked about today and yesterday -- nutrients, the pathogens, and toxics -- I've heard arguments on both sides of those issues that I could probably use to make a case for prioritizing them one way or another. I also heard Commissioner Carothers, and I think she hit it right on the money when she said we need good science and we need commitment from everyone. I think what we need to do to establish some of those priorities is to bring together people who are going to be effective, who are going to be making decisions, who are going to be affected by the decisions, and who need to make a commitment and bring more public interest and public input into this. I think nutrients, at least in Long Island Sound, are a systemwide problem and need to be dealt with by both states and dealt with in the very near future. Many of the other issues, e.g., pathogens, combined sewer overflows, some toxics in some cases may be more local problems. I think that we, as regulators, need input from people in terms of the value of some of the affected resources because everyone has said solutions are very expensive and they are not going to be accomplished overnight. We need broad-based input; we need to hear from everyone, we need to go out and solicit input because the regulatory program itself, whether it be permits or enforcement, is not going to accomplish the whole job. It needs to be done in collaboration with a whole group of people including scientists and so forth, and we need to get our act together to determine what makes the most sense for a given resource area. We need a process for doing that. In my region, I've been trying to work with my states to develop what we are calling a state clean water strategy. What we are looking at is a nonpoint source strategy, issues dealing with nonpoint sources. We have always had a permit strategy which is basically to take care of the permits, reissue permits, and enforce permits. We need to have some integrating approach to bring those two strategies together and to identify the resources and the actions that the public is most interested in and most committed to implementing because that's really what it's all about. We need some kind of a process like that. In Long Island Sound and some of the estuary programs we have many of the ingredients for achieving it. We have very good CACs and technical advisory committees. I think we need to reach out and bring in the politicians, and in some cases we've done that. That, to me, is a decisionmaking process. It is not necessarily what a scientist can say is the worst problem or the most serious problem. We need to be able to solve the problem. People need to know what is important to them, and they need to know how to communicate that to us. I don't feel it can be a scientific approach to things. Science certainly has to play a role but so does everyone else. So, I think that what I would do in the coastal areas would be to continue the coalitions that have been built, build on them, and continue the dialogue. I hope we can arrive at some consensus on what things are really the most important in terms of the ecosystem and the public's interest, and move forward with that kind of an approach.

AN INTEGRATED AGENDA FOR CLEANING UP OUR COASTAL WATERS

QUESTIONS AND ANSWERS

Q. **Arthur Glowka, Long Island Sound Task Force.** *There are a couple of things that Mr. Di Gangi left out. The Norwalk Plant, which is 75 miles up the Sound was probably one of the worst run sewage treatment plants on Long Island. It was sued successfully by a group of citizens in 1985 and they settled out of court. The plant is now being run by Malcolm Pirnie, Engineers, because the city does not have the facilities or the people to run it themselves. One of the reasons that this plant was picked out for nutrient removal was because you have a very active citizens water monitoring group who have a good profile on exactly what the water quality is of the Norwalk River. Any of this work that gets done on the Norwalk Plant you can tell whether it's improving the Norwalk River or not. But Mr. Di Gangi also forgets the fact that he can't even handle his own sludge; it's being trucked up to Naugatuck, right?*

A. In the interim, yes.

Q. *In the interim. For how many years in the interim? All right, now. The last thing are these pilot plants, for 3,000 gallons a day. Are these actually operating and who's paying for them?*

A. They are part of the state grant, as I mentioned. Either they are on the verge of operating or will operate.

Q. *So they are not operating. What kind of money and who's paying it?*

A. I believe it's about $600,000 to $450,000.

Q. *I just want to bring these up.*

A. The Norwalk Treatment Plant is operated by city personnel, managed by Malcolm Pirnie, who provides two people. Yes, there is a consent degree that was initiated and settled out of court that occurred about two years after the City was in the process of making massive improvements to the treatment plant. A monitoring period was created as part of the settlement and the plant performed, I believe, very well. The fine that was instituted was theoretically to be $750 per violation and I think there were five. Yes, there was a suit but it caught the plant on its upturn not its downswing.

Q. *It couldn't have gotten any worse.*

Q. **Eugenia Flatow, Coalition for the Bight.** *I would like to know how do you compare the cost of the improvements that were made.*

A. The treatment plant, in the last five years, has doubled most of the operations. Most of the capital improvements come out of the capital budget and are spread out over a 20-year period. The cost to the taxpayer has been tremendous. There's been about $10 million in investments for the treatment plant, I believe, over the last five years. It is normally the city's number one priority on its capital budget.

Q. *I guess I was really interested in the cost beyond the secondary treatment.*

A. I don't believe we have a handle on those numbers.

PRELIMINARY CONCLUSIONS FROM TUESDAY'S WORKSHOP SESSIONS: THE PRIMARY FACTORS CAUSING USE IMPAIRMENT AND OTHER ADVERSE ECOSYSTEM IMPACTS

Facilitators

NUTRIENT/ORGANIC ENRICHMENT

John P. Lawler
Lawler, Matusky & Skelly

The conclusions of the three groups that addressed nutrient/organic enrichment were presented in plenary session on Wednesday, March 14, 1990, in four categories: information requirements, point source control, nonpoint source control, and original source control.

INFORMATION REQUIREMENTS

Under this category, the group identified four subcategories: models, costs of control options, achievable standards, and a unified data base.

Everyone in all three groups saw a need to complete the component models for the Sound, the Bight, and the Harbor; a high priority was placed on doing this, on a short-term basis, within the framework of the studies. The understanding was that we really can't get the answers we're looking for without the completion of these models. The development of a systemwide model was recommended, in which the components from the three individual models would be taken and put together. This was given a medium priority and viewed as a long-term effort.

Most people in each of the groups felt that there simply wasn't enough work done at this time in any of the management studies in terms of developing the costs of the various control options. Cost development needs to take place on a parallel basis, now, in the short-term, while the models are being developed; i.e., we need to know the costs of various control options at the same time the answers from the models being developed are becoming known.

Achievable standards was a discussion specific to the Sound. Dissolved oxygen standards on the Sound are at least 5 mg/L in all cases and in some places 6 mg/L, whereas the maximum level at which adverse effects have been observed is 4 mg/L, and the hypoxia problem is discussed in terms of 3 mg/L or less. To achieve 5 or even 6 mg/L was perceived to involve a major cost, and questions as to how realistic such standards are were addressed.

A long-term need to continue the monitoring program and to see that the data from all of the areas were placed in some kind of unified data base was identified.

POINT SOURCE CONTROL

Point source control was viewed largely in terms of nitrogen removal at sewage treatment plants. Current operations should be maximized as much as possible to obtain whatever nitrogen removal can be achieved at the plants now. The issue of additional sludge generation by changing certain process operations may not have been addressed.

Again, focusing on the Sound and on the short-term basis, facility planning was aimed first and foremost on retrofits at the existing plants. Several different speakers discussed what was going on in Connecticut at this time, and New York City's program at Tallman's Island was also noted.

Facility planning to evaluate what would be required for new additions to achieve major nitrogen removal should also be done, with cost and achievable removal the twin objectives of each study.

No position whatsoever should be taken on what additional requirements, if any, should be placed on the New York City plants on the East River and Long Island Sound until the level of East River transport of nutrients from the various plants on the Sound is determined on completion of the models, particularly the Sound model.

Consideration should be given to requiring that new plants, in areas where such could clearly be considered to be contributing to the hypoxia problem, include nitrogen removal.

NONPOINT SOURCE CONTROL

One group felt atmospheric deposition should be studied on short-term basis and put a medium priority on it. Another group felt that it should be reduced on a long-term basis and also put a medium priority on it. Both viewed the problem as systemwide as opposed to individual water bodies.

Land use controls and land use management programs were discussed with specific reference to wetlands. This was viewed on a systemwide basis and both short and long term.

A high priority should be placed on beginning the planning now as part of the program and ultimately seeing it become a continuing thing.

Some specific commentary was made on tributaries as to what their contributions actually are and what one could do to attenuate that effect.

Stuart Freudberg presented a large number of steps that are being taken in the Chesapeake Bay region in the area of nonpoint source controls. With respect to new developments, more thought should be given to the stormwater retention that already takes place in many developments. Though normally required from a flooding standpoint, the kinds of things that we do today for flooding, with some minor changes, also have some benefits in the area of nutrient control, e.g., wet rather than dry detention ponds, particularly two-stage.

ORIGINAL SOURCE CONTROL

All three groups saw education of the public as to how each individual person can contribute to source control as the important factor to achieve original source control. This recommendation focused on the lifestyle changes that were heard in any number of discussions through the three days of the conference.

Two groups felt that at least there should be some studies on phosphate bans.

Everybody felt that water conservation is a must. All kinds of benefits come from it and strong recommendations should be made for it.

Either on a required basis or at least by encouraging it through some kind of incentive, organic fertilizers with slow release of nitrogen should be fostered as the commercial fertilizer of choice.

Boat sewage at marinas should be pumped to sewers and sewage treatment plants.

PATHOGENS/FLOATABLES

Robert Runyon
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Although the workgroups for pathogens and floatables issues were combined, comments on the impacts and recommended control strategies were segregated based upon significant differences in the activities associated with assessment and implementation mechanisms.

PATHOGENS

The first topic for which a necessary action was considered centered on the need to develop a water quality indicator related to health risk. During this discussion, consideration was also given to investigating a human-specific indicator. The basis for this consideration is recent data showing that existing indicator systems have little or even negative correlation with human health risk from bathing. It was proposed that regulators working with the scientific community throughout the entire system would accomplish this activity. Timing was considered to be short term owing to the obvious need, but several years may be needed to accomplish this task. Priority ranking was high.

The second necessary action discussed was development of minimal standards for bathing beach closures relevant to the task mentioned previously. The current inconsistencies among various states involved in classifying bathing waters, as well as the opening and closing of bathing areas for swimming, were discussed. There is, however, national consistency in classifying and regulating the use of waters for harvesting of shellfish. The scope of this action is systemwide with a short-term time frame and is rated as high priority.

The third recommended action involves investigating the effectiveness and the adverse impacts of disinfection. This action is directed toward two related areas: the first would investigate current disinfection practices to evaluate their efficiency in killing the pathogens that most frequently result in human illness from either ingestion of shellfish or swimming in polluted water; the second would investigate the adverse environmental impacts of disinfectants currently discharged into the harbor receiving waters. The scope was considered to be systemwide; priority was considered to be medium for localized areas and lower for offshore areas of the Bight itself.

The fourth topic for recommended action was the reduction and abatement of CSO discharges. This effort requires coordination of all Federal, State, and city authorities in the Harbor and the Sound. The three prior recommended actions were discussed before this action, since it is recognized that the information developed in actions one through three would serve to ensure that the most appropriate, cost-effective abatement strategies would be implemented. This is critical owing to the immense cost of implementing this action to reduce pathogen concentrations. This also needs to be accomplished as soon as possible and was rated as a high-priority action.

The fifth recommended action discussed recognizes the need to control pathogen contributions from marina operations, standardizing requirements for pump-outs or other mechanisms to eliminate this source. This was rated as a short-term medium priority action to be accomplished by coordinated Federal, State, and local authorities.

FLOATABLES

The group developed more recommended actions regarding floatables issues during the discussion. A central theme that was expressed throughout the discussion by virtually all participants was the emphasis that must be placed on public education concerning the role of the individual in controlling floatables pollution. Topics discussed in this area involved the individual's role in floatables from CSOs and stormwater. Methods of "getting the message out" were discussed, including the use of the media and educational curricula in the schools. Additional discussion mentioned the role of the individual in recycling, particularly medical-related waste.

The second recommended action recognized the contributions of shoreline cleanup to reducing floatables, recommending an expansion of New Jersey's "Operation Clean Shores" and a continuation of the waterborne cleanup by the Army Corps of Engineers and the regional "Floatables Action Plan." This effort is rated as a short-term, high-priority action within the Harbor.

The third recommended action lumped a variety of recommendations into the category of source reduction. This included recycling, redesign of packaging, and instruction on disposal for insulin syringes and instruction on disposal of home-generated medical-related waste. Discussion also involved education to implement changes in life style, involving industry and all levels of government as well as the public in implementation. The scope was considered systemwide, timeframe as short term and continuing, and the priority was rated as high.

The fourth action, surveillance and enforcement, was discussed in the framework of a perceived need to have adequate surveillance coverage to detect illegal disposal or other illegal activities resulting in floatables discharges as well as to have appropriate enforcement authority to penalize offenders. It was recommended that the public have the opportunity to report violations that they observe. This action scope was systemwide, with a short-term time frame and a medium to high priority.

The reduction of CSO discharges was also recommended as an action item under floatables, since the most objectionable floatable items stranded on shorelines often are sewage-related material. Additionally, group members expressed concern that stormwater collection systems must also be addressed since they also contribute significant floatables concentrations. The CSO abatement action was rated as high priority within the Harbor and Sound, with the stormwater system operation and maintenance throughout the system rated as medium to high. Both were recommended as short-term and continuing timeframe actions.

TABLE 1. Pathogens

Action	Who	Where	Time frame	Priority
1. Develop indicator related to health (Human specific)	Regulators/ scientists	Systemwide	Short and long	High
2. Develop minimal standards relevant to No. 1 bathing standard	Regulators	Systemwide	Short	High
3. Investigate effectiveness and adverse environmental impacts of disinfection	Regulators/ scientists	Systemwide	Short	Med.-localized Lower-offshore
4. Reduction/abatement of CSO discharges	Federal, state, city	Harbor, Sound	Short	High
5. Standardize marina operating procedures	Federal, state, local	Systemwide	Short	Medium

TABLE 2. Floatables

Action	Who	Where	Time frame	Priority
1. Public education on individual's role with respect to floatables, CSOs, stormwater (use of media, educational curricula), recycling, medical waste, litter, individual responsibility	All levels and public	Systemwide	Short	High
2. Expansion of shoreline and water cleanup (Operation Clean Shores, Floatables Action Plan)	Interagency	Harbor	Short	High
3. Source reduction (recycling, redesign packaging, syringe disposal, lifestyle changes)	All levels and industry	Systemwide	Short and long	High
4. Surveillance and enforcement	All regulators and public	Systemwide	Short	High (M)
5. Reduction/abatement CSO discharges	Federal, state, city	Harbor, Sound	Short and continue	High
6. Stormwater system design, and O & M	State, local	Systemwide	Short and continue	Medium (H)

TOXICS

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In facilitating discussions for several workgroups at this conference I noted that any group tends to develop a premise around which discussions are centered. I believe that this tendency influences the recommendations finally chosen by the group and that it is important to know the proposition that served as a ground for recommendations. Two workgroups dealt with Toxics. One worked off the premise that the toxic chemical problems in this system are poorly understood and the first order of business is to improve our understanding, whereas the other group's premise was that toxic chemicals are impacting the system, and irrespective of our level of understanding of the problem, we must immediately expand efforts to decrease inputs of all toxics.

Both groups did not distinguish between the Harbor, Bight or Long Island Sound. All of the recommended actions are applied system-wide. With few exceptions the actions are considered to be short term, i.e., to be implemented as soon as possible.

The first group recommended the following actions:

1) **Criteria & Standards.** Criteria and standards exist for only a limited number of toxic chemicals and thus we do not have end points that would allow an assessment of the toxic chemical problem. It is critical that the development of biological and numerical criteria and standards for water, sediment and biota be fast-tracked. It is also critical that these be consistent across states.

2) **Coordinated Intensive Monitoring.** We don't understand the toxics problem because we do not have proper end points, but also because we do not have enough data to determine concentration levels in the environment. A coordinated intensive monitoring program is needed to quantify loadings (point, nonpoint and atmospheric) and concentrations (water, sediment, biota and atmosphere). It is critical that such a program be coordinated so that all agencies involved use common sampling and

analysis procedures and that all data reside in a single database accessible to all interested parties.

3) **Evaluation of Disposal Alternatives.** It is necessary that the impacts of all possible alternatives be considered in decisions regarding the disposal of toxic wastes. In particular, ocean disposal of sludges should be reevaluated relative to the environmental and public health impacts of land disposal and incineration. The group was strongly committed to reopening the issue of ocean disposal of sludges.

4) **Fate Processes.** An increased understanding of the processes controlling the fate of toxics in all phases of the environment is needed. In particular, intermedia transport of toxics must be better understood.

5) **Modeling.** Current modeling capabilities are insufficient. We must improve and further develop modeling frameworks for predicting the fate of toxics on both micro and macro scales, with particular emphasis on assessing public health impacts.

The second group recommended the following actions:

1) **Implementation of Existing Regulations.** Good regulations to control the sources of toxic chemicals already exist, e.g., the pretreatment program and 304L program. However, these regulations have not been aggressively applied. We must speed up their implementation.

2) **Increased Enforcement.** Standards are not rigorously enforced. Greater compliance with effluent standards would help curtail the toxic chemical problem.

3) **Reduce Nonpoint Sources.** Toxics loadings to the system from nonpoint sources are substantial. A program of nonpoint source control must be developed immediately.

4) **Land Use Controls.** A recommendation for long-term action was to attempt to reduce toxic loading by controlling land uses.

5) **Cost-Benefit Analysis for Individual Chemicals.** Establish the true cost of a chemical by including disposal costs and the costs of environmental controls so that informed decisions regarding the production and use of the chemical can be made by contrasting benefits with the true cost. This recommendation was assigned a medium priority.

6) **Lifestyle Changes.** Change the way we live so that we minimize the generation of toxic wastes. For example, limiting automobile use would reduce toxic loading to all phases of the environment.

HABITAT

Allan Hirsch
President, Dynamac Corporation

Three groups developed recommendations on habitat, facilitated by Bob Dietrich, by Fred Grassle, and by me.

One of the first points to be made is that "habitat" is not limited to wetlands. It includes adjacent uplands, shallow water environments, and dunes and beaches, all of which directly affect coastal resources or coastal ecosystems.

Our discussions also recognized the overall relationship between habitat protection and the much broader question of controlled growth, coastal development, and open space preservation. Even though we focused on recommendations dealing explicitly with habitat, there was an undertone in our discussions that reflected the broader fundamental problem of too much congestion and of ways to address that issue.

We developed four categories of recommended actions -- regulation, land use planning, acquisition, and information development:

A. Regulation

Of the various types of habitat or open space that are important to maintenance of coastal environmental quality, wetlands and aquatic environments are the ones most subject to regulatory protection, and the only ones subject to direct federal regulation. Our recommendations in this category, therefore, are specific to improved wetland regulatory programs. Some of these should be accomplished on a short-term or immediate basis. They are as follows:

1. The "no net loss" policy should be codified. It is very important to have this policy reflected in the formal regulatory structure.

2. Closely related, there should be more consistent application of mitigation requirements and better adherence to the water dependency requirements. For

example, we should not allow a marina attached to a proposed housing development in a wetlands to be used to circumvent water dependency requirements.

3. There should be increased staff and funding for wetland regulatory programs at all levels -- state and federal. The current effort is too limited.

4. The monitoring of permit compliance and enforcement provisions should be strengthened. Again, this is related to increased staffing and resources. Very often mitigation requirements in a permit are not monitored or followed up, and probably a great deal of noncompliance results.

5. Regional ecosystem approaches should be incorporated into wetland regulation. We need to find ways to consider wetland permits not on an ad hoc basis but rather on a regional and on a cumulative impact basis. One mechanism is advance identification under the 404 program.

6. Improved integration of regulatory procedures is needed. This was discussed principally from the standpoint of improving how applicants could interact with the regulatory agencies. There are several federal agencies involved as well as state and sometimes local agencies. The thought was not to recommend that all those agencies have to reach a uniform decision on proposed permits, because they may have very different viewpoints and missions. However, the application procedures should be unified -- such simple things as assuring that applicants do not have to fill out different sets of permit forms for the state and federal agencies.

B. Land Use Planning

This is where the concern for habitat preservation and the fundamental issue of regional development come together. Recommendations are as follows:

1. Review existing statewide planning processes in the region to determine their adequacy for incorporating ecosystem protection and ecological goals. Statewide growth management efforts now under way should be identified and evaluated to determine how useful they would be in incorporating some sort of ecological goals for coastal areas. The New Jersey State Redevelopment Plan, a statewide planning process, was specifically identified. There were said to be a number of similar planning processes in Connecticut; nothing similar was known to be under way in the State of New York.

2. Review the adequacy of the three states' coastal zone management programs, from the same standpoint. The Coastal Zone Management Act is coming up for reauthorization, and that review could lead to recommendations as to how the act should be strengthened or modified.

3. Review the Maryland Critical Area Program. This is a program that emerged from the Chesapeake Bay Program. It places density limitations on different kinds of lands adjacent to the Bay and designates the kind of development that can occur within a thousand feet of the water line. That program should be reviewed to see whether the same concepts might be recommended for adoption in this region.

4. In the final analysis, the local governments control much of what happens through their land use planning and zoning. It was recommended that the Local Government Committees of the Estuarine Management Conferences review the adequacy of local government planning and zoning. They should look at such matters as whether there are still tax incentives in effect that encourage unsound development. The Management Conferences should attempt to exercise leadership in conducting such reviews and developing recommendations.

5. Review the Federal Floodplain Insurance Program to determine whether improvements could be recommended in the way the program is administered, and possibly, in the fundamental regulatory structure itself, to create greater disincentives for development in vulnerable coastal areas.

C. Acquisition

This is the ultimate mechanism for protecting sensitive and critical habitat areas. Recommendations are as follows:

1. That a regional plan framework for acquisition be developed. This framework would outline regional acquisition priorities. The potential role of acquisition includes more than wetlands or unique sensitive areas. There has to be a concern for a total regional framework, including buffer zones, corridors, or other provisions. Based on regional goals and a regional framework, efforts should be made to develop a long-range action program for acquisition. Acquisition itself takes place through many bodies: federal agencies such as the Fish and Wildlife Service; private bodies such as the Nature Conservancy or the Audubon Society; and the state agencies. However, we should seek to develop an overall regional framework of goals and priorities. Both fee and easement types of acquisition should be considered; acquisition of littoral rights was specifically mentioned.

2. We should use regulatory actions on a pending or interim basis prior to acquisition itself. Once an acquisition plan is outlined and certain areas are identified as priorities, land costs can very quickly skyrocket. Regulatory procedures should be used in tandem with acquisition wherever possible.

3. Various kinds of financing mechanisms that might be used to implement acquisition programs were identified, such as real estate taxes, permit fees,

gasoline taxes, and sequestering enforcement fines for use in acquisition. The use of development transfer rights was also mentioned as a mechanism to set aside or preserve various kinds of open spaces.

4. Finally, it is important to find incentives for non-public acquisition programs such as those of the Audubon Society or the Nature Conservancy, through various kinds of matching or cooperative efforts.

In summary, no short-term, immediate implementation actions were developed in the acquisition category, but rather in areas where the Management Conference should develop recommendations for the future.

D. Information Development

We continue to need a better technical information base for habitat preservation. This includes the following:

1. Maintaining good inventories and maps both of habitat and species distribution. Much of that work is under way, but many of the findings are not accessible to the public and to interest groups. It is not pulled together and presented in a convenient way.

2. Devising better criteria for considering trade-offs; which are the most valuable things to acquire and protect? We need to develop better criteria for assessing habitat values that can be used in planning decisions.

SEAFOOD SAFETY

Rosemary Monahan
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The safety of seafood to human consumers is of national importance and the recommendations developed by the workgroup apply nationwide, and not just to local waterbodies. Many groups need to be involved in solving current problems, including all levels of government, the fishing and food industries, and public interest groups.

Two themes emerged in the workgroup discussion:

-- one is that we need to ensure that the seafood consumed in this country is safe, and

-- the second is that we need to make sure the public understands how safe their seafood really is.

Our recommendations follow in order of importance.

Public Education

Our highest priority for action was public education. We felt that the public perceives eating seafood as risky, although this perception often is false and results from misinformation.

Our public education efforts should be focused on several groups:

1. Media. In the past, the media have been responsible for disseminating some misinformation on seafood safety and exaggerating risks, so we should do a better job providing them with accurate information and explaining it.

2. Elected officials. Since elected officials create our laws and determine our budgets, we need to ensure they have and understand all the information they need to make informed decisions.

3. High-risk groups. We need to communicate potential risks to high-risk groups so they understand how safe their seafood is or isn't. Recreational and subsistence fishermen (and their families) usually eat much more seafood than ordinary consumers. These fisherman often catch much of their seafood from one site, and if that site is contaminated, they may be running a larger risk than the average consumer. (Seafood sold in stores often is caught in less contaminated offshore waters, and usually comes from many locations.)

4. Coastal residents. Residents of the coastal zone tend to eat more seafood than those living inland, and should be targeted for educational efforts.

5. Environmental groups and the public. We spent some time discussing who should be educating the public and targeted groups, and how to coordinate these efforts. Several groups need to be involved, including public agencies, the fishing and processing industries, and public interest groups. We agreed that it would be best to have one credible voice that is seen as being independent and objective. The Centers for Disease Control (CDC) might serve as a good model.

We need to clarify for the public what the true risks of eating seafood are. For example, we need to ensure that consumers really understand the differences between the risks they run from eating shellfish versus those from eating finfish. Health risks associated with shellfish typically are related to pathogens, which can produce almost immediate illness (e.g., gastroenteritis). By contrast, health risks associated with finfish typically are related to toxic chemicals, and illnesses might develop over a time span of decades. Our understanding of the risks posed by pathogens is often much better than our understanding of the risks posed by consuming small quantities of chemicals over a lifetime of seafood consumption.

Consumers need to have information available to them so they can make their own decisions both about whether to eat seafood and also about how much to eat. For example, in order to decide whether or not to eat raw shellfish, they need to know and understand the probability of developing gastroenteritis. Both for fish and shellfish, they also need to understand how risk is related to quantity consumed (meals eaten per year), and to where the product is harvested.

The public needs to know how the safety of their seafood compares to that of other products in their diet. They also need to understand the relative merits of eating seafood (for limiting cholesterol in their diet) versus the possible risks of developing cancer from exposure to contaminants.

We need to reach agreement on how protective we want to be. What risk is "acceptable" to society: a chance of one in 1,000,000 of developing cancer as a result of consuming seafood, or one in 10,000?

We spent some time discussing mechanisms for educating the public. These include distributing information to recreational fishermen when they apply for saltwater fishing licenses (in states where required) or register their boats. Trade journals and magazines are examples of the many other vehicles available for education.

Public education is something that needs to be undertaken in the short term, but it will require a long-term commitment.

Seafood Inspection and Enforcement

Another high priority that needs to be undertaken over the short term is to develop a model seafood inspection program. Legislation is pending in Congress that is supported by the fishing industry. A seafood inspection program would do two things: it would help ensure the safety of our seafood, and it would also rebuild some public confidence that has been eroded in the last few years.

We agreed that there needs to be additional enforcement of existing regulations. We recognized that we will never have enough money to hire an army of enforcers, however, and we therefore should build on self-enforcement in the fishing industry.

Standardize Risk Assessment Methodologies and Communication

Also of high priority is the need to standardize risk assessment methodologies, risk management responses, and how we communicate risks. Different agencies have different methods of assessing and managing risks. This has resulted in one authority asserting that eating seafood from a certain waterbody poses a defined risk, and another authority claiming that no risk exists. This does nothing but confuse the consumer. Agencies need to speak with a unified, credible voice. We also need to make sure the public knows why or why not risk management responses are made, and what level of risk we are regulating.

Reduce Contaminants and Prioritize Sources

We agreed that it is of high priority to reduce loads of contaminants now entering coastal waters, but it is of medium priority to work on in-place contaminants (e.g., sediments in urban harbors). In-place contaminants can be very difficult and expensive to remove, and letting them be buried by natural sedimentation may in some cases cause the least environmental impact. In general, we felt that money would be best spent building on existing programs to better regulate new sources of contamination, and that this is something that should be done over the short term, but continued over the long term. However, areas with very high contaminant levels (hot spots) should be prioritized for remediation.

Research New Indicators

For pathogens in shellfish, we felt that existing indicators (coliform bacteria) are inadequate for predicting threats to human health. Much work already is under way nationwide to identify better indicators, so the priority for the New York area is moderate. This is something that needs to be done over the short term and continued over the long term.

Set New Standards and Revise Existing Ones

We have no health standards for many contaminants that are found in seafood. Because coastal waters typically are contaminated by many pollutants, it was felt that the standards that do exist (e.g., for PCBs) will provide some protection and therefore it is of moderate priority for additional standards to be developed (e.g., for PAHs). It was felt that revising existing standards (as needed) is of lower priority. Again, these are activities that should be started over the short term and revised over the long term.

OCEAN DISPOSAL

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The workshop on Ocean Disposal focused attention on two main areas of concern: Disposal of dredge material, which will likely continue for the foreseeable future, and sludge disposal, which is being phased out.

The work groups stressed the need for public education targeted at the various public sectors, including the general public, involved citizenry, and elected officials. Education efforts would focus on environmental issues in general. More specific efforts should be targeted at fully describing the disposal options available for dredge material and sludge and the environmental effects of the various disposal options. Finally, education should stress recycling reuse to reduce the amount of material that must be disposed.

The second item raised was termed "good science." There is a need for better technical information on land-based alternatives and on the environmental effects of these alternatives including relative risks.

The third item raised was pollution prevention. There is a need to reduce the direct and indirect discharges of toxics and other substances that contaminate sediment and sludge. Pollution prevention may make disposal on land or incineration less objectionable.

Legislation was discussed at length. The consensus was that disposal options should not be legislated. Rather, disposal should be based on a multi-media approach that assesses disposal options on land, water, and air. The analysis should be based on a cumulative regional assessment.

Present practices for wood burning, disposal of dredge spoils, and cellar dirt should be allowed to continue as long as it can be demonstrated that they are meeting current regulations and are not causing significant environmental harm.

Finally, the issue of cost was discussed, especially as it relates to dredge spoils. The concern is that since dredge disposal is costly in the Northeast, it puts the New York-New Jersey Harbor at a disadvantage as a port with other areas of the country. There is a need to investigate methods of taking the cost of dredge spoil disposal out of the equation of port operations.

PRELIMINARY CONCLUSIONS FROM TUESDAY'S WORKSHOP SESSIONS: AN INTEGRATED AGENDA FOR CLEANING UP OUR COASTAL WATERS

Dr. Dominic Di Toro
Professor
Manhattan College

CONFERENCE SUMMARY AND INTEGRATION OF RESULTS

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There is a certain historical precedent for my being asked to present a summary of the conference and to attempt an integration of the results. As some of you know, the reason that I am an Environmental Engineer is because Don O'Connor[1] needed people to integrate differential equations. As his research assistant during my last year at Manhattan College, my task was to integrate peculiar mathematic equations that O'Connor would dream up. So I think there is a certain amount of precedent for the task at hand.

The problem: How does one integrate all of the recommendations and all of the work that has been done over the last two days? So I examined the methods that are available to integrate various problems. The first one that occurred to me was to find a table of integrals and look this one up. Unfortunately, most of the integral tables had nothing about this particular kind of integration. So I examined some other techniques. One common approach when an analytical solution doesn't exist is a numerical integral. Now that was really appealing. I could take all of the categories and all of the recommendations and just number them one, two, etc., and the integration would be complete. I would have succeeded at numerically integrating the Conference. But upon sober reflection it was clear that enumeration is not integration.

Perhaps integration by parts, or the more complicated methods -- contour integrals, volume integrals, surface integrals -- this could go on and on. Then, in a stroke -- a flash of understanding -- it finally occurred to me that what I needed was a category integral. I had to find categories into which I could put all of the recommendations. So what follows is my attempt to perform a category integration of the recommendations of the Conference. I would like to thank the conversations I had with the facilitators and with Kevin Bricke and Bob Thomann who talked me out of the first four ways of doing the integration.

A good place to start is with Fred Grassle's summary of the priorities that were decided on after the first day (Table 1). What I found remarkable was that there really was an expression of priorities. Normally one gets a rather bland "everything is important" out of this kind of an exercise, but in this case there really was some discrimination. You can

[1]Donald J. O'Connor, Professor of Civil Engineering, Manhattan College.

TABLE 1. CLEANING UP OUR COASTAL WATERS: An Unfinished Agenda

	PRIORITIES[a]			
	SOUND	HARBOR	BIGHT	SYSTEM
NUTRIENTS	H !!	M	M	M
PATHOGENS	M(H)	H !	M(L)	M(H)
FLOATABLES	M(L)	H	H	M
TOXICS	M	H	M(H)	H
HABITAT	H	H !	H	H

[a] H = High; M = Medium; L = Low; ! denotes superlatives.
Source: Frederick Grassle, Director, Institute of Marine and Coastal Science, Rutgers University.

see that nutrients are a very high priority in the Sound. I think what struck me most forcefully was the importance of habitat across the board. One would not have seen this ten or fifteen years ago. So there has been a real sea of change in the environmental perceptions of professionals as well as lay people.

THE PEOPLE

Okay, the first category: One can call it the people, the body politic (Table 2) -- those out there who pay the bills for the environmental controls and for whom, presumably, the controls are being implemented. A number of recommendations have to do with lifestyle changes. John Lawler whispered in my ear just before this talk: "Think about someone standing up at an International Water Pollution Control Federation meeting ten years ago and saying we have to change the way we live and that's going to help water pollution." It's unthinkable. And yet here we have serious people proposing that we must change the way people live in order to influence the environment. We have to educate them. We have to educate them directly with regard to seafood safety, and we also have to give them ways to educate themselves. We have to do something about the credibility of our profession. We have to do something about influencing the state of belief that is associated with governmental and private academic evaluations. If I were the Director of EPA, I would open an office of public education and I would have my most talented person

TABLE 2. THE PEOPLE

1. LIFE STYLE CHANGES
   * RECYCLING
   * WATER CONSERVATION
   * BIODEGRADABLE, REUSABLE

2. EDUCATION
   * DIRECT
   * SELF: INFORMATION STORAGE AND ACCESS

3. CREDIBILITY
   * CENTERS FOR DISEASE CONTROL ANALOG

4. RESTRICTIONS
   * COASTAL DEVELOPMENT

running that office. Because clearly what's important is influencing the will of the people since they are ultimately going to provide what we need. The Centers for Disease Control somehow does it -- we should do the same thing. We are going to put a lot of restrictions on freedoms that people enjoy currently. When we talk about restricting coastline development, when we talk about buying up wetlands and so on, what we are talking about is restricting freedom. Since this country is a democracy, if we are going to do these things, we really need the people behind us. As a consequence, the category "the people" is, I suspect, a focus that is a new part of environmental thinking.

THE ECOSYSTEM

Another idea which is slightly older but which, I think, is equally important is the view that we have to deal with the ecosystem (Table 3). It is not sufficient to look at the problem piecemeal. One has to put together analysis frameworks that are integrated. This was captured by the workshop recommendations that the mathematical models be physically integrated. There should be no artificial boundaries that divide the middle of the river into the part we study and the part we don't study. For biological evaluations, we examine biota across the spectrum, i.e., entire food chains.

TABLE 3. THE ECOSYSTEM

1.	INTEGRATED ANALYSIS * PHYSICAL - ARTIFICIAL MODEL BOUNDARIES * BIOLOGICAL - INTERACTIONS AMONG BIOTA
2.	INTEGRATED HABITAT MANAGEMENT * INVENTORY
3.	INTEGRATED DATA COLLECTION * COORDINATED

It's pretty clear that habitat management needs to be done in an integrated manner. One can't just worry about one little wetland at a time because incrementally they amount to the whole.

And, finally, it's pretty clear that you need integrated data collection programs. From those of us that actually use data from various places, believe me, it would be nice if there were some ecosystem-wide, well-thought-out data collection programs.

THE SCIENCE

A category that continually turned up might be called "the Science" (Table 4). Commissioner Carothers talked about the need for good science. I would like to make a distinction between what I think of as regulatory science or environmental science where the accent is on environmental regulation -- science in the service of the environmental regulation -- and scientists who play around in the environment, which is essentially "I've got a problem I'd like to do and I wonder if I could find an environmental context that would let me play around with this problem." What we really need are scientists that are environmental scientists. And, I think we're getting there. But it hasn't been easy, as some of you who deal with this sort of problem know.

For example, we need consistent data collection methodologies. It became clear, for example, that EPA does not have standard marine chemical methods for measuring

TABLE 4. THE SCIENCE

1.	CONSISTENT DATA COLLECTION: * METHODS * CENTRALIZED STORAGE
2.	STRENGTHEN: * DATA ANALYSIS * MODELING
3.	DEVELOP: * HUMAN VIRUS MEASUREMENT METHODS
4.	DEFENSIBLE END POINTS AND CRITERIA * CONSISTENT FOR PATHOGENS * WATER, SEDIMENT, BIOTA FOR TOXICS * DISSOLVED OXYGEN * TOXICS AND PATHOGENS FOR SEAFOOD
5.	ECOSYSTEM INDICATORS * BENTHIC COMMUNITY STRUCTURE * SYSTEMWIDE IMPACTS

nutrients. And it would be nice to centralize the data storage. For all of its ills, STORET is the only repository that exists and is easily accessible.

We really have to figure out what to do with all the data that we've got. Unexamined data is like an unexamined life -- it's not worth living. And, therefore, I think both data analysis and modeling have to play a role.

Finally -- and this is a key one -- we really have to develop measurements of pathogens that look at the pathogens themselves (viruses, what have you). I think there's an area where some biotechnology methods, for example gene probes, can really see the pathogen and not the indicators we have at present. We are going to have the world's best fecal coliform standards. Question -- are we going to drink the water?

The area of appropriate criteria has been developing quite rapidly recently, but I think it still has a way to go. The issue is defensible endpoints. When I went to school at Manhattan College, we thought that dissolved oxygen criteria had been chiseled into the back of the Ten Commandments, that somehow the criteria came down from on high. And we had a simple problem -- design the solution to meet the criteria and we were done. Environmental engineering was easy in those days!

Unfortunately, it's become clear that the criteria are as, how shall I say, as approximate and as difficult as any other part of an environmental analysis. So, there is a clear need for defensible criteria for pathogenic organisms, and for water, sediment, and fish flesh criteria. One of the reasons that you know things are approximate is that dissolved oxygen criteria are being examined again. So, clearly it's an interesting area.

There is a whole area of ecosystem indicators that has been receiving attention. One would like to be able to take the temperature of an ecosystem -- you know, how sick is it? And people have talked about structural measures, and so on. The problem is that there's no really solid, well-agreed-upon way to do the problems. There's clearly a need for science in this area.

COMMON SENSE

A large number of recommendations can, I think, be fairly called common sense (Table 5). Let's get to doing these. They are not a moon shot. We know how to do this stuff -- let's do it! These are the recommendations to do with the implementation of present programs. Get after loadings that we know are involved in the problem. Continue the planning efforts that are under way. Do the things that practical technical people really know how to do. The floatables action plan really did work. Continue it, do more of it. Get some decent cost estimates as we go into these new problems. If we know what it's going to cost us to do some modifications, we will have a much better idea of what we should be spending in terms of studying. This whole raft of recommendations can fairly be called common sense.

THE UNEXPECTED

There were a couple of recommendations that I would call the unexpected (Table 6). These really surprised a number of us. The first one was that people were not blindly accepting the ban against the disposing of sewage sludge at sea. Reconsider the ban. Do a multimedia analysis. My God, actually analyze the problem! Quite surprising. I was really quite delighted. Someone pointed out that, of course, we are sitting in New York City. So, there may be a vested interest in this problem. But, nevertheless, it isn't all New York City types out there. Maybe it has something to do with the tough urban mentality. But that really surprised me. Once that got going, things really got going. Let's examine

TABLE 5. COMMON SENSE

1. FULL IMPLEMENTATION OF EXISTING PROGRAMS
   * MUNICIPAL COMPLIANCE
   * PRETREATMENT
   * SWIFT AND SURE PENALTIES FOR VIOLATIONS
   * NO NET LOSS OF WETLANDS

2. AFFECT LOADINGS NOW
   * INVESTIGATE LOW-COST NUTRIENT REMOVAL
   * REDUCE TOXIC INPUTS - BMPs - IN-PLANT CHANGES

3. CONTINUE PLANNING EFFORTS OF THE NEP
   * LONG ISLAND SOUND, NEW YORK BIGHT, NEW YORK-NEW JERSEY HARBOR

4. FLOATABLES ACTION PLAN
   * ENHANCED

5. DEVELOP RELIABLE COST AND BENEFIT INFORMATION

TABLE 6. THE UNEXPECTED

1. OCEAN DISPOSAL
   * RECONSIDER THE OCEAN DUMPING BAN ACT FOR SEWAGE SLUDGE
   * MULTIMEDIA ANALYSIS OF THE PROBLEM

2. EXAMINE ALL THE LEGISLATION - RE-AUTHORIZATION OF CWA

all the legislation: the authorizations are coming up for the Clean Water Act, the Clean Air Act. Let's get to it. Why do we think that the staffers on the Senate and the House side who write these bills know what they are doing? What is the evidence? Rather audacious, don't you think? You know, let's get out there and hammer on their heads. I like that; I really was surprised.

And then to hear the new Commissioner of the New York City Department of Environmental Protection, Commissioner Appleton, get up and tell us that there is a revolution out there. That the system is out of control. We're losing the war. It was wonderful. It was exhilarating. I've never heard a regulator say that. I thought Bill Reilly was a new form of governmental regulator. It was really quite astonishing.

NEW INITIATIVES

There are a number of new initiatives that have been talked about, which deal with the next generation or the current generation's problems, and they really follow along the categorization that the facilitators and the planners of this meeting put together (Table 7). They cover the problems of nutrients and organics. The suggestion is to do some tributary management planning, see whether we can actually affect nonpoint source runoff. That has never been demonstrated, by the way, to my knowledge. On the pathogens side, examine the effects of chlorination. It is a very toxic compound. See if we're not going to have a problem with the solution as well.

You can see how a category integral works, I think. On the floatables -- go after the sources. On the habitat -- go out and buy a lot of land. It's a very good idea, I think. It's a way to do the problem. Just buy it. On ocean disposal of dredge materials, evaluate possible containment sites, evaluate new disposal locations. On toxics, I thought it was interesting. Half the group, as I understand it from the facilitator, said let's get to wasteload allocations and the other half said we don't know enough to do it.

So, I think where we end up is three major classes of actions. One is the broader -- the people, the ecosystem -- the broader kinds of contexts. One is basic common sense -- let's just get out there and do what we know how to do. Third is the category of new initiatives, basically following the lines along the planning problems that have been discussed.

TABLE 7. NEW INITIATIVES

1.	NUTRIENTS/ORGANIC ENRICHMENTS * FACILITIES PLANNING * FINAL INTEGRATED MODEL * TRIBUTARY MANAGEMENT PLANNING
2.	PATHOGENS * CSO CONTROL PROGRAM * EFFECTS OF CHLORINATION - AQUATIC TOXICITY * PERMITS FOR STORMWATER DISCHARGES
3.	FLOATABLES * SOURCE CONTROLS
4.	HABITAT * LAND ACQUISITION POLICY
5.	OCEAN DISPOSAL OF DREDGED MATERIAL - EVALUATE: * CONTAINMENT * NEW DISPOSAL LOCATIONS
6.	TOXICS * WASTE LOAD ALLOCATIONS (TOO SOON?) * MULTIMEDIA ANALYSIS

PERSONAL OBSERVATIONS - PUZZLES

Category analysis requires one more category: personal observations.[2] Okay, I termed these puzzles (Table 8). Why is there a mismatch between our technical analysis and the public's perception of what the problems are? The best example is, why does an ocean disposal ban pass by unanimous vote in both houses? There must be something going on. Why is there such a large mismatch between what our technical analyses tell us and

[2]John Lawler suggested that these are the arbitrary constants of the integration.

TABLE 8. PERSONAL OBSERVATIONS ** PUZZLES **

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1. THE MISMATCH BETWEEN TECHNICAL ANALYSIS AND PUBLIC PERCEPTION:
   * BANNING OCEAN DISPOSAL AND OCEAN INCINERATION

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2. THE INCONSISTENCIES BETWEEN TECHNICAL ANALYSES:
   * WHY ARE EFFLUENTS, SEWAGE SLUDGE, AND DREDGED MATERIAL TREATED DIFFERENTLY?

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3. THE BATTLE FOR MASS BALANCE MODELING:
   * NOT UNIVERSAL AMONG NEP PLANNING STUDIES
   * STILL SKEPTICS IN THE FACE OF WASTE LOAD ALLOCATION REQUIREMENTS

---

4. RISK ANALYSIS
   * LACK OF PUBLIC UNDERSTANDING AND ACCEPTANCE

---

what the body politic interprets and acts on? Seafood safety is another good example. What's going on? Why don't we get through to the people?

I think this has to do with historical problems. Also, there are a large number of inconsistencies within our own technical analyses. For example, when we consider ocean disposal we treat these sources differently: effluents, sewage sludge, and dredge materials. All are discharging masses of various toxics and nutrients to the environment. They are not analyzed within the same context.

Mass balance modeling. This has more to do with the fact that we are sitting in Manhattan College than perhaps the topic. The battle for mass balance modeling is a fight that we've been fighting since the beginning. It is interesting that it has not been won yet. For example, it is not universal among the National Estuary Program Planning Studies. In fact, I think that aside from the New York waters and Chesapeake it's not that common. There are still skeptics out there, lo and behold. So, I think that battle still needs to be joined.

And finally, one that I really am puzzled about -- why don't we trust risk assessments and risk analysis? Why don't we really believe in them? Maybe we do, but certainly the public doesn't. For example, the concern over drinking Lake Ontario water, with very small concentrations of chemicals. It doesn't square with risk analysis. Maybe the risk analysis is wrong. That's an explanation. However, maybe the public needs to be educated. In either case, the situation, as it currently exists, is not very satisfactory.

PERSONAL OBSERVATIONS - PROGRESS

The progress that has been achieved in the last twenty years has been remarkable (Table 9). There is clearly a much improved atmosphere for working together. Scientists and engineers no longer guffaw in each other's presence. They actually listen. Technical people can talk to lay people without both of them going to sleep. And regulators actually will talk to everybody, which is a remarkable turn of events. Things are clearly changing on that score.

One very hopeful development. There's a much broader view of the problems. The problems are not chopped up and isolated the way they used to be. They go from wasteload allocations to criteria to biological endpoints to multimedia assessments. Things are really progressing at a rapid rate. And we have a vastly expanded technical arsenal. If this Conference had been held ten years ago, the number of problems and the number of solutions we could have offered would have been ten percent of what we can do now. So things are moving fast. We do indeed have a lot of technical tools at our disposal. We also have a lot of problems, and we have to deal with them.

PERSONAL OBSERVATIONS - CHALLENGES

Finally, there are a lot of challenges that we should look at (Table 10). There's surely a lot of biology out there that we don't understand very well. The whole issue of the impact of toxics on the ecosystems and on human health is really a quagmire. Are there any problems at all? Are there overwhelmingly many problems? One can't make an informed choice. One can guess. But one really doesn't have enough information to choose.

An interesting question: Is there the political will to do the problem? Commissioner Carothers correctly pointed out that the function of an administration is to provide the political will and to convince the people to provide the support. Is there enough time and money to do the problem? As some of you know, the worst way to do a problem is to take a large sum of money, for example, ten million dollars, and try to spend it in one year. And the best way to do a problem is to take the ten million dollars and spend it at a rate of one million dollars a year for ten years. Will there be enough time and money? Will we learn how to deal with the uncertainties of the answers that come out? And finally, is there

TABLE 9. PERSONAL OBSERVATIONS ** PROGRESS **

1. A MUCH IMPROVED ATMOSPHERE FOR WORKING TOGETHER
    * SCIENTISTS AND ENGINEERS
    * TECHNICAL AND LAY PEOPLE
    * REGULATORS AND EVERYBODY

2. A MUCH BROADER VIEW OF THE PROBLEMS
    * CRITERIA, END POINTS, EFFECTS IN RECEIVING WATER

3. A VASTLY EXPANDED TECHNICAL ARSENAL
    * LARGE, INTEGRATED, MULTIDISCIPLINARY STUDIES
    * SYSTEMWIDE MODELS
    * EUTROPHICATION AND TOXICS

TABLE 10. PERSONAL OBSERVATIONS ** CHALLENGES **

1. STILL A LOT OF BIOLOGY THAT'S VERY POORLY UNDERSTOOD
    * TOXICS IMPACTS
    * ARE THERE REALLY ANY PROBLEMS?
    * ARE THERE OVERWHELMINGLY MANY PROBLEMS?

2. IS THERE THE POLITICAL WILL TO DO THE PROBLEM?
    * ENOUGH TIME AND MONEY
    * DEAL WITH UNCERTAINTY

3. IS THERE THE SCIENTIFIC AND ENGINEERING FORTITUDE TO GET AN ANSWER?
    * MORE STUDY...

enough scientific and engineering fortitude to get an answer? Will we come down on something at the end of ten years, one million dollars a year? Or will we just say, plaintively, we really have to study some more?

So there are a number of positive things going on, and there are a number of negative things going on. I'd like to read you a quote, which I think really summarizes the state of things the way I see it. It is from Charles Dickens' *A Tale of Two Cities*. It's the beginning when he is talking about the French Revolution, and I'll just paraphrase it slightly:

> It is the best of times, it is the worst of times. It is the age of wisdom, it is the age of foolishness. It the epoch of belief, it is the epoch of incredulity. It is the season of light, it is the season of darkness. It is the spring of hope, it is the winter of despair. We have everything before us, we have nothing before us. We are all going to Heaven, we are all going direct the other way.

DISCUSSION: PRELIMINARY FORMULATION OF RECOMMENDATIONS TO GUIDE CONTINUED DELIBERATION OF THE MANAGEMENT CONFERENCES

DISCUSSION

David A. Fierra
Water Management Division, U.S. EPA Region I

Thank you very much. I'll try to make my remarks brief since I just wrote down what they were supposed to be.

We have not coordinated our comments here, so I suspect there will be a lot of repetition. I tried to carve out a couple of areas that are important based on my perspective and experiences in other estuary programs in coastal waters. For one thing, in terms of priorities, there were not very many low priorities listed by the earlier speakers and I guess I'm not surprised at that. That may seem to be overwhelming to an agency that might consider itself responsible for all of those activities, but I'd like to say that in many of these areas there are many levels of government and many citizens, and many agencies that play a role. One thing that we should be doing as regulators, scientists, and activist groups is to try and reach out to other groups with other authorities, other wills, and other commitments. For example, I don't think that land use management was mentioned many times as a necessary element, and I strongly believe it is. That is not a role for the federal government now or probably never will be.

I think that what I can do as a federal regulator is to work with people who have that responsibility and to help to convince them, if they are not already convinced, that everything I do in controlling point sources may not have positive impact unless they are willing to do some things as well. I think that although I will never have a direct role in that, I can take a proactive role, and by working with the state regional planning agencies and local agencies, in some cases provide tools to accomplish that. We should not be overwhelmed listing all of the areas that appear to be high priorities because there is not a single group or agency that has authority and responsibility over all of these areas.

Certainly communicating to the public and educating the public on consequences is something that we have to do in order to promote the will. I have two comments on some of the more specific issues in terms of what should be done first. I mean these in the context of starting all of these things now by reaching out to agencies and integrating and communicating. I truly think that the protection, restoration, and preservation of habitat is, without question, the most significant issue, for several reasons. One is that we know the consequences of destroying habitat. You don't need a tremendous scientific analysis to understand the problem as we do with some issues such as nutrients. The loss of habitat is irreversible and it is not the same as going back and dealing with combined sewer overflows, for instance. In fact, some people are violating the law right now, and have been since 1977. CSOs are very expensive but we know that we can deal with them. Although CSOs are causing problems, I don't mean to belittle them, they are something we can solve. Habitat loss is not something we can solve tomorrow.

The other area is toxics. Of the two groups that dealt with toxics -- one wanting more study, one wanting more action -- I strongly support more action. We don't have all of the information, particularly on toxics that biocumulate, but there's no question that keeping them out of the environment is what that we need to look at. We do not need more study in terms of the overall impact of toxics.

I think I'd like to close with that, and I'd be happy to answer questions later.

DISCUSSION

Richard L. Caspe
Director, Water Management Division, U.S. EPA Region II

I have a lot of comments. I'll try to run through them very quickly.

First, I believe we need to be learning more. Throughout this conference, the theme has been that we have to keep on studying. I also heard the theme that we have to come up with practical solutions, getting on with the job, doing what we can as quickly as we can. I think that accomplishes two things and really will reflect a lot of my comments. Number one, I hope, it doesn't allow the problem to get any worse while we keep on studying it.

The second issue that I've heard throughout the conferences is the need to educate the public. How do you educate the public? You can invite them to seminars like this and sit and talk, or you can start putting in front of them specific proposals dealing with specific issues that show them where they are responsible for the problem and how they can deal with it. I think that's really what you have to do, and I think a lot of the things I am going to discuss now will accomplish that.

I will start with nutrients and organics in the Sound. Certainly, we need a systemwide model of everything, to see how everything works. However, to deal with the Sound, I think we need a "max-min" program immediately, if you remember the old term. We need to talk about the concept of freezing nutrient loadings to the Sound; if nitrogen is the problem that might or might not be practicable. You certainly can be asking people to do the best they can with what they have. I think you'll find that at least the nitrogen loadings to the Sound will not get worse while we try to get a better handle on exactly how to deal with them. I also think it will give the public a better sense of what's going on.

The same thing applies to combined sewer overflows -- a "max-min." I know that a lot of work is being done on them but one of the speakers talked about firm EPA enforcement. I can assure you that there will be no dry weather overflows that will go unnoticed or unenforced within the regions.

Floatables. We talked about public education. For example one of the things that I tried to push last year and I'm going to try to push again, for example, is how do you get to the public and start talking about floatables. Last year the New York Water Pollution Control Association did a lot of work on Long Island; they made all kinds of nice things. There are other things that have been going on as well. For instance in the federal building where I work. I suspect there are things that are being flushed down the toilets that shouldn't be flushed down toilets. I'd like to propose a "Don't Flush" campaign, in which we go out and try to explain to people what should and shouldn't be flushed down a toilet. That, hopefully, will conserve water and also get some problems out of the waste stream.

Toxics. I hear that we really don't know the extent of the problem. Whenever we start to deal with toxics the question arises -- How do toxic substances partition in the water? What's soluble and what isn't soluble? What is available and what isn't available? How does it get into the biota? I'm not sure we have the answers to that and I'm sure we're going to have the answers right now in the short term. But, in the meantime, we know we have some toxic problems and toxic loadings continue to increase. I think we have to deal immediately and aggressively with toxic loadings throughout the area. This would at least assure that things don't get worse while we start on a path to determine, in short order, how to fix it.

Habitat (no net loss). We have some concerns about the no net loss policy that's come out. The no net loss policy seems to have set out a procedure based on mitigation as the possible solution to all problems. It clearly isn't. The first thing to look at is avoidance of wetlands. I think we have to deal with that and as we codify it in this region, we will perhaps, deal with the issue of what no net loss means. How do we want to protect our wetlands? I love the idea of -- I can see Mario in the back cringe on this thing -- a whole systems approach to try and figure out and plot the value of the wetlands throughout the system. To figure out on which wetlands we should absolutely hold the line. I'm not sure of the resource implications of that. It is certainly something that I'm going to be looking further into.

Dredged material. I think that's a real problem. As you get more into it, you get more sediment loads, and you find more and more places where you can't dispose of dredged material. You are going to be faced with the option of closings or coming up with solutions. I think containment islands may be the answer. But, frankly, there is no one federal agency or political entity that has the oomph to push containment islands in this area. As soon as it comes up, somebody is going to blow it out of the water. I think we need a large group. You need a consensus approach to really start pushing on something like this.

The last item I would like to quickly discuss is sludge dumping -- the Ocean Dumping Ban Act. I have spent probably more of my time dealing with the Ocean Dumping Ban Act than most of you. I wasn't always in favor of it, as it was proposed. But, I can assure you that Congress knew exactly what it was doing. Congress was briefed and they were told both formally and informally of the implications of act. Don't believe that you can change it.

Another issue is dealing with science. I've heard statements about the impact of sludge dumping in the oceans and that there's no problem in the ocean. I'm the person that has to stand up in front of the public and explain what the impact is and isn't, and I'm not sure what the impact is on the ocean. I can tell you that there are certain diseases and problems that cannot be directly linked to ocean dumping. But that doesn't mean that ocean dumping isn't a contributing or indirect cause. I can't find the linkage. The ocean is an awfully big place. Sure, you put sludge on land, or you put it in an incinerator with a stack and you see air emissions, or if you put it in a landfill you can see something. It's very easy to quantify that effect. And that's why balancing disposal methods through the years has been so difficult. When you put sludge into the ocean you can just shrug your shoulders and say who knows where it goes. We don't.

DISCUSSION

Salvatore Pagano
Director, Division of Water, N.Y.S. DEC

I just want to cover a couple of the items. One that particularly concerns me and was touched on occasionally by the speakers is an overall funding and overall concern for how we can accomplish everything we talked about whether we agree with it or don't agree. Where do the resources come from? How do we move forward?

Resources. Right now, the picture is not as good as it has been in the past. Yet, we are saying that we are going to do more. The federal government has been tinkering a lot with other agencies and EPA's budget. The monies that are coming from Congress and were proposed in the President's budget for next year are less, generally, than they were this year. On the state side, the state's budget for the environment is about two-tenths of one percent of the entire state budget. It's a lot of money but as a percentage it's not a lot in terms of the environmental program. On the other hand, when you talk to the public or when you see national or state goals there are two things that are given as a major concern or issue -- drugs and the environment. It doesn't appear to me that that message gets through to congressional people so that Congress will pay more attention to it, or at the state level. As an influence within the programs, either at a state or federal level, or for associations you belong to, our success at being able to raise our concerns about protecting the environment or repairing things in the environment has been limited. We've also been somewhat limited in influencing those program areas and the resources that are put into those programs. Somehow, the public must be more of an influence than it is right now.

Education was mentioned six or seven times by speakers this morning in various parts of their talks. I believe a major key to our being able to raise the consciousness of Congress, of the state, of the agencies, and the public and local communities is by a lot of grass roots support. We are going to try to develop, at the state level, the guidance and the methodologies for dealing with things like nonpoint source pollution, wellhead protection programs, and a lot of the activities that we believe should not be strongly regulated if regulated at all from the federal or the state levels. We've got to build that constituency. People must better understand what it means to them as individuals -- how their lifestyle and their actions may affect the environment. I think the public is ready for that. Our job should be to find ways to get that information to them. As one speaker said, this is a continuing process. It's not something that you do once and you walk away. The school system is ultimately where these kinds of activities, interests, programs, and education have got to get through. You can't do it on a "hit or miss" basis.

Risk assessment. There was recognition by one of the speakers that there's got to be a better way to discuss risk assessment so that the public understands the issue. Personally, I think the public understands. What they are telling us is -- we don't like your answers. I'm not sure it's that they don't trust what we're saying. They believe that when we give a number such as one in a million we are probably truthful, but we may doubt it. They hear that doubt. What I think they're saying is -- that's not good enough. We've got to listen to that message. We've got to pay attention to the fact that they are saying toxics in the environment are not welcome. Find ways to keep them out. If you tie that in with their interest in the environment, individual lifestyle changes can make some sense and can make some headway. I'm not talking about one year. We are talking about a 10- or 20-year evolution of change or recognition. It's part of the education process. But the answer does not lie in the public having an understanding of what risk assessment means. It's our having a better understanding that the public doesn't want toxics in the environment.

Anti-degradation. In the State of New York, one of our state program shifts is to deal with toxics more aggressively. We have a point source control program. We do have water quality standards. We do have technology standards. Beyond that, Congress said in the Clean Water Act Amendments of 1987, "Thou shalt have an anti-degradation policy." Tied in with what we believe the public is saying about toxics, at least, anti-degradation means that we've got to find ways, beyond the standards, as good or bad as those standards are, and beyond technology, to take toxics out of the environment. We will be initiating an anti-degradation program on particularly persistent toxics. Things that don't go away. It makes no sense to me that we talk about water quality standards and we talk about fish standards with persistent toxics when, in fact, we aren't very comfortable that those things will ever break down. Or they will break down so slowly that we really can't feel very comfortable that there's any control mechanism or the controlled release of those kinds of substances is going to be effective. Therefore, we're going to attempt a ratcheting-down process, at least with persistent toxics.

Land acquisition. If we talk about wetlands protection, if we talk about ways and means of communities providing controls, we must talk about the actual acquisition of land. If comes down to dollars, it's either going to be a state or local community buying land for protection or they're going to be paying somebody not to use the land for certain things. At this conference we're talking about areas where growth is a major issue. In upstate New York, we run into the same argument in the Adirondacks. The attempts and desires to build in the Adirondacks. Either acquire the land so that the state owns it or somehow provide compensation to those who cannot use their land.

The time for difficult choices is now. Thank you.

DISCUSSION

Eric Evenson
Acting Director, Division Of Water, New Jersey DEP

I would like to talk about credibility, land use, pathogens, seafood safety, and follow up with ocean disposal of sludge.

The first thing is credibility. Dominic mentioned in his integration of the topics this morning that there was a basic problem of credibility and he used the CDC as an analog. I would like to mention a couple of things about that because it really got me thinking. The Centers for Disease Control is responsible for looking at the pathways of diseases, the impact of them, and helping us to deal with those issues. It's an area where we are united against a common enemy -- disease. In the area of the environment, when it often gets down to the point that we finally start looking at individual environmental impacts, the enemy really turns out to be ourselves. I think that's where oftentimes the credibility issue breaks down, because we are pointing out to one another that we are, in fact, the problem. There are a couple of things that we can do in this area. One, we can sharpen our science and also sharpen our communications, but in order to effectively gain credibility in the environmental field, one of things that's going to have to be recognized on a nationwide basis is that we have to let go of our personal interests to further the common good. I don't think that realization has hit home as yet. We need to help that along.

On land use. I liked very much hearing a lot of the emphasis on land use during these talks. We have a real problem out there with nonpoint source impacts and there's a lot that needs to be done. In New Jersey, in our Division of Water Resources, we've been talking a lot about nonpoint source impacts and the need to develop best management practices that will be employed statewide. I told everybody that it is time to stop talking about them and get on with the business of developing them. So, the charge that I have given to my staff is that by the end of the year, I want to have developed a set of best management practices that can be implemented on a statewide basis. By the time they get those developed, I will have figured out a way for us to get them implemented on a statewide basis.

We also need to have more research in the area of nonpoint source controls and determine what we can do about the areas that are already developed. Best management practices are very easy to implement in new areas and there are some you can implement in already developed areas. However, there is a lot that needs to be done to tackle the problem of our existing urban and suburban areas -- to clean up their nonpoint source impacts. I believe that the vitality not only of this New York Harbor estuary, but of all estuaries around the country, is going to hinge upon land development issues, best management practices, and nonpoint source control impacts on water quality.

We also need to consider seriously the issue of acquisition of critical lands. There are going to be some lands that, because of their sensitivity and because of our ability to control impacts, are going to have to be bought and taken out of the developable pool, rather than have us attempt to regulate what is done with them.

For pathogens, I concur completely with the recommendation that we need to look at the development of a human-specific or an indicator that really gives an indication of the pathogenicity of the water. This is something that's necessary and that both the state and federal government should be putting considerable money toward.

There's a lot that's being done in the area of seafood safety but a critical point needs to be made -- the funding in this area is simply inadequate right now. In many of the state programs the funding is inadequate to do what really needs to be done. This is affecting our public education efforts, our monitoring efforts, and our enforcement efforts. In order to maintain a safe seafood industry in the country, we need to increase the funding for this program.

Before I go on to sludge disposal I'd like to throw in one item on floatables. For the Floatables Action Plan we need to keep on doing what we are doing right now. It has worked, and worked very well. We need to expand our public education efforts.

Finally, on sludge disposal. We know a lot more about the impacts that sludge will have when it is handled on land than we do about it impacts out in the ocean. Director Caspe's comments were right on the mark. Just because we can't prove that there are impacts from what is occurring in the ocean, it does not mean that there is no impact there. I offer a couple of suggestions for approaching Congress about changing the law. You have to be able to answer the question about the unknown impacts. There are some basic policy issues that the Congress laid out a long time ago about the reuse of materials and managing ocean sludge through other practicable alternatives when they are available. Other alternatives are available, and it's time to get Congress to follow through with instituting them. If we are going to go back and redo risk analyses, it's not going to be the nine facilities that are currently using ocean disposal that are going to be at the center of the argument, it's going to be all the municipalities that have ceased ocean disposal in the past. In New Jersey alone that amounts to 150 communities. This should be kept in mind when making any recommendations about revisiting the issue of the ocean dumping ban. With that, I will conclude my remarks. I will be happy to answer any questions when the question period comes up. Thank you.

DISCUSSION

Robert Smith
Bureau Of Water Management, Connecticut DEP

Good morning. There are four points I would like to make today to wrap things up. One is where are we? We're ready to tackle Long Island Sound and we're ready to address these problems. In 1971, when the Housatonic River Basin Commission began its study of the Long Island Sound, my job at that time was to get a state car and drive out to the Naugatuck River and find out if Anaconda American Brass was putting hundreds of thousands gallons a day of untreated waste into the river. Back then our job was to control gross pollution. In 1971, we were not ready to address the Sound -- we are ready at this time. Virtually all of the sources of pollution in the inland waters of Connecticut drain into Long Island Sound. What happens in upstate Connecticut and even in Massachusetts is important to what happens in Long Island Sound.

The second point is that we now have tools available to us that make it easier to get the job done. The National Estuary Program has facilitated management conferences for Long Island Sound. The program has done some good science -- quite a bit of it in my opinion -- and we have unprecedented cooperation from two regions of EPA, the States of New York and Connecticut, and other agencies. We have made a lot of progress, have facilitated investigation of the Long Island Sound, have learned a lot about it, and we are on our way. The mathematical models, particularly the three-dimensional hydrodynamic water quality models, are the best we've ever had. They will probably get better in the future. We need to be careful about the decisions we make, but they are good enough to make decisions today.

The third point is that it's time to move on. In Connecticut, the support from the people is there. In the last few years I must have attended 40 to 50 conferences. They were hosted by environmental groups concerned about Long Island Sound. It's obvious, at least along the southern border of Connecticut, that there are a great number of people who are concerned about Long Island Sound and who want to understand what the problems are and, of course, to have solutions. The legislature of Connecticut has also asked us to explain to them what is going on. They are very interested in the problem. We are being asked questions by the Long Island Sound Bi-State Commission for Connecticut and New

York. They want pollution stopped and they want to make a difference. So we have the public's interest. We have an excellent foundation on which to build.

The last point is on a personal note. I began working in water pollution control in 1970 and the first challenge was gross sources of pollution in surface water. The surface waters had been grossly contaminated from before the turn of the century. It wasn't until Connecticut passed its water pollution control law that we began to wrestle with the problem. So the pollution sources existed for almost 100 years with serious degradation. It was really simple in the early days to find the sources of pollution and control them. The results were rewarding. Groundwater pollution is also a big challenge. We've gone through a program of developing regulations, laws, standards, criteria, classification systems, and so forth. I'd say we're at the stage of late program development and long-term remediation. In both of these cases, it was fun to do the work because you could see the results. I really view this as the last big challenge. The inland waters and groundwaters are important because they all drain into the Long Island Sound. You have to control them first, because if you cannot assess the impact on Long Island Sound if you do not know what is going on upstream. Now we are at the point of addressing Long Island Sound. I've never seen so many dedicated knowledgeable people assembled together for one issue. When there's a lot of hysteria and a demand for action, you need the cohesive approach that we have here. I think we can move ahead. Personally, I think it's going to be fun and I look forward to the challenge.

DISCUSSION

Edward O. Wagner
Assistant Commissioner, New York City DEP

I'm not going to attempt to be comprehensive in my reactions to all that has been said at this conference. My first point is to react to the unexpected items that Dom DiToro brought up this morning. I think there are few people in this room who were more surprised than I at the remarks made by Commissioner Appleton yesterday. I'm going to find learning to work with him very interesting, but basically I reacted positively.

The second surprise was the vigor and the courage many of you expressed when talking about getting out and participating actively in the reauthorization process for the Clean Water Act. I find that a very good sign. Many of us stay in our bureaucratic protective shells and leave the process to somebody else.

The third surprise also has to do with the courage of some of you when talking about reopening the Ocean Dumping Ban Act. Good luck to you! I agree with Rich Caspe. I think Congress was fully informed about the issue of ocean disposal when they made that decision. The action in my view, was a public policy decision and was not based on the technology or the science of the issue. For those of you who are out there trying to reopen that option, New York City will not be with you.

Another area that struck me was the different perceptions people had, but that's not new. It's obvious to all of us that we have different perceptions of the problems, the solutions, the magnitude of problems, the priorities, the sense of urgency, and the differences between engineers and scientists and regulators and regulatees. It was clear that there's a difference of opinion in many of these areas. Specifically, there is a conflict between the sense of urgency between the desire to get on with attacking these problems and the need for further study. There are extremes for both of these viewpoints. The greatest challenge in developing these National Estuary Programs is how do we balance the sense of urgency that we all feel against the need to get all the information needed.

New York City has been viewed as the classic foot dragger. I'm glad that we have representatives from our department at this conference because they can testify to the sense of urgency that we program managers have to live with in terms of advocating and competing with other programs for increased resources. The stakes are high, that much is clear. Much of what needs to be done will have a great impact in terms of both social changes and economic demands. For instance, look at the program outlined by the Public Works Director of the City of Norwalk for nutrient control. If you extrapolate their $15 million program from Norwalk to New York City, it's a $5 billion program without acquiring any additional lands. That's a high stake. The number doesn't frighten New York City. Our CSO Program Director talked about a $4.5 million dollar program for CSOs. We are moving rapidly into that area. If that's what it takes, that's what we'll do.

Where do we go and what should we do? First of all, we need to work harder at communicating and trying to break down some of these different perceptions. We should be able to articulate what we know and believe in order to fully understand what each side is trying to say. We need to be accurate and not posture, but rather present the facts. We need to break down barriers so that we can trust each other. I have been involved personally in communicating a number of issues with private citizens and business leaders. What struck me was that our motivation and our goals are all basically the same. As for a common sense approach, the CSO program is a good example of this type of communication.

In New York City we're proceeding with an examination of what it might mean to control nutrients. We are not burying our heads in the sand. For the challenges that I see, many of us are going to have to develop new knowledge, skills and ability. Over these three days, there's been a lot of talk about land use controls. In New York City today, land use planning is a sphere that doesn't essentially bear on water pollution. We need to develop a political understanding and communicate with our leaders. We need to know how to use and not misuse the political process for developing political will.

Setting priorities is an issue, and we've talked about that need. In the past, we have all dealt with an agenda without a clear sense of priorities. We would like to do everything that the existing legislation and regulations require us to do. In many cases there are statutory deadlines. If the estuary conferences are going to have priorities, we need to reconcile them with existing statutes.

This was an invigorating conference for me, as I knew it would be. I encouraged many of my staff to come and they did. I hope that it was invigorating for them, and I hope that we can continue to have success, especially in trying to integrate the three estuary programs.

DISCUSSION

Terry Backer
Soundkeeper For The Long Island Sound Keeper Fund

-- Tape Untranscribable --

DISCUSSION

Dr. Anthony Sartor
Principal, Paulus, Sololowski & Sartor

I think Mario and Janice have a plot against me because yesterday I followed Eugenia and today I follow Terry. Wow!

My closing remarks are presented with a dichotomy of feelings. I'm home again. This is the first time I've been back to Manhattan College in many years. I am a Manhattan College graduate. It's good to be back and it hasn't changed much. On the other hand, I feel somewhat lonesome because one of my disappointments over the last three days is the lack of input from the development community. That's why I'm here, to address some of those issues.

Just as the regulatory and environmental community have become much more sophisticated over the years, so has the development community. There are developers and representatives of the developers who are responsible. What the development community is looking for as I said yesterday, is some consistency in guidelines and permitting. I believe that the development can be compatible with the environment, but we need a regional approach to establishing guidelines. The states have taken a step in that direction. The Coastal Zone Management Plan does work, but there are problems with it. I think it has to be, and will be, revisited. But I think you can move ahead along these lines, by getting the development community to the table with the scientists, the engineers, and the environmental community. I think something can be accomplished at conferences such as this. You must reach out to the development community and have them come in and put their ideas on the table with you. Development, despite what people may want, will take place, but it should be responsible development. Despite what Terry said, take advantage of the fiscal resources that are available from the development community. The responsible developers realize that there has to be a give-and-take and they are willing to look at this issue. The habitats can be helped on both the short-term and the long-term approach by responsible development because there are funds available for habitat restoration and rehabilitation.

My closing comment is to recommend that developers stop having to spend their fiscal resources on the lawyers and the legal system. Instead, have them put the money into an area that would be helpful, especially in the area of habitat. That's my closing message.

DISCUSSION

QUESTIONS AND ANSWERS

Q. **(Speaker unidentified).** *One of the things that surprised me as an attendee of this forum is that we touched on things that I didn't think would be touched on. One of them was the limits on treatables. I didn't expect to hear that at this forum. We talked about limits on the freedom of lifestyle, we talked about freedom of property use. One of the things that we haven't talked about and maybe it is a taboo subject and shouldn't be discussed at this forum, is the question of the controls on population density and also, again a taboo subject, birth control and its impact on the environment in general.*

A. **David Fierra**. We have religious taboos and the current climate in this country toward planned parenthood and so forth. It is very difficult to talk about. You know and I know that the bottom line is how many people we have. If we are not going to be able to address that issue in a free society, I think these engineers have to work harder.

Spreading people out all across the country causes more difficulty because they keep moving to the coast. I think the answer is going to be providing fast, rapid transit to move the people so they can live in the middle of the country and have an economical way to get to the coast. That solves the difficulty of the coast, which is privately owned in many places. It's a tough question, but we all know that if you have too many people you start losing your freedoms. Those are freedoms as we traditionally see them: To be able to do what we want, where we want. There are other freedoms that come with being able to walk along the water. So it's private freedoms versus public freedoms. We're going to have to concentrate on the public's right to that access to the water.

(Speaker unidentified.) Thank you Dave Fierra. I want to give a very partial response and that has to do with Cape Cod and the regional regulatory agency in land use and growth management. This agency deals with virtually all aspects of growth impact. In terms of environmental impact, they are looking at the impact of a resource such as drinking water or coastal waters and trying to develop a limiting approach in terms of density of the people that sustain the value of the resource. It's a small step in the direction of dealing with density as an impact on the ecological system. Thank you.

Q. **Frank Coltrip.** *I would like to address this to anyone who feels technically competent to answer. In talking about pathogens and indicators, isn't it quite possible that we won't find any* *indicators or at least not a single indicator that is going to do for us all the things that people have suggested should be done.*

A. **(Speaker unidentified.)** I think we will find an indicator. We've been doing work in the State of New Jersey on an ocean health study. We can monitor for certain viruses and we have done that. What we need is an indicator substance or organism that we can turn around in approximately a 24-hour period to get the analysis instead of a 7-day period. Then we can make a judgment about the health of ocean waters or estuarine waters. I think that we will eventually find one.

Q. **Martin Garrel, Adelphi University.** *I have a question about whether the documents that come out of the workshop will have a money tab, or a bill, or a reckoning for the total cost of everything that people would like to have done. I've been sitting back in row number 5 sandwiched between two very interesting ladies who are from the Office of Management and Budget. I can only guess that they're here because they want to be sure that you people from EPA don't give away the farm or something. We talk about trade-offs. I realize that when you total everything up, and get the bill for what we want, we are going to have to make a pitch to the public what the cost is and why we want it. Again, I'm sure that Mr. Wagner must have considered that in New York City. When you look at that a $1.5 billion tab for nutrient removal at STP, you have to figure out how it's going to be financed and weigh that against the cost of handling those people that are sleeping in every car of the number one train that rides out here on the subways. It's tough. Have you given some thought to that?*

A. **Richard Caspe.** As far as the cost goes, we're talking about two different issues. One is the short-term response and the other is the long-term response. If you are dealing with issues that might cost $5 billion for the City of New York to denitrify waste of some level, before any decision is made on that there is going to have to be some real good science performed. Not just on the impact of the nitrogen the water body, but the impact of denitrification on the nitrogen in the water in terms of living things within the water body and what the effects of excess nitrogen are. There's going to be some type of a cost-benefit analysis done before a decision is made. That doesn't mean that you don't deal with nitrogen, if nitrogen is the problem as in the case in the Sound, for example. I'm not saying that you don't deal with it now. There's two different levels. Again, there are certain things that can be done to reduce nitrogen that might not cost $5 billion or $1 billion or $100 million. It may cost substantially less. Those are the things in which I have a very keen interest. There are going to be some important, responsible decisions made. I don't think anyone here is suggesting irresponsible decisions. I appreciate the fact that Ed and the City of New York are not frightened by the $5 billion number. When you add $5 billion for identification and add surface water treatment or requirements, for water supply in the Delaware and Catskills, as well as sludge and CSOs -- those $5 billions start adding up and they become $20 billions or more. Those number become very frightening. From the regulatory perspective, we can't demand everything. You can't ask somebody to fly. You have to prioritize and come up with a responsible way to deal with these issues. I don't think anyone here is suggesting anything but that.

Salvatore Pagano. Let me reemphasize the point of funding. I think we are fighting a losing battle right now. The budgets at the federal and state levels, I can speak for New York State, don't address what the people are reacting to, and the state government does the same thing. Guess what the top water bill is this year in Congress? It has to do with oil pollution. Remember the Valdez? That's what causes them to take action. We're talking about actions to prevent problems and they're telling us to take actions when there is a problem. When bridges fall down, money goes to the Department of Transportation to inspect bridges, so they don't fall down. We're trying to get ahead of that. That's the problem we are faced with. We can add up all the price tags on all the things we talked about today but we're not going to get anywhere with those things. Since 1972, when there was an understanding and a belief that we had to rebuild the infrastructure, at least for wastewater disposal systems, we haven't made a whole lot of progress. That program is done as a self-policing, self-monetary system that is done on a loan basis. Congress wants to walk away from a lot of these things. The state and federal budgets do not necessarily deal with these problems. It comes back to the issue of the public being heard so that there is an impact, and also the governments are aware that people are concerned or afraid to ignore these issues.

Q. **Gerald Lawler, Environmental Consultant.** *I would like to make one point, actually two points. The first point has to do with credibility. The scientific community sometimes has credibility problems.*

Nothing was done about acid rain. None of the things that were done in response to the problem have been carried out long enough to be able to determine the striped bass in the Chesapeake system. When things such as acid rain happen, they really reflect inadequate knowledge. We are then faced with having a credibility problem and the dilemma of being asked to explain why something has happened. We really aren't prepared to give reasons.

Another credibility problem is in the engineering area, the whole area of solid waste management, particularly recycling. Landfills are being closed. Recycling and reuse are really laudable. In our area, I know of at least three examples where recycling efforts can implement solid waste programs. Everybody has to put their trash in separate containers and sort out their waste. If the waste get picked up, people pay an extra fee and what happens? It goes to the landfill. There's no market for this stuff. So it gets all piled up in the landfill after going through the expense of sorting it. It has to do with the lack of marketing. Is that a federal or a state role? Who's role is it to put through policies and/or tax laws which favor the use of recycled materials in preference to raw materials?

The other point that I would like to make has to do with what went on at this conference. One thing I really didn't hear is that the more successful we become in cleaning up the water and cleaning up the beaches, the more intensive is the use of these areas, which counteracts the cleanup efforts.

A. **Terry Backer.** Who is responsible for recycling programs? The same guys who mandate recycling by the public should be mandating the use of those materials. We currently do some stuff with newsprint. We have a tendency to pat ourselves on the back when we encourage people to move to the coastline, to get them out there, help them to get water, and so forth. I don't believe in that. I believe that it works like economic structure. In the 1980s, there was plenty of money around so lots of people moved to the coast and could afford that expensive problem. I have a tendency to think that's a lot of self-back patting and I don't buy it at all. I think it has to do with being an unprecedented economic situation more than whether the rivers or the waterfront were cleaned up. If Congress and the state legislators are not going to mandate the use of recycled materials, it is an exercise in frustration. Its doing something to make it look good to the public. It always falls back to political solutions.

Q. **Peter Mack, N.Y.S.D.E.C.** *I'm a regulator and it seems to me that when people want to locate in areas that perhaps they shouldn't, people try to use our laws to prevent them from moving there. Our laws aren't set up to control, nor should they be used to control, development. I've heard a lot of people talk about, over the last few days, how development is a concern and we should consider development in our deliberations on the oceans or the shore. But, on the other hand, once somebody gets where they are, whether they should be there or not is irrelevant. As a regulator, and as communities, we're told that when developers cause a problem -- fix it -- once they're there. In the last three days, we talked about a lot of fixes and yet no one has ever said we're not going to be able to fix some of these things simply because there are too many people where they are. Anyone want to take a shot at that?*

A. **Terry Backer.** You started out your statement by saying that regulators shouldn't use the law to prevent development. I think maybe it is time to fess up on these problems and say that some of these problems are big and we don't know how to solve them but we're not going to stop working on them. Maybe the credibility problem lies with the fact that we keep looking for answers that in some way get presented as a promise and the promise is never fulfilled. Maybe we can clean up some of the toxic sites. Maybe it's better, I don't know, you're the scientist. I think honesty and being straightforward is best. Maybe we can say we have problems that already exist that we can't solve but we can prevent a lot of new ones. This is what we need to say. Is that what you're saying? Well then, as regulators maybe you have to say that, not as a cop out but really look at what you are doing and say technology got us into this but technology isn't ready to get us out yet. And as an engineer I'd like to say exactly that.

Q. **Joyce Freeling.** *I'd like to address this to Terry Backer. I'm a creative marketer -- let me explain the difference between a marketer and a creative marketer. A marketer moves things out to the public. A creative marketer responds to the totality of what's needed in the marketplace. With a group of other professionals in this area, we have been designing a highly creative consumer education vehicle. Monday, I asked who I would present this to if I was looking for a public service. The program is developed so that major corporations could be involved in it as well. I was received with not only nervousness but by being passed over. Now*

I've heard over and over again how critical public education is. But there's no response to it. It seems to me that if you have something, there should be an opportunity to present it to someone to find out if it really is highly beneficial. This program is designed to be introduced both nationally and bi-regionally because it's modular. I am as frustrated as everyone else in trying to get something accomplished.

A. **Terry Backer.** Part of being involved in environmental stuff is public support. Public support is the media and the way that we do that is we have to be pretty controversial. An idea is the hardest thing to sell. We use selective memory.

Q. *No, No. What I'm asking you for is information. We know how to market and create something that will gain consumer involvement -- that's contextual education. It's entirely different from anything anyone here has seen because we're in different professions. What I'm looking for are two things. I want to get information that is critically needed in the regions and I want to get, if possible, health service corporations involved. If it's approved.*

A. **Salvatore Pagano.** A suggestion. For the selling of the water program and selling of water resources along with the need for prevention and protection, whether we correct water problems or not, a foundation has been set up in Washington called the Water Foundation. Their major interest and concern is to explain the water program to the public. I have a reference for you if you want to speak to somebody there.

Q. **Dave Rourke with the American Littoral Society.** *It seems to me in the future you ought to have a demographer in your group because it appeared to me that one of the questions that's going to come up in the future is knowing what's happened in the past 50 years, what is going to happen in the next 50. A lot of things that involve coastal use can become of more economic value. For example, if gasoline were to triple or quadruple in price, what would the 30 million people, some of whom are near poverty level, do if they wanted to go for a swim? It's got to be close by; it can't be in Maryland or in Cape Cod. It's got to have beaches and so forth. Many more facilities may be available in the future than are available now. Okay, if you're going to continue to use the coasts for recreation.*

Water -- If you have a regional plan, for water you also have a chance for the three governors to get together on issues such as mass transit, in wanting rebuilding in certain areas that be served by mass transit. They could get together and make gasoline $3 a gallon in a regional area.

A. **Salvatore Pagano.** Let me say this. Trying to get some public officials to attend this conference was difficult. Trying to talk to the governor -- I don't do that. I think the idea is probably a good one. How it's done I don't know. If you want to use a gasoline tax as an example, a penny a gallon is worth approximately $100 million in New York State. A one cent tax increase on a gallon of gas. Right now the tax is split between federal and state taxes. I think the idea is a good one. There are many similar funding sources. The problem is getting people interested enough to say that the state or states in a region should implement programs to accomplish some good. That connection hasn't been made as yet and so putting a penny tax or some tax on some consumer product is not popular. It's got to become popular.

Just a follow-up comment. Using the example of the gasoline tax, if we remember back to the mid-1970s when there was an oil crisis, the public responded very quickly, in a matter of a few years. We were buying a lot of little cars and there were more carpools than we have ever seen before. Then it stopped. The crisis was over and people returned to their old habits. I think the public can respond to a need. They are very adaptable.

APPENDIX I: ISSUES DOCUMENT

CLEANING UP OUR COASTAL WATERS: An Unfinished Agenda

LONG ISLAND SOUND STUDY

The New York-New Jersey Harbor Estuary Program

NEW YORK BIGHT RESTORATION PLAN

MANHATTAN COLLEGE · NEW YORK · SIGNUM FIDEI

ISSUES FOR DISCUSSION

March 12 - 14, 1990

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

CLEANING UP OUR COASTAL WATERS:
An Unfinished Agenda

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is currently funding three major water quality management planning efforts for the coastal waters in the New York-New Jersey-Connecticut region: the Long Island Sound Study (LISS), the New York-New Jersey Harbor Estuary Program (HEP), and the New York Bight Restoration Plan (NYBRP). Each of the three planning efforts is overseen by a Management Conference established by the Administrator.

The three efforts require close coordination since, in many respects, the Sound, Harbor, and Bight function as single ecosystem; control actions taken in one component of the system affect water quality in the other components of the system. Furthermore, there is a compelling need to evaluate the total burden on the regulated community associated with implementing the recommendations in all three plans. For example, New York City will be required to implement provisions contained in all three plans.

For this reason, the Management Conferences, in conjunction with Manhattan College, have decided to sponsor this conference. Manhattan College is celebrating the fiftieth anniversary of its Environmental Engineering program this year and views this conference as an appropriate opportunity to place coastal environmental issues into the proper historical context.

The conference will be held March 12-14, 1990, at Manhattan College. Conference participants will include government regulators; elected officials; representatives of the regulated, professional, and academic communities; and private citizens. The agenda for the conference is included as Appendix A; maps of the Sound, Harbor, and Bight study areas are included as Appendix B; management questions that the invited expert speakers will address are included as Appendix C.

CONFERENCE OVERVIEW

On the morning of the first day, conference participants will convene in plenary session to hear speakers who will set the direction for the conference:

- Brother Thomas Scanlan, President of Manhattan College, will deliver a welcoming address;
- EPA Administrator William K. Reilly will deliver a keynote address providing a national perspective on coastal issues; and

- The Management Conference Policy Committees will present the charge to the conference.

After breaking for lunch, conference participants will reconvene in plenary session to begin a three-phase workshop process. Manhattan College Professor Dr. Donald J. O'Connor will initiate the process by providing a historical perspective on coastal issues. In each phase of the workshop process, conference participants will begin by listening to expert speakers who will address the detailed questions that have been posed by the Coastal Conference Steering Committee; these questions are included as Appendix C. The expert answers to these questions will provide a firm technical foundation for workgroup deliberations. Having heard the presentations, conference participants will be divided into groups of approximately twenty to facilitate discussion. In these groups, conference participants will be asked to develop answers to the questions posed on Tables 1-3 in the document. Each group will have a facilitator and a recorder. Afternoon meetings of the facilitators will provide the opportunity to synthesize workgroup conclusions and recommendations. Designated facilitators will then report the synthesized conclusions back to the conference in plenary session. The workshop process has been designed to enable conference participants, working together, to develop a single, integrated agenda for cleaning up our coastal waters.

Once the integrated agenda resulting from the workshop sessions has been presented in plenary session, a distinguished panel will be asked to react to it. The conference will then conclude with a brief summary of how the integrated agenda produced by conference participants will influence the continued deliberations of the Management Conferences established by the Administrator.

PHASE I WORKSHOPS

THE CONDITION OF OUR COASTAL WATERS: STATUS, TRENDS AND CAUSES

During the first set of workshops, conference participants will attempt to

- Define the primary factors causing use impairments and other adverse ecosystem impacts in the Sound-Harbor-Bight system (based upon readily available information);

- Define the relative ecological and economic significance of these factors (based upon readily available information); and

- Define the major gaps in our information base that limit the confidence that we have in identifying these primary factors and in estimating their relative significance.

During this phase, priorities will be established without regard to the costs of cleanup. Specifically, during Phase I, conference participants will be asked to answer the questions in **Table 1**.

Table 1. Primary Factors Causing Use Impairments and Other Adverse Ecosystem Impacts

	SOUND	HARBOR	BIGHT	SYSTEMWIDE
Nutrient/ Organic Enrichment	1	1	1	1
	2	2	2	2
	3	3	3	3
Pathogens	1	1	1	1
	2	2	2	2
	3	3	3	3
Floatables	1	1	1	1
	2	2	2	2
	3	3	3	3
Toxics	1	1	1	1
	2	2	2	2
	3	3	3	3
Habitat	1	1	1	1
	2	2	2	2
	3	3	3	3
Other (Specify)	1	1	1	1
	2	2	2	2
	3	3	3	3

For each element of the matrix, answer the following questions:

1. How significant is this factor in contributing to use impairments and other adverse ecosystem impacts (High, Medium, or Low)?
2. On what basis do you draw these conclusions?
3. What additional information would improve the confidence that you have in your conclusions?

PHASE II WORKSHOPS

INDIVIDUAL AGENDA ADDRESSING THE PRIMARY FACTORS CAUSING USE IMPAIRMENTS AND OTHER ADVERSE ECOSYSTEM IMPACTS

During the second set of workshops, participants will be divided into six issue-oriented groups:

- Nutrient/organic enrichment;
- Pathogens/floatables;
- Toxics;
- Habitat;
- Seafood safety; and
- Ocean disposal.

Within each group, participants will focus narrowly on the single issue before them, attempting to develop ranked lists of recommended short- and long-term planning and implementation actions. In this phase of the workshops, conference participants will consider the costs of addressing the factors causing use impairments and will select remedies for each factor, based on cost-effectiveness.

Specifically, each group will be asked to fill out **Table 2**:

- Identifying recommended actions to deal with the issue;
- Identifying whether the action should be undertaken for the Sound, Harbor, Bight, or systemwide;
- Identifying whether the action should be undertaken in the short or long term[1]; and
- Identifying whether the action should be assigned a high, medium, or low priority.

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[1] For the purposes of this analysis, short-term actions can be defined as those undertaken prior to the completion of a Final Management Plan; long-term actions can be defined as those undertaken after the completion of a Final Management Plan. Final Management Plans for the three programs will be completed as follows:

- Long Island Sound Study - November 1991
- New York-New Jersey Harbor Estuary Program - April 1994
- New York Bight Restoration Plan April 1991

Table 2. Individual Issue-Specific Agenda

Issue: ______________________

Recommended Action	Sound, Harbor, Bight, or System-Wide	Short/ Long Term	Priority (High, Medium, Low)

NOTE: Consider factors such as cost, effectiveness, the need for prompt action, the need for a sound technical basis for action, and the need to balance competing uses of our coastal waters. Ensure that adequate consideration is given to potential pollution prevention initiatives.

In answering these questions, the groups are asked to consider factors such as cost, effectiveness, need for prompt action, need for a sound technical basis for action, and need to balance competing uses of our coastal waters. Furthermore, groups are asked to ensure that adequate consideration is given to potential pollution prevention initiatives.

PHASE III WORKSHOPS

AN INTEGRATED AGENDA FOR CLEANING UP OUR COASTAL WATERS

During the third set of workshops, conference participants will be asked to forge a single, integrated agenda from the six issue-specific agendas developed during Phase II. The participants will be asked to balance the costs and benefits of addressing the individual factors in terms of overall ecological and economic significance, and will be asked to factor into their discussions a sensitivity to the total burden being placed on the regulated community.

Specifically, conference participants will asked to fill out **Table 3.**

Table 3. Integrated Agenda

Recommended Action	Sound, Harbor, Bight, or System-Wide	Short/ Long Term	Priority (High, Medium, Low)

NOTE:
- Use six issue-specific agenda developed during Phase II as a starting point.
- Balance cost and benefits in terms of overall ecological and economic significance.
- Be sensitive to the total burden being placed on the regulated community.
- Prepare a single, integrated agenda.

APPENDIX A

Agenda

CLEANING UP OUR COASTAL WATERS:
AN UNFINISHED AGENDA

The first annual regional conference, co-sponsored by Manhattan College and the Management Conferences for the Long Island Sound Study (LISS), New York-New Jersey Harbor Estuary Program (HEP), and the New York Bight Restoration Plan (NYBRP). This conference is the first in a continuing series. The Management Conferences will solicit expressions of interest in co-sponsoring future conferences from other academic institutions within the region.

Riverdale, New York
March 12-14, 1990

Time	Topic	Speaker/Facilitator
MONDAY, MARCH 12, 1990		
8:30 a.m.	**Registration**	
9:00 a.m.	**Welcome**	Br. Thomas Scanlan President Manhattan College
9:20 a.m.	**Keynote Address:** A National Perspective	Hon. William K. Reilly Administrator USEPA
9:50 a.m.	**Questions to Administrator Reilly**	
10:10 a.m.	**Signing of the Coastal Waters Pledge**	Morning speakers and invited elected officials
10:30 a.m.	**The Charge to the Conference -** Management Questions to be answered at the Conference, as posed by the members of the Management Conference Policy Committees (a joint statement)	Ms. Julie D. Belaga Regional Administrator USEPA, Region I Mr. C. Sidamon-Eristoff Regional Administrator USEPA, Region II Mr. Thomas C. Jorling Commissioner N.Y.S Dept. of Environ. Conserv.

Time	Topic	Speaker/Facilitator
		Ms. Judith A. Yaskin Commissioner N.J. Dept. of Environ. Prot.
		Ms. Leslie Carothers Commissioner Conn. Dept. of Environ. Prot.
11:30 p.m.	**Lunch** (Buffet)	
1:00 p.m.	**Keynote Address: A Historical Perspective**	Dr. Donald J. O'Connor Professor Manhattan College
1:30 p.m.	**The Condition of Our Coastal Waters: Status, Trends, and Causes -** Technical presentations in plenary session	
	Historical Trends in the Abundance and Distribution of Living Marine Resources	Dr. J.L. McHugh Professor Emeritus Marine Sci. Res. Center SUNY - Stony Brook
	Conditions in the Long Island Sound	Mr. Paul Stacey Project Manager Long Island Sound Study Conn. DEP
	Conditions in New York-New Jersey Harbor	Dr. Dennis J. Suszkowski Science Advisor Hudson River Foundation
	Conditions in the New York Bight	Dr. R. Lawrence Swanson Director Waste Management Inst. Marine Sci. Res. Center SUNY - Stony Brook

Time	Topic	Speaker/Facilitator
	An Integrated Assessment of Conditions in the Sound-Harbor-Bight System	Dr. J.R. Schubel Dean and Director Marine Sci. Res. Center SUNY - Stony Brook
	Conditions in the Sound-Harbor-Bight System Viewed in the National Context	Dr. Tudor T. Davies Director Office of Marine and Estuarine Protection, USEPA
3:30 p.m.	**Workshop Sessions To Discuss "The Condition of Our Coastal Waters" -** Break-out sessions in groups of approximately 20 to discuss management questions related to the condition of our coastal waters	Facilitators
5:00 p.m.	**Adjourn** **Social Hour - Cash Bar** **Meeting of Facilitators**	

TUESDAY, MARCH 13, 1990

Time	Topic	Speaker/Facilitator
8:30 a.m.	**Conclusions from Monday's Workshop Sessions -** A report, in plenary session on the conclusions reached at the previous day's workshop sessions	Dr. J. Frederick Grassle, Director Institute of Marine and Coastal Science Rutgers University
9:00 a.m.	**Workshop Sessions on the Primary Factors Causing Use Impairments and Other Adverse Ecosystem Impacts**[1]	

[1]At these workshop sessions, Conference attendees will initially be divided into six groups. Each group will hear technical presentations on one of the following six topics: Nutrient/Organic Enrichment, Pathogens/Floatables, Toxics, Habitat, Management of Living Marine Resources, and Ocean Disposal. The technical presentations, which will address the pertinent management questions posed by the Policy Committees, will last approximately 20 minutes each. Upon completion of the technical presentations, the six groups will be further divided into groups of approximately 20 persons, to facilitate the formulation of group responses to the management questions.

Time	Topic	Speaker/Facilitator
	NUTRIENT/ORGANIC ENRICHMENT	
	Nutrient/Organic Input and Fate	Mr. John P. St. John, P.E. HydroQual, Inc.
	Ecological Effects and Acceptable Ambient Levels	Dr. Joel S. O'Connor USEPA, Region II
	Controlling Point and Non-Point Nutrient/ Organic Inputs: A Technical Perspective	Mr. Stuart Freudberg Director Dept. of Environ. Prog. Metropolitan Washington Council of Governments
	Controlling Nutrient/Organic Inputs: A Regulatory Perspective	Mr. Robert Smith Acting Director Planning and Standard Div. Conn. DEP
	PATHOGENS/FLOATABLES	
	Inputs and Fate of Pathogens and Floatables in the Sound-Harbor-Bight System	Mr. Michael Skelly General Manager Mr. Guy Apicella Modeling Program Manager Lawler, Matusky & Skelly
	Addressing the Pathogens and Floatables Problems: Planning and Engineering Solutions	Mr. Robert Gaffoglio, P.E. Chief Division of CSO Abatement Control N.Y.C. DEP
	Addressing the Pathogens and Floatables Problems: A Regulatory Perspective	Richard L. Caspe, P.E. Director Water Management Division USEPA, Region II
	Addressing the Pathogens and Floatables Problems: An Affected Community's Viewpoint	Honorable Paul J. Noto Mayor Village of Mamaroneck

Time	Topic	Speaker/Facilitator
	TOXICS	
	Inputs of Toxics to the Sound-Harbor-Bight System	Dr. James Mueller, P.E. Professor Manhattan College
	Levels of Toxics in Water, Sediment, and Biota, and Their Effects	Ms. Fredrika Moser Office of Sci. & Research N.J. DEP
	Controlling Toxic Inputs: Source Reduction and Treatment Options	W.W. Eckenfelder, P.E. Dist. Prof. Emeritus Vanderbilt University Senior Tech. Director Eckenfelder, Inc.
	Controlling Toxic Inputs: A Regulatory Perspective	Mr. Albert W. Bromberg, P.E. Chief Quality Eval. Section Division of Water N.Y.S. DEC
	HABITAT	
	A Historical Review of Changes in Aquatic Habitat in the Sound-Harbor-Bight System	Dr. Donald F. Squires Director Marine Science Institute Univ. of Connecticut
	Preventing Further Degradation of Aquatic Habitat: A Regulatory Perspective	Mr. Mario P. Del Vicario Chief Marine & Wetlands Prot. Branch, USEPA, Region II
	Preventing Further Degradation of Aquatic Habitat: A Citizen's Perspective	Ms. Eugenia M. Flatow Coordinator Coalition for the Bight

Time	Topic	Speaker/Facilitator
	Balancing Habitat Protection and Urban Growth: A Developer's Perspective	Dr. Anthony Sartor Principal Paulus, Sokolowski, & Sartor
	SEAFOOD SAFETY	
	Seafood Safety: Regulatory and Risk Assessment Perspectives	Dr. Edward Horn Research Scientist N.Y.S. Dept. of Health
	Seafood Safety: A Commercial Fisherman's Perspective	Mr. Lee Weddig Executive Vice President National Fisheries Inst.
	Seafood Safety: A Sport Fisherman's Perspective	Mr. Joseph J. McBride President Montauk Boatman's Captain's Association
	Seafood Safety: An Environmentalist's Perspective	Mr. Arthur Glowka Chairman Long Island Sound Task Force Director Hudson River Foundation
	OCEAN DISPOSAL	
	Dredged Material Disposal: A Regulatory Perspective	Mr. John F. Tavolaro Chief Water Quality Compliance Branch, New York District Army Corps of Engineers
	Monitoring the Recovery of the Former 12-Mile Sewage Sludge Site	Mr. Robert Reid, Chief Benthos Task Natl. Marine Fish. Serv. Sandy Hook
	Sewage Sludge Disposal: A Regulatory Perspective	Mr. Bruce Kiselica, Chief Ocean Dumping Task Force USEPA

<u>**Time**</u>	<u>**Topic**</u>	<u>**Speaker/Facilitator**</u>
	Environmental Impacts of Ocean Disposal	Dr. Wayne R. Munns Senior Biologist Science Applications International Corporation ERL-Narragansett
	Impacts of Decisions on Ocean Disposal in the Port of New York-New Jersey	Ms. Lillian C. Liburdi Director Port Dept. Port Authority of NY-NJ
12:00 p.m.	**Luncheon**	
1:30 p.m.	**An Integrated Agenda for Cleaning Up Our Coastal Waters -** Conference attendees will convene in plenary session to hear presentations that provide a context within which to formulate an agenda for cleaning up our coastal waters.	
	Existing and Planned Environmental Control Programs: A New York City Perspective	Mr. Albert F. Appleton Commissioner N.Y.C. Dept. of Environ. Prot.
	Existing and Planning Environmental Control Programs: A Norwalk Perspective	Mr. Dominick M. DiGanges Director Public Works City of Norwalk
	Existing and Planned Environmental Control Programs: An Industry Perspective	Dr. Geraldine V. Cox Vice Pres. & Tech. Dir. Chemical Manufacturers Association
	Setting Priorities: A National Perspective	Mr. David A. Fierra Director Water Management Division USEPA, Region I

Time	Topic	Speaker/Facilitator
3:30 p.m.	**Workshop Sessions To Develop an Integrated Agenda for Cleaning Up Our Coastal Waters**[2]	Facilitators
5:00 p.m.	**Adjourn** **Meeting of Facilitators**	

WEDNESDAY, MARCH 14, 1990

9:00 a.m.	**Preliminary Conclusions from Tuesday's Workshop Sessions on Primary Factors -** Reports in plenary session on conclusions reached in the six workshop sessions pertaining to Nutrient/ Organic Enrichment, Pathogens/Floatables, Toxics, Habitat, Seafood Safety, and Ocean Disposal	Facilitators
10:00 a.m.	**Preliminary Conclusions from Tuesday's Workshop Sessions on An Integrated - Agenda -** Report in plenary session on the conclusions reached in the workshop sessions pertaining to the development of an integrated agenda	Dr. Dominic DiToro Professor Manhattan College
10:30 a.m.	**Break**	
10:45 a.m.	**Discussion -** Preliminary formulation of recommendations to guide continued continued deliberation of the Management Conferences	Mr. David A. Fierra Director Water Management Div. USEPA, Region I

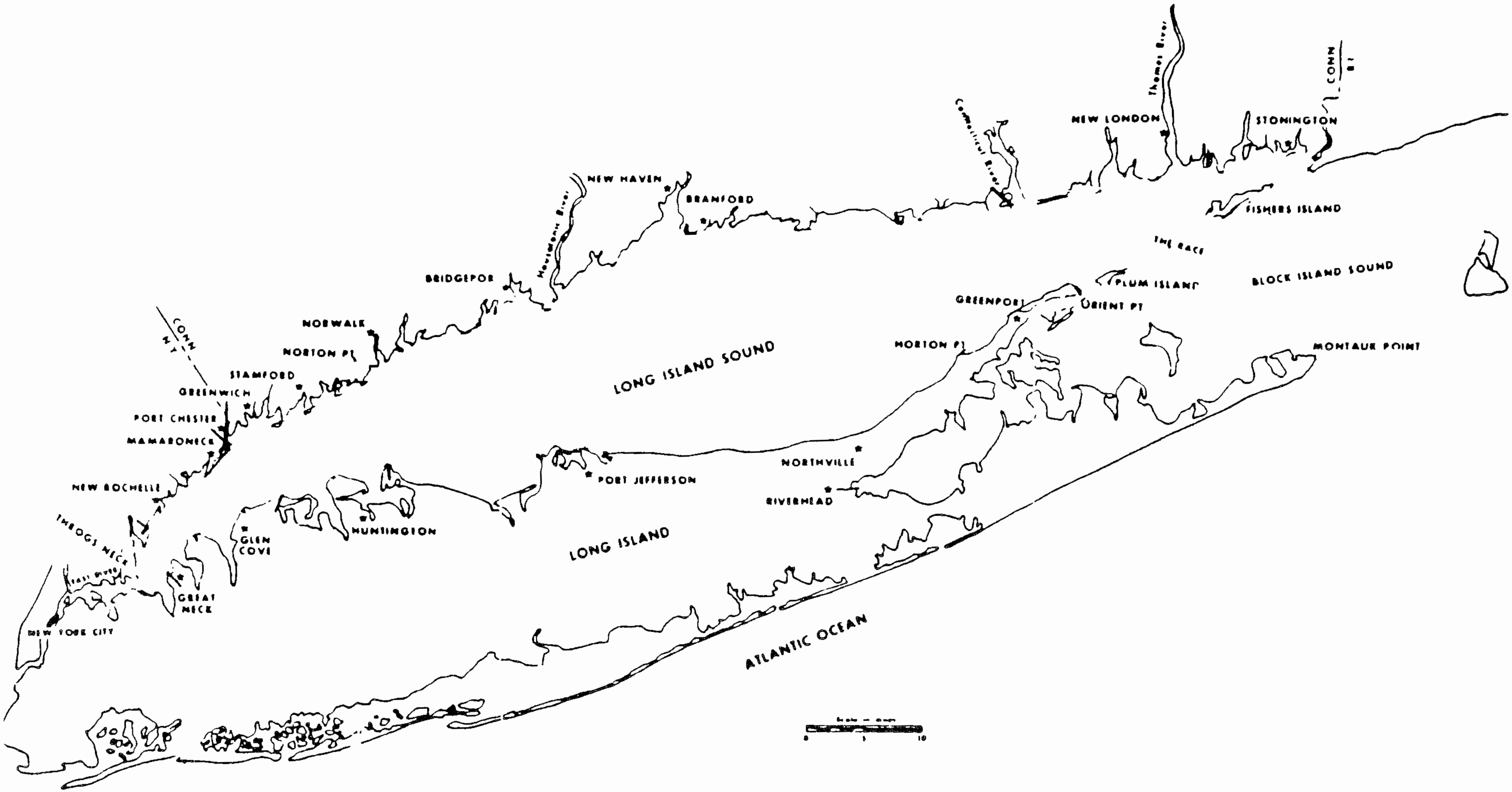
[2]Conference participants will be divided into workgroups of approximately 20 to begin formulation of an integrated agenda that deals with all of the primary factors causing use impairments and other adverse ecosystem impacts. Care will be taken to ensure that each workgroup has representatives who dealt with each of the six topics addressed at the workshop sessions on Tuesday.

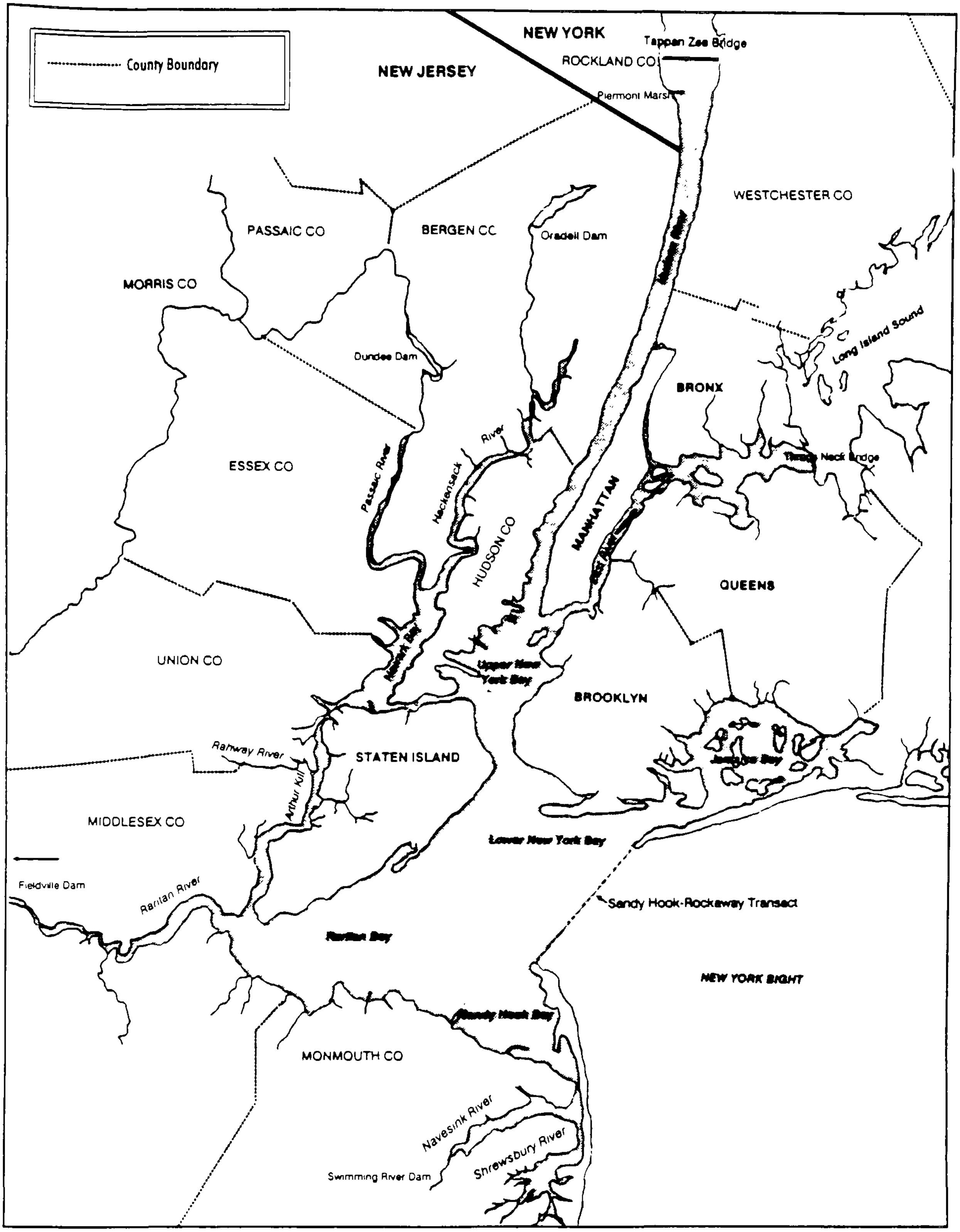
Time	Topic	Speaker/Facilitator
		Mr. Richard L. Caspe Director Water Management Div. USEPA, Region II
		Mr. Salvatore Pagano Associate Director Division of Water N.Y.S. DEC
		Mr. Eric Evenson Act. Director Division of Water N.J. DEP
		Mr. Adrian P. Freund Chief Bureau of Water Management Conn. DEP (invited)
		Mr. Edward O. Wagner, P.E. Asst. Commissioner Bureau of Wastewater Treatment N.Y.C. DEP
		Mr. Terry Backer Soundkeeper for the Long Island Sound Keeper Fund
		Dr. Anthony Sartor Principal Paulus, Sokolowski, & Sartor
12:15 p.m.	**Next Steps**	Mr. Richard L. Caspe, P.E. Director Water Management Division USEPA, Region II
12:30 p.m.	**Adjourn**	

APPENDIX B

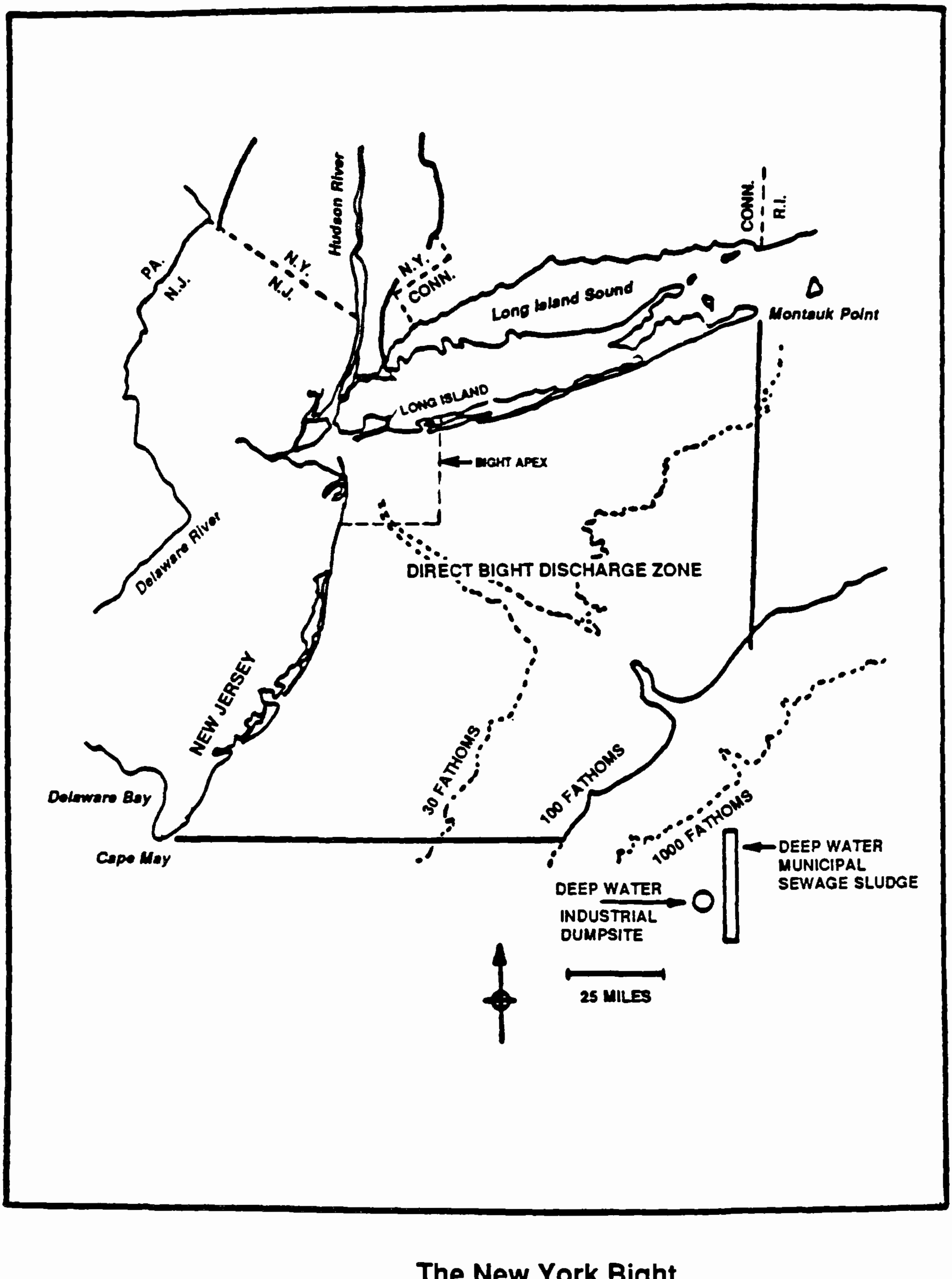
**Maps of the Long Island Sound,
New York-New Jersey Harbor, and
New York Bight**

LONG ISLAND SOUND





The New York - New Jersey Harbor



The New York Bight

APPENDIX C

Management Conference Questions

MANAGEMENT CONFERENCE QUESTIONS

The Condition of Our Coastal Waters: Status, Trends, and Causes

Historical Trends in the Abundance and Distribution of Living Marine Resources . . . . Dr. J.L. McHugh

1. What are the historical trends in the abundance of living marine resources in the Sound? In the Harbor? In the Bight? Systemwide?

2. What are the major factors causing these trends? What is the relative importance of each of these factors?

Conditions in the Long Island Sound . . . . Mr. Paul Stacey

3a. What are the use impairments and other adverse ecosystem impacts in the Sound?

4a. What is the ecological and economic significance of these impacts?

5a. What are the primary factors causing these impacts?

6a. Are conditions getting better or worse? Have any trends been established in the present century?

7a. What is the prognosis for the future of the Long Island Sound?

Conditions in New York-New Jersey Harbor . . . . Dr. Dennis J. Suszkowski

3b. What are the use impairments and other adverse ecosystem impacts in the Harbor?

4b. What is the ecological and economic significance of these impacts?

5b. What are the primary factors causing these impacts?

6b. Are conditions getting better or worse? Have any trends been established in the present century?

7b. What is the prognosis for the future of New York-New Jersey Harbor?

Conditions in the New York Bight . . . . Dr. R. Lawrence Swanson

3c. What are the use impairments and other adverse ecosystem impacts in the Bight?

4c. What is the ecological and economic significance of these impacts?

5c. What are the primary factors causing these impacts?

6c. Are conditions getting better or worse? Have any trends been established in the present century?

7c. What is the prognosis for the future of the New York Bight?

An Integrated Assessment of Conditions in the Sound-Harbor-Bight System .... Dr. J.R. Schubel

8. When viewed from a Sound-Harbor-Bight systemwide perspective, what is the relative significance of the individual impairments and the factors causing them? Which impairments are manifested with equal intensity systemwide? Which are manifested with greater intensity in the individual subsystems of the Sound-Harbor-Bight?

Conditions in the Sound-Harbor-Bight System Viewed in the National Context .... Dr. Tudor T. Davies

9. How do the problems in the Sound-Harbor-Bight system compare with those in other estuarine systems in the United States? In the world?

<u>Nutrient/Organic Enrichment</u>

Nutrient/Organic Inputs and Fate .... John P. St. John, P.E.

10. What are the loadings of BOD, N, and P to the Sound-Harbor-Bight system?

11. What are their relative contributions to hypoxic conditions and the development of undesirable algal species?

12. What do we know at this point about the level of load reduction required to meet existing standards or alternative endpoints?

13. Do we have the necessary systemwide analytic effort under way at this time to determine the required level of control?

Ecological Effects and Acceptable Ambient Levels .... Dr. Joel S. O'Connor

14. What are the current standards and criteria for dissolved oxygen? Are there standards and criteria for other parameters associated with nutrient/organic enrichment?

15. What do we know about the ecological effects of nutrient/organic enrichment?

16. What do we know about the relationship between ambient levels of dissolved oxygen and ecological effects?

17. What is the relationship between phytoplankton concentrations and perceived water quality?

18. How best can we formulate alternative endpoints for management consideration?

19. How best can we estimate the benefits of control programs?

Controlling Point and Non-Point Nutrient/Organic Inputs: A Technical Perspective . . . . Mr. Stuart Freudberg

20. What pollution prevention options are available for limiting the point source loads of BOD/N/P to the system, and what are their costs?

21. What treatment options are available for limiting the point source loads of BOD/N/P to the system, and what are their costs?

22. What pollution prevention options are available for limiting the non-point source loads of BOD/N/P to the system, and what are their costs?

23. What treatment options are available for limiting the non point source loads of BOD/N/P to the system, and what are their costs?

24. By reducing or preventing point and non-point inputs of BOD, N, P entering the system, what are the associated benefits for other parameters?

Controlling Nutrient/Organic Inputs: A Regulatory Perspective . . . . Mr. Robert Smith

25. Considering what we know about nutrient and organic inputs to the Sound-Harbor-Bight system, how can the Management Conferences select appropriate environmental objectives and develop plans to achieve them?

26. What short-term actions can be implemented to prevent the problem from getting worse? What short-term actions can be implemented to begin reducing the existing problem?

27. How best can we expedite the development of cost-effective long-term remedies to resolve the problem of nutrient/organic enrichment?

Pathogens/Floatables

Inputs and Fate of Pathogens and Floatables in the Sound-Harbor-Bight System . . . . Mr. Michael Skelly & Mr. Guy Apicella

28. What are the primary sources of pathogens and floatables in the Sound-Harbor-Bight system?

29. What is their fate in the system?

30. To what extent do pathogens and floatables have to be controlled to allow the restoration of beneficial uses in the system?

31. What are the current indicators of the pathogen and floatable problems? Are these indicators adequate? Is there a need to develop new and/or additional indicators?

Addressing the Pathogens and Floatables Problems: Planning and Engineering Solutions . . . . Mr. Robert Gaffoglio, P.E.

32. What planning and engineering solutions to the pathogens/floatables problem are currently being implemented? What further actions are planned?

33. What pollution prevention techniques are most appropriate for discharges to the Sound-Harbor-Bight system?

34. What treatment options are most appropriate for this region in terms of practicality, effectiveness, and cost?

35. What are the lead times required to implement these controls?

36. By reducing or preventing pathogens and floatables from entering the system, what are the associated benefits for other parameters?

Addressing the Pathogens and Floatables Problems: A Regulatory Perspective . . . . Mr. Richard L. Caspe, P.E.

37. What are the regulatory agencies doing to encourage short-term remedies to restore beneficial uses?

38. Are there additional measures that the regulatory agencies can implement to encourage short-term remedies to restore beneficial uses?

39. What can regulatory agencies do to encourage cost-effective long-term remedies to restore beneficial uses?

Addressing the Pathogens and Floatables Problems: An Affected Community's Viewpoint . . . . Hon. Paul J. Noto

40. What floatables- and pathogens-related adverse impacts are currently experienced at the local level?

41. What can local government do at its own initiative to address these adverse impacts?

42. How can local government respond to anticipated regulatory requirements?

<u>Toxics</u>

Inputs of Toxics to the Sound-Harbor-Bight System . . . . Dr. James Mueller, P.E.

43. What are the current loadings of toxics to the Sound-Harbor-Bight system?

44. What are the trends in these loadings?

45. What do we know about the fate of toxics in the Sound-Harbor-Bight system?

Levels of Toxics in Water, Sediment, and Biota, and their Effects . . . . Ms. Fredrika Moser

46. What are the existing levels of toxics in water, sediment, and biota in relationship to existing standards and criteria developed to protect the Sound-Harbor-Bight ecosystem?

47. Are the existing standards and criteria adequate?

48. What do we know about the ecological effects of the existing levels of toxics?

Controlling Toxic Inputs: Source Reduction and Treatment Options . . . . Mr. W.W. Eckenfelder, P.E.

49. What pollution prevention options are available for limiting the point source loads of toxics to the system, and what are their costs?

50. What treatment options are available for limiting the point source loads of toxics to the system, and what are their costs?

51. What pollution prevention and treatment options are available to deal with non-point sources of toxics such as atmospheric deposition, urban runoff, and leachate from hazardous waste dumps?

52. By reducing or preventing toxic inputs from entering the system, what are the associated side benefits for other parameters?

Controlling Toxic Inputs:
A Regulatory Perspective . . . . Mr. Albert W. Bromberg, P.E.

53. What is the status of existing programs to control toxic inputs to the system?

54. What more can be done to limit toxic inputs using technology-based and water quality-based limits?

55. What can be done to control toxic inputs that are entering the system from other media?

Habitat

A Historical Review of Changes in
Aquatic Habitat in the Sound-Harbor-Bight System . . . . Dr. Donald F. Squires

56. What changes have occurred in nearshore aquatic habitat since the arrival of the European settlers?

57. What have been the primary factors contributing to the destruction and degradation of nearshore habitat over the past fifty years?

58. What measures have been taken over the past fifty years to minimize the destruction and degradation of nearshore habitat?

Preventing Further Degradation of
Aquatic Habitat: A Regulatory Perspective . . . . Mr. Mario P. Del Vicario

59a. Are existing environmental regulations adequate to protect nearshore aquatic habitat? If not, what type of measures are required to protect nearshore habitat?

60a. What can be done in the short-term to prevent further destruction and degradation of aquatic habitat? What can be done in the short-term to enhance or restore nearshore habitat that has been degraded or destroyed?

61a. What can be done in the long-term to prevent further destruction and degradation of aquatic habitat? What can be done in the long-term to enhance or restore nearshore habitat that has been degraded or destroyed?

62a. Can a balance be struck between protecting nearshore habitat and developing land to satisfy urban growth?

63a. By reducing or preventing point or non-point sources of fill material from entering the system, what are the associated benefits for other parameters?

Preventing Further Degradation of Aquatic Habitat: A Citizen's Perspective . . . . Ms. Eugenia M. Flatow

59b. Are existing environmental regulations adequate to protect nearshore habitat? If not, what type of measures are required to protect nearshore habitat?

60b. What can be done in the short-term to prevent further destruction and degradation of aquatic habitat? What can be done in the short-term to enhance or restore nearshore habitat that has been degraded or destroyed?

61b. What can be done in the long-term to prevent further destruction and degradation of aquatic habitat? What can be done in the long-term to enhance or restore nearshore habitat that has been degraded or destroyed?

62b. Can a balance be struck between protecting nearshore habitat and development?

63b. By reducing or preventing point or non-point sources of fill material from entering the system, what are the associated benefits for other parameters?

Balancing Habitat Protection and Urban Growth: A Developer's Perspective . . . . Dr. Anthony Sartor

62c. Can a balance be struck between protecting nearshore habitat and development?

Seafood Safety

Seafood Safety: Regulatory and Risk Assessment Perspectives . . . . Dr. Edward Horn

64a. What are the existing levels of toxics in water, sediment, and biota in relationship to the standards and criteria developed to protect human health?

65a. Is there a human health risk from consuming fish and shellfish from the Sound-Harbor-Bight system? If so, how significant is the risk?

66a. What are the existing regulatory mechanisms and standards to protect the public from consuming unsafe fish and shellfish?

67a. Do these regulatory mechanisms and standards adequately protect human health?

68a. What changes to the existing regulatory mechanisms and standards would enhance the protection of human health?

Seafood Safety: A Commercial Fisherman's Perspective . . . . **Mr. Lee Weddig**

64b. What are the existing levels of toxics in water, sediment, and biota in relationship to the standards and criteria developed to protect human health?

65b. Is there a human health risk from consuming fish and shellfish from the Sound-Harbor-Bight system? If so, how significant is the risk?

66b. What are the existing regulatory mechanisms and standards to protect the public from consuming unsafe fish and shellfish?

67b. Do these existing mechanisms and standards adequately protect human health?

68b. What changes to the existing regulatory mechanisms and standards would enhance the protection of human health?

69a. How have government actions and legislation affected the commercial seafood industry?

Seafood Safety: A Sportfisherman's Perspective . . . . **Mr. Joseph J. McBride**

65c. Is there a human health risk from consuming fish and shellfish from the Sound-Harbor-Bight system? If so, how significant is the risk?

69b. How have government actions and legislation affected sportfishermen?

Seafood Safety: An Environmentalist's Perspective . . . . **Mr. Arthur Glowka**

64c. What are the existing levels of toxics in water, sediment, and biota in relationship to the standards and criteria developed to protect human health?

65d. Is there a human health risk from consuming fish and shellfish from the Sound-Harbor-Bight system? If so, how significant is the risk?

66c. What are the existing regulatory mechanisms and standards to protect the public from consuming unsafe fish and shellfish?

67c. Do these existing mechanisms and standards adequately protect human health?

68c. What changes to the existing regulatory mechanisms and standards would enhance the protection of human health?

Ocean Disposal

Dredged Material Disposal: A Regulatory Perspective ..... Mr. John F. Tavolaro

70. What are the current and planned disposal practices for dredged material in the Sound-Harbor-Bight system?

71. What are the adverse environmental impacts associated with dredging and ocean disposal of dredged material?

72. What type of mitigative measures are currently practiced? Is additional mitigation possible? Dredged material disposal?

73. Are there short-term and/or long-term alternatives to the ocean disposal of dredged material in this area?

Monitoring the Recovery of the Former 12-Mile Sewage Sludge Site ..... Mr. Robert Reid

74. What adverse environmental impacts have been experienced from dumping sewage sludge at the former 12-mile sewage sludge site?

75. Has the 12-mile site shown any environmental improvement since sewage sludge dumping ceased in 1987?

76. What are the prospects for implementing mitigative measures at this site?

77. What are the prospects for and benefits of opening this site and adjacent waters to shellfishing?

Sewage Sludge Disposal: A Regulatory Perspective ..... Mr. Bruce Kiselica, P.E.

78. What are the current disposal and planned practices for sewage sludge disposal at the 106-mile site?

79. What are the current plans for implementation of land-based alternatives?

80. What do we know about the adverse environmental impacts of this activity?

81. What further monitoring and analysis are planned to improve our understanding of these impacts?

Environmental Impacts of Ocean Disposal . . . . Dr. Wayne R. Munns

82. What are the adverse environmental impacts associated with dredging and the ocean disposal of dredged material?

83. What are the adverse environmental impacts associated with disposal of sewage sludge at the 106-mile site?

84. What are the adverse environmental impacts associated with other ocean disposal activities such as cellar dirt, acid wastes, industrial wastes, and woodburning at sea?

Impacts of Decisions on Ocean Disposal in the Port of New York-New Jersey . . . . Ms. Lillian C. Liburdi

85. How is the commercial viability of the Port of New York-New Jersey and other ports within the Sound-Harbor-Bight system impacted by decisions on dredging and dredged material disposal?

86. How is the commercial viability of the Port of New York-New Jersey impacted by decisions on other ocean disposal activities such as woodburning?

87. Would the Port Authority serve as a sponsor for innovative programs for dredged material disposal?

An Integrated Agenda for Cleaning Up Our Coastal Waters

Existing and Planned Environmental Control Programs: A New York City Perspective . . . . Mr. Albert F. Appleton

88a. What have you done to date to contribute to the cleanup of the Sound-Harbor-Bight system?

89a. What are your current plans for implementing additional pollution abatement projects?

90a. On what basis did you establish your priorities?

91a. What are the costs of these projects?

92a. How will they plans be funded?

93a. To the extent that the Sound, Harbor, or Bight studies include recommendations for control programs not currently part of your plans, how can the recommendations be accommodated?

Existing and Planned Environmental Control Programs: A Norwalk Perspective .... Mr. Dominick M. DiGanges, P.E.

88b. What have you done to date to contribute to the cleanup of the Sound-Harbor-Bight system?

89b. What are your current plans for implementing additional pollution abatement projects?

90b. On what basis did you establish your priorities?

91b. What are the costs of these projects?

92b. How will they be funded?

93b. To the extent that the Sound, Harbor, or Bight studies include recommendations for control programs not currently part of your plans, how can they be accommodated?

Existing and Planned Environmental Control Programs: An Industry Perspective .... Dr. Geraldine V. Cox

88c. What have you done to date to contribute to the cleanup of the Sound-Harbor-Bight system?

89c. What are your current plans for implementing additional pollution abatement projects?

90c. On what basis did you establish your priorities?

91c. What are the costs of these projects?

92c. How will they be funded?

93c. To the extent that the Sound, Harbor, or Bight studies include recommendations for control programs not currently part of your plans, how can they be accommodated?

Setting Priorities:
A National Perspective . . . . **Mr. David A. Fierra**

94. What are the national water pollution abatement priorities, and how have they been established?

95. What criteria should we use in establishing priorities for the short-term? For the long-term? For further analysis?

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