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The National Estuary Program After Four Years

A Report to Congress

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Foreword

The National Estuary Program After Four Years: A Report to Congress

The National Estuary Program After Four Years: A Report to Congress is a status report on the National Estuary Program (NEP) and the seventeen Management Conferences that are part of the NEP.

The NEP was established in 1987 as part of the Clean Water Act amendments. The program, starting with six estuaries, has grown to include seventeen Management Conferences along the East, West, and Gulf of Mexico coastlines. Two of the original estuaries have completed their missions of producing Comprehensive Conservation and Management Plans (CCMPs) and are carrying out their plans with the support of state and local government and private citizens. The experiences gained by these two Management Conferences during the development of their CCMPs have provided valuable lessons; their work will continue to serve as a model for others. Just as the early NEP built upon lessons learned in the Great Lakes and Chesapeake Bay Programs, the NEP will continue to evolve as new information and technology are developed.

This Report is divided into six parts:

Part I Meeting a Need: The National Estuary Program outlines the NEP approach to managing estuarine ecosystems.

Part II Understanding Estuaries: The Key to Better Management describes how estuaries are characterized and tells what is being learned through cooperative efforts.

Part III Managing Estuaries: The Best Methods presents some of the management actions being developed to address problems defined through characterization; these actions are the core of the CCMP.

Part IV Assessing the NEP: What Has Been Learned describes how the NEP process and philosophy have advanced our knowledge of estuaries and estuarine management.

Part V Looking to the Future: Trends and Needs addresses areas where new efforts are being directed in light of our increasing understanding of estuarine management.

Part VI Moving Ahead: The NEP Projects summarizes the progress being made in each of the seventeen NEP projects.

The NEP is a relatively new program in the Environmental Protection Agency (EPA) Office of Water. It is administered by the Office of Wetlands, Oceans, and Watersheds in partnership with EPA Regional Offices.

The NEP addresses a major challenge—restoring and protecting estuaries of national significance. Although it will probably take decades to meet this challenge, the NEP has already taken important steps forward and is on the way toward meeting its goals.

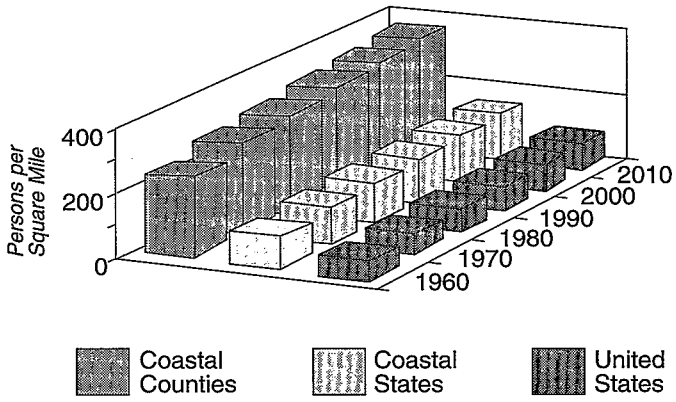
Part I

Meeting a Need: The National Estuary Program

Along our nation's coasts are special bodies of water—estuaries. In these unique bodies of water, fresh water draining from the land mixes with salt water from the sea. These critical coastal habitats serve as spawning grounds, nurseries, shelters, and food sources, sustaining the health and productivity of finfish, shellfish, birds, and other wildlife. Estuarine marshes and vegetation serve as filters for sediments and pollutants, barriers against floods, and nurseries for the oceans. Estuarine waters and the living resources they help support form unique ecosystems.

The natural beauty and bounty of these ecosystems are among the reasons estuaries are threatened. People appreciate their unique qualities and are drawn to their shores and the shores of their tributaries. According to National Oceanic and Atmospheric Administration figures, almost half of the United States population now lives in coastal areas. Total coastal population growth between 1960 and 2010 is expected to increase by almost 60 percent; Florida's population alone is expected to increase by 226 percent during those years. With people come housing, business and industry, recreational fishing and water sports, commercial fishing, cars, and roads. Uncontrolled and controlled development and exploitation of estuarine resources are threatening the existence of these important ecosystems.

Congress recognized that estuaries are unique and endangered ecosystems and that traditional water pollution control programs alone are insufficient to address the more complex issues relating to estuaries. These issues include protecting living resources and their habitats, controlling discharges into waterways of diffuse sources of pollutants, and managing estuaries as watershed ecosystems. Responding to the unmet needs of estuarine ecosystems, Congress established the National Estuary Program in 1987 under Section 320 of the Clean Water Act.



Note: Does not include Alaska

Source: *A Special Earth Week Report: 50 Years of Population Change Along the Nation's Coasts - 1960-2010,* U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service

Figure 1. Population Density

The National Estuary Program

The mission of the National Estuary Program (NEP) is to identify nationally significant estuaries and to establish and oversee a process for improving and protecting their water quality and enhancing their living resources. Under the Clean Water Act, a state governor nominates an estuary in the governor's state for participation in the National Estuary Program. If the estuary meets the program guidelines, the Administrator of EPA convenes a Management Conference in the selected estuary to develop a Comprehensive Conservation and Management Plan (CCMP) for managing the estuarine watershed. A CCMP addresses three general resource areas:

- water and sediment quality, focusing on pollution abatement and control.
- living resources, including restoration as well as protection of special habitat areas.
- land use and water resources, using regulatory and nonregulatory means to conserve land and water.

The NEP process for developing the CCMP is unique. It consists of four phases:

- Planning - Building a management and decision-making framework, involving all appropriate federal, state, and local government agencies, state and local elected officials, academic institutions, interest groups, and the public.
- Characterization - Identifying and characterizing the estuary's environmental problems and their probable causes.
- CCMP Development - Developing both conventional and innovative management approaches and specific actions for solving the problems.
- CCMP Implementation - Implementing management solutions with the support of state and local officials and private citizens, using all available and applicable regulatory, institutional, and financial means.

Though EPA provides technical and management assistance, oversight, and funding for CCMP development, the responsibility for creating and implementing the CCMP is in the hands of members of the Management Conference. The final CCMP, however, must be approved by the EPA Administrator, with the concurrence of the governor of each affected state.

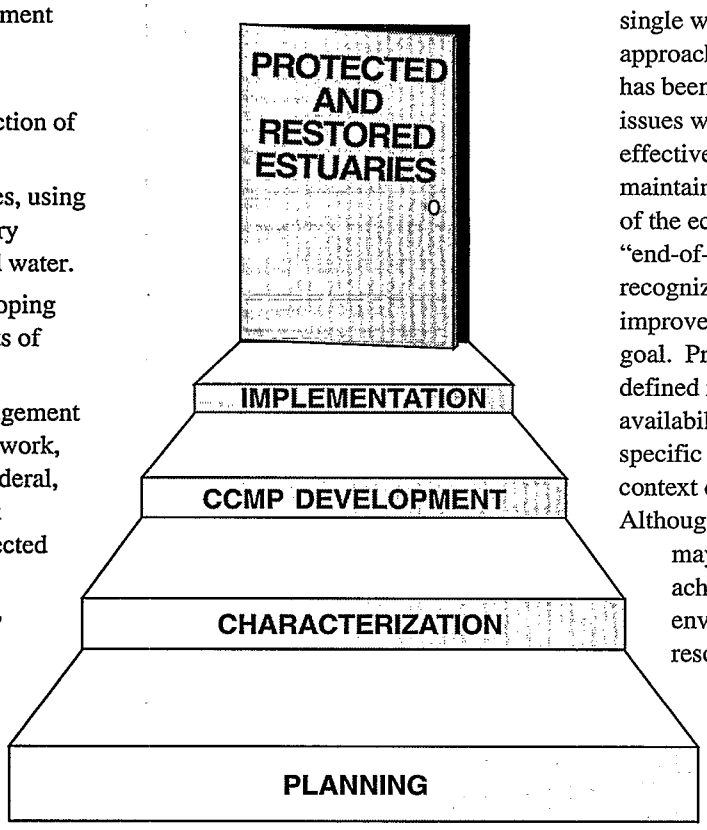


Figure 2. NEP Phases

A Geographic Approach to Ecosystem Management

From the beginning, the NEP has focused on selected estuarine watersheds and the living resources associated with those estuaries. The NEP targets nationally significant estuaries, using a geographic approach—a focus on selected locations where a collective concentration of the best public and private efforts are brought to bear on solving an estuary's problems.

The geographic approach permits comprehensive identification, assessment, and action on a variety of environmental problems within a single watershed. The traditional approach to environmental protection has been to consider specific program issues with little consideration of the effectiveness of such actions on maintaining or improving the condition of the ecosystem as a whole. These "end-of-pipe" solutions failed to recognize the protection or improvement of the resource as their goal. Priority issues have often been defined in the past more by the availability of programs focusing on a specific problem than by need in the context of the whole watershed. Although the geographic approach may be complex, the rewards achieved by gaining healthy environments and robust resources are much more satisfactory. In applying the geographic approach, Management Conferences use traditional water quality control measures as well as innovative and

nontraditional methods, both regulatory and nonregulatory, that are available through all levels of government and the private sector.

Because of the variety and complexity of stresses on an estuary, Management Conferences rely on laws, management tactics, and funding available from numerous public and private sources. For example, local leadership can provide for the development of protective land use and growth management practices. These practices can augment Clean Water Act base programs such as the National Pollutant Discharge Elimination System (NPDES), through which dischargers are regulated by permit, and other federal and state programs. Estuarine management requires the formulation of a complex web of federal, state, and local mechanisms that together promote recovery and prevent degradation of estuarine systems. By coordinating and integrating all the authorities, expertise, and available funding, Management Conferences implement the most effective combination of regulatory and management tools to protect estuaries.

Estuary Projects in the NEP

Each estuary selected for the NEP is voluntarily nominated by a state governor or, for multi-state estuaries, state governors who document the estuary's national significance and request participation in the NEP. To show that an estuary is nationally significant, each governor must demonstrate that the problems of the estuary are of major national concern and that the commitment and financial capability exist to develop and implement a comprehensive management plan to fulfill stated goals and objectives for the restoration or protection of the estuary. Many of the estuaries selected for the NEP had been identified by Congress for priority consideration prior to governors' nominations.

The NEP currently includes 17 estuary projects: Albemarle-Pamlico Sounds in North Carolina; Buzzards Bay in Massachusetts; Long Island Sound in Connecticut and New York; Narragansett Bay in Rhode Island; Puget Sound in Washington State; San Francisco Estuary and Santa Monica Bay in California; Delaware Estuary in

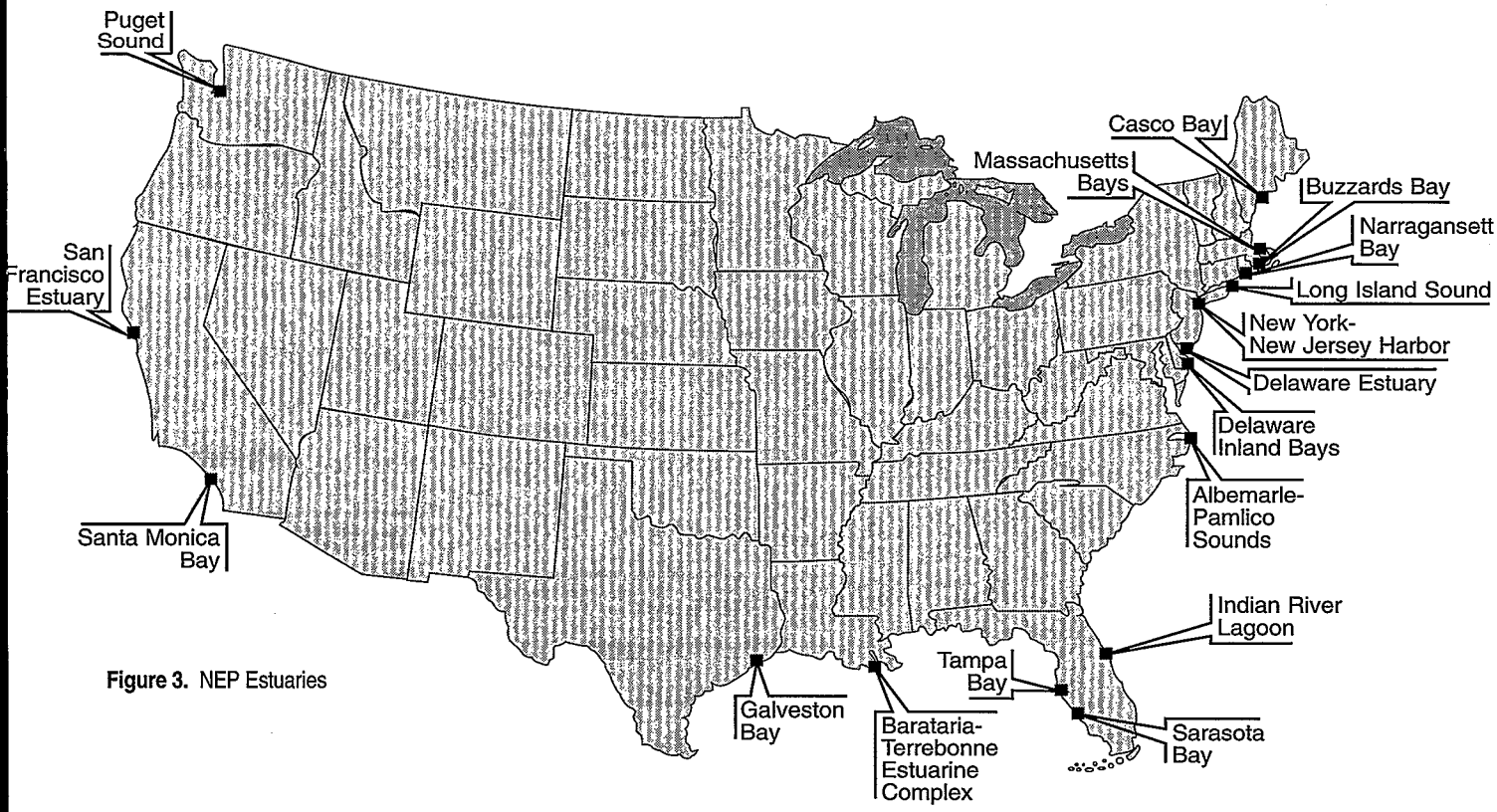


Figure 3. NEP Estuaries

New Jersey, Pennsylvania, and Delaware; Delaware Inland Bays in Delaware; Galveston Bay in Texas; New York-New Jersey Harbor in New York and New Jersey; Sarasota Bay in Florida; Barataria-Terrebonne Estuarine Complex in Louisiana; Casco Bay in Maine; Indian River Lagoon in Florida; Massachusetts Bays in Massachusetts; and Tampa Bay in Florida.

Establishment of Management Conferences

The Management Conference is the decision-making framework for carrying out the NEP process. Through Management Conferences, all interested parties work together to develop a plan—the CCMP—that will be supported and carried out under state and local auspices. The members of the Conference identify major problems in their estuaries, decide where to focus corrective actions, and agree to specific political, financial, and institutional commitments.

Management Conferences include representatives of citizen and user groups and of scientific and technical institutions, and they include all relevant government agencies and resource managers at the federal, state, and local levels. Representatives of these groups serve on committees that comprise the formal Management Conference and oversee development of the CCMP.

A major responsibility of Management Conferences is to build and sustain the strong public support and political cooperation needed to carry out the seven major tasks with which they are charged (see box). This public commitment is particularly important because it will take a long time to restore these estuaries and even longer to develop lasting protective measures to sustain them for future generations. Congress gave each Conference up to five years to build the initial framework for action, to begin some priority cleanup activities, and to develop the CCMP for long-term problem solving.

The first task of each Management Conference is to adapt a standard committee design to meet its own needs. Most of the 17 estuary projects now part of the NEP use a formal committee organization, which includes a policy-level committee, a management-level committee, a representative citizens committee, and a committee of science and technical advisors. (The scientific and technical advisory committee is described in Part II.) Other committees and task groups are established to address concerns including local government needs, financial planning, and monitoring. In addition, each estuary project has staff who report to a management or policy committee. Staff is responsible for day-to-day operations.

Through its committee structure and public outreach efforts, the Management Conference serves as a forum for collaborative decision making and consensus building around often conflicting issues. It encourages open discussion and compromise that result in support for the actions needed to restore and protect the estuary. A policy committee, comprised of high-level EPA and state representatives, is responsible for overseeing the decision-making process.

The policy committee directs all Management Conference activities. Committee members are key officials, or their designees, who help to provide the resources needed to support the Management Conference. Usually appointed by the EPA Administrator or a state governor, they are responsible for making decisions after considering the needs of the estuary ecosystem, the costs and benefits of restoration and protection strategies, and the value the community places on the estuary's resources.

From the beginning, the Management Conference builds its support base in part from the key federal, state, and local government

According to Section 320 of the Clean Water Act, Management Conferences are charged with carrying out seven major tasks:

- ☐ assess trends in the estuary's water quality, natural resources, and uses;
- ☐ identify causes of environmental problems by collecting and analyzing data;
- ☐ assess pollutant loadings in the estuary and relate them to observed changes in water quality, natural resources, and uses;
- ☐ recommend and schedule priority actions to restore and maintain the estuary, and identify the means to carry out these actions—the CCMP;
- ☐ develop plans for the coordinated implementation of priority actions among federal, state, and local agencies involved in the Conference;
- ☐ monitor the effectiveness of actions take under the CCMP; and
- ☐ review federal assistance and development programs to determine whether they are consistent with the goals of the CCMP.

agencies responsible for estuary-related activities. These activities include agricultural management, land-use planning and zoning, fish and wildlife management, and sewage treatment. Federal, state, and local managers, who have potential implementation responsibilities, are included early in the CCMP development process. Agency managers usually serve on the management committee.

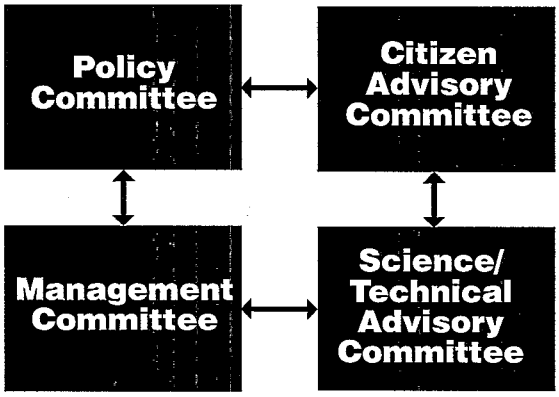


Figure 4. Management Conference Committees

The citizen advisory committee includes representatives of the major businesses, industries and their associations; environmental and civic groups; farmer and fishing groups; and educators and other affected and interested citizens. This group helps the Management Conference understand the concerns of the people living in the watershed. The citizen advisors inform their colleagues and friends about the Management Conference activities and help win their support. The committee also oversees the public participation program sponsored by the Management Conference.

Because public involvement is a vital function of every Conference, another early Management Conference activity is to develop a public participation strategy. This strategy usually contains specific activities to inform the public, including developing a mailing list and preparing newsletters, fact sheets, and a slide show that describe the estuary's problems and invite participation in solving them. The strategy also includes meetings and workshops planned around significant points in developing the CCMP. Another strategy component targets school children for special programs to make them aware of the need to protect the estuary. These steps not only help ensure that the CCMP will have strong public support, but that the public will be willing to help take care of the estuary in the future.

To support the citizen involvement efforts of estuary projects, EPA sponsors workshops and an inter-estuary newsletter, which promotes citizen participation. In 1991 more than 70 representatives from NEP Management Conferences took part in a four-day workshop that focused on the role of citizens in CCMP development. EPA also conducts activities that encourage citizen monitoring programs. Volunteer monitoring programs have been found to provide both learning experiences for citizens and information useful to estuary projects.

Characterization of the Estuary

The first substantive work of the Management Conference is to identify the chief estuary problems and to begin characterizing, or describing the status of, the estuary. Relying primarily on existing scientific information, with some additional work performed to fill in the most important information gaps, the estuary is characterized. Characterizations focus on known facts about the current status of estuary health, estuary problems and their likely causes and sources, and any trends that are apparent. A characterization report may recommend immediate actions to address a problem, additional work to fill in information gaps, or a long-term approach to address a more difficult problem. The characterization report leads to the development of optional strategies and to specific action steps from which a CCMP is developed.

Part II of this *Report to Congress* further describes the NEP characterization process and some of the efforts in which estuary projects are engaged.

Development of a CCMP

The CCMP is a blueprint for restoring and protecting an estuary. After selecting the most pressing problems, the CCMP states goals and objectives aimed at solving those problems. It also prescribes activities directed to meet the Management Conference goals and objectives. To help ensure its success, a CCMP also requires detailed plans for its implementation. Essential elements of a CCMP include a funding program, monitoring strategy, and ongoing public participation component.

Although the CCMP is directed toward solving long-term problems, the NEP encourages estuary projects to take action on a problem as soon as action is feasible. Most Management Conferences have identified obvious problems early in their development process. Following NEP guidelines, they develop and implement early action plans targeted to address these

problems. In this way, the Management Conference can demonstrate an action prior to completing the full estuary characterization and CCMP phases. If an early action is successful, it will become a key part of the completed CCMP. EPA encourages early action projects as part of the CCMP development process.

The NEP four-phased process is generally followed; however, each estuary project is different and may take a slightly different approach. EPA allows flexibility, as long as the Management Conference works toward an acceptable and implementable CCMP within a five-year time frame.

Implementation of Plans

A CCMP must be implemented effectively. To ensure successful implementation, the plan must be endorsed by and must receive continuing commitment from the scientific community, the public, elected officials, and the government agencies responsible for its implementation. Such commitments require that the plan outline practical strategies for addressing the estuary's problems. Section 319 (nonpoint source program) and Titles II and VI (State Revolving Fund) of the Clean Water Act, as well as other EPA programs, are sources of funding for implementation. Management Conferences are responsible for obtaining these and other federal, state, and local resources essential for implementation.

A financial plan describing the commitment of resources is a key component of the CCMP. Some of the early NEP projects have made substantial progress toward developing CCMP financial plans. The experience of these projects has prompted other projects to get an early start in considering financing issues. As a result, several NEP projects have established financial planning committees as part of their Management Conferences.

Implementation is generally to be carried out through existing or redirected state and local programs; however, it might also involve the passage of new laws, formation of new institutions, and development of new programs. Though these needs are often identified through the CCMP development process, it is up to state and local government and the public to carry them out. Public information, education, and participation efforts help to bring such needs to light and lay the groundwork for long-term stewardship of the estuary. A Management Conference with a solid institutional and public support base built in the early phase of the process stands to be more successful in finding state and local commitments for implementing its CCMP.

An Evolutionary Process

The NEP expanded upon lessons learned in the Chesapeake Bay and Great Lakes Programs. Since its start in 1987, it has continued to evolve, based on the experiences of each NEP project; reshaping the process to take advantage of new experiences is part of the NEP's evolutionary development. In addition, each estuary program experience serves as a lesson for others; the NEP fosters an exchange of information, technology, and experience among the estuary projects.

Restoring and protecting estuaries is a relatively new goal; the NEP offers a new approach to achieving this goal. We are just beginning to understand these unique bodies of water. It will take time—decades—and a cooperative effort among all interested parties to more fully understand, restore, protect, and maintain estuarine ecosystems in the future.

Part II

Understanding Estuaries: The Key to Better Management

Once a Management Conference is convened, each estuary project begins to characterize the estuary. A characterization is the description of the quality of the estuary, defining its problems and linking problems to causes. Characterization provides the objective basis for developing and testing action strategies for the CCMP.

Using the institutional framework built by each Management Conference, all appropriate parties are brought together to examine all the information known about the estuary that can lead to sound management decisions for restoring and protecting the estuary. Through this examination, the Management Conference begins to understand the estuary.

Estuary characterization relies primarily on existing scientific information. Through characterization, all estuary-related information is put together like a jigsaw puzzle, identifying pieces that fit, as well as missing pieces. Using this process, the Tampa Bay National Estuary Program conducted workshops to develop its framework for characterization. The workshops addressed all sources of information that define Tampa Bay's physical, chemical, and biological status; identified data gaps needed to be filled for characterizing Tampa Bay; and developed a structure for the characterization process. Once the estuary's key problems and their probable causes are determined, remedial actions can be prescribed.

The characterization process sheds light on the most important needs for new data. Often new information is needed to establish links between causes and effects. The NEP allows for limited applied research and strongly encourages estuary projects to work closely with local universities and government research entities that perform scientific studies. In addition, the NEP, through scientific symposia, facilitates interactions and scientific exchange among research institutions and estuary projects. Exchanges such as these also help to focus research efforts on estuarine problems.

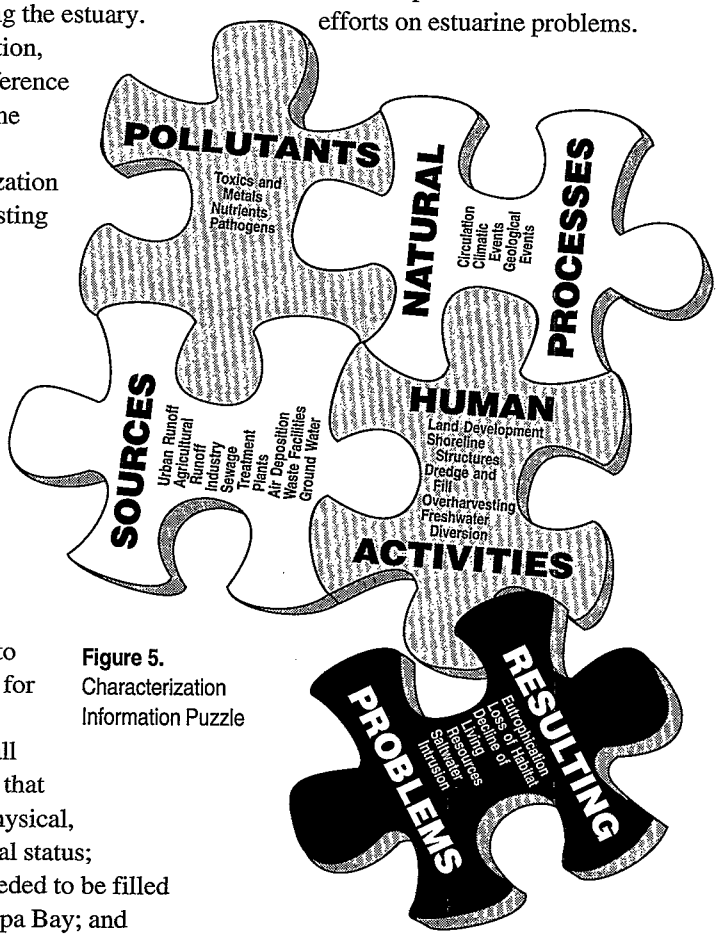


Figure 5. Characterization Information Puzzle

The NEP provides a process to integrate science and decision making for the protection, restoration, and maintenance of estuaries. Management Conferences are investigating their estuary's physical characteristics and stresses, and they are developing and implementing actions aimed at improving estuarine water quality and living resources. The results of this effort provide a basis for implementing critical actions beyond the five years designated for the Management Conference under the Clean Water Act.

Supporting Estuarine Study

Through the characterization process, scientists from federal, state, and local government agencies, at academic institutions, and in the private sector are conducting studies to determine an estuary's problems and their causes and are working with estuary managers to suggest remedies. Because the NEP is not a research program, it relies heavily on the past and current research of other agencies and institutions to support its work.

The Science and Technical Advisory Committee

Each Management Conference has a Scientific/Technical Advisory Committee (STAC) charged with directing and evaluating the scientific work of the Management Conference. This committee is responsible for ensuring that management decisions are based on sound scientific and technical information. The STAC oversees the assembly and analysis of both historical and new data and determines the need for new studies to fill information gaps. Using this information, the STAC helps to characterize the estuary. The committee also guides the Management Conference's monitoring, assessment, and data management activities. STAC members conduct peer reviews of studies, report on the status of the estuary, and alert the Conference to emerging problems. To ensure scientific quality, members of the STAC review requests for scientific proposals and evaluate the proposals submitted.

Members of the STAC represent government agencies and public and private institutions conducting scientific studies in the estuarine system. Most STACs include members with expertise in aspects of water quality, transport and fate of pollutants, ecological and human health, and biological resources.

In addition to their efforts to support estuary characterization and the development of the CCMP, STAC members help determine where data gaps exist and recommend research activities to fill these gaps. Moreover, once management actions are taken, a long-term monitoring program is needed to measure results of these actions. Monitoring helps assess whether the estuary water quality and living resources are responding to management actions and whether other natural or human-induced effects are coming into play. The STAC is vital in making these assessments and recommending further actions or adjustments.

EPA Research

Research programs of EPA's Office of Research and Development (ORD) help provide information about how estuarine ecosystems work. For instance, ORD has been part of a major research effort in the Great Lakes, the results of which will contribute to scientific knowledge about large watershed systems. This effort is a multi-media approach that will culminate in a five-year strategy for restoring the quality of the Great Lakes. The study will address goals of restoring and maintaining the ecosystem by reducing toxic substances pollution, controlling habitat degradation, and restoring damaged habitats to support plant and animal communities. This major research effort is required to develop the base for such a management strategy.

The Environmental Monitoring and Assessment Program (EMAP), another ORD program, has been monitoring estuaries along the mid-Atlantic and Gulf of Mexico coasts as part of an effort to find out if conditions in the estuaries are getting better or worse. This long-term monitoring program is interacting with NEP estuary projects to allow both EMAP and the estuary projects to enlarge their information bases. The NEP will be able to incorporate new findings from these efforts to advance work in individual estuaries and will benefit from methodologies being developed under these programs.

NOAA's Role

The National Oceanic and Atmospheric Administration (NOAA), the nation's chief marine sciences agency, supports the NEP characterization efforts. Two of its programs are the National Marine Fisheries Service, which assesses fishery stocks, reviews fishing permits, and performs research in coastal habitats; and the National Ocean Service, which is responsible for the National Status and Trends Program and the National Estuarine Inventory.

NOAA's National Status and Trends (NS&T) Program is attempting to assess current coastal conditions and determine whether these conditions are improving or deteriorating. Since 1984, the NS&T Program has been collecting information on the presence of chemical contaminants in mussels, oysters, fish, and sediments at almost 300 sites along the nation's coastlines. NS&T data are supplemented with selected high-quality historical data and data from other special studies. NOAA has also been characterizing estuaries and contributing to the interpretation of monitoring results in coastal areas. Further, NOAA and EMAP are conducting monitoring and assessment programs in coastal waters and sharing information.

The NS&T Program is also conducting surveys of bioeffects to assess the magnitude and extent of ecological degradation in NEP project areas. Studies have been conducted in San Francisco Bay and Long Island Sound and are currently under way in Boston Harbor, Tampa Bay, and New York-New Jersey Harbor. Sea Grant Programs, also sponsored by NOAA, are also active in Management Conferences, working with citizen monitoring teams. Representatives from other NOAA programs, such as the National Marine Fisheries Service, also participate in individual Management Conferences, serving on management and scientific committees.

As part of NOAA's monitoring and research efforts, a statistical information base on 102 of the nation's estuaries, including the 17 selected for the National Estuary Program, has been published. This National Estuarine Inventory lists estuary characteristics that include physical and hydrologic features; natural resources, including fish, shellfish, habitat, and wildlife; and human uses. The index also includes information about an estuary's susceptibility to pollution—that is, its ability to flush out and to dilute pollutants. The index is being evaluated as part of a national survey of nutrient enrichment in estuaries, sponsored jointly by EPA and NOAA (see Table 1).

NOAA also supports a network of 25 coastal and marine research facilities, 17 estuarine reserves in the

Table 1. Estuarine Features

ESTUARY	PHYSICAL and HYDROLOGIC FEATURES						NATURAL RESOURCES			ECONOMIC ACTIVITIES					SUSCEPTIBILITY TO POLLUTION	
	Estuarine Drainage Area (100 sq.mi.)	Total Drainage Area (100 sq.mi.)	Water Surface Area (sq.mi.)	Average Depth (ft.)	Avg. Daily Fresh-water Inflow (100 cfs)	Volume (billion cu.ft.)	Wetlands (sq.mi.)	Classified Shellfish Waters (sq.mi.)		Population Density, 1980 (per sq.mi.)	Land Use (% of EDA)		Point Sources of Pollution		Dissolved Concen-tration Potential	Particle Reten-tion Efficiency
								Approved	Total		Urban	Agriculture	Industrial	MWTP		
Casco Bay	12	12	164	42	21	191	61	144	168	172	14	10	40	10	M	H
Massachusetts Bays	27	27	981	180	65	2014	141	79	141	5409	122	6	115	34	M-H	M-H
Buzzards Bay	6	6	228	34	12	215	75	184	199	780	13	6	7	5	H	H
Narragansett Bay	13	18	165	30	32	139	155	110	165	1065	26	9	113	24	M	H
Long Island Sound	72	172	1281	62	300	2192	315	1122	1342	1008	25	14	226	87	L	H
Hudson River/Raritan Bay	85	165	298	21	267	172	269	0	257	1471	24	25	582	287	M	M
Delaware Estuary	48	135	768	21	198	448	641	549	623	1082	24	42	181	153	M	M
Delaware Inland Bays	3	3	32	4	3	4	N/D	19	30	126	10	46	9	7	H	M
Albemarle-Pamlico Sounds	116	296	2949	13	460	1081	1768	2524	3088	182	9	59	103	84	M	M
Indian River Lagoon	12	12	280	7	14	51	161	34	106	327	17	30	14	54	H	H
Sarasota Bay	3	3	44	6	4	8	N/D	N/D	N/D	923	28	26	6	11	H	M
Tampa Bay	26	26	346	13	24	123	394	9	88	476	17	40	69	29	H	H
Barataria-Terrebonne Bays	38	38	1326	11	101	200	1458	623	782	270	9	30	1	51	M-H	M
Galveston Bay	45	245	540	6	152	92	374	0	547	665	16	50	747	566	M	M
Santa Monica Bay	5	5	211	314	9	1844	4	0	0	4088	60	2	6	4	M	H
San Francisco Bay	111	863	716	42	370	412	909	0	125	1321	27	86	178	87	M	M-H
Puget Sound	111	197	1292	585	942	7081	887	94	141	495	27	16	308	72	L-H	M-H
NEP TOTAL	733	2223	11621	1391	2974	16267	7112	5491	7802	19860	468	497	2705	1565		

Abbreviations: sq.mi., square miles; ft., feet; avg., average; cfs, cubic feet per second; cu.ft., cubic feet; EDA, estuarine drainage area; MWTP, municipal wastewater treatment plant; H, high; M, medium; L, low; N/D, no data.

Source: NOAA, "Estuaries of the United States: Vital Statistics of a National Resource Base." A Special 20th Anniversary Report. U.S. Department of Commerce, October 1990.

National Estuarine Reserve System, and 29 universities and colleges in the National Sea Grant Program. An agency under the U.S. Department of Commerce, NOAA contributes considerable amounts of the scientific information that is now being used to advance an understanding of how estuaries work and how estuarine systems are being stressed. This information is used extensively by NEP Management Conferences in their estuary characterization work.

The development and production of the *National Shellfish Register of Classified Estuarine Waters* is a NOAA information activity performed in conjunction with the Food and Drug Administration. In addition, NOAA's National Coastal Pollutant Discharge Inventory is a data base which significantly contributes to the body of knowledge used by Management Conferences.

NOAA and EPA are currently partners in designing a questionnaire to help determine how estuaries are used. The questionnaire will be used to produce the 1992 National Survey on Recreation and the Environment, which involves a broad coalition of public agencies and private organizations.

Other Federal Agencies

In addition to EPA and NOAA research programs, the Food and Drug Administration (FDA) is responsible for assuring the safety of fish and shellfish in interstate commerce. As part of its responsibility, FDA establishes safe levels for poisonous or deleterious substances, such as lead, mercury, and polychlorinated hydrocarbons (PCBs). These safe levels can be used as guidelines by states in issuing advisories on local fish consumption. FDA also works with NOAA to classify estuarine waters and make determinations about their safety for shellfish harvesting. Working closely with these two agencies, EPA issued risk assessment guidelines for assessing human health risks for chemicals in seafood. EPA is also responsible for controlling pesticides that cause fish contamination. EPA, NOAA, FDA, U.S. Geological Survey (USGS), Army Corps of Engineers (COE), Fish and Wildlife Service (FWS), Department of Agriculture (DOA), and other federal government agencies support the work of individual estuary programs; representatives of these agencies often serve on Management Conference committees.

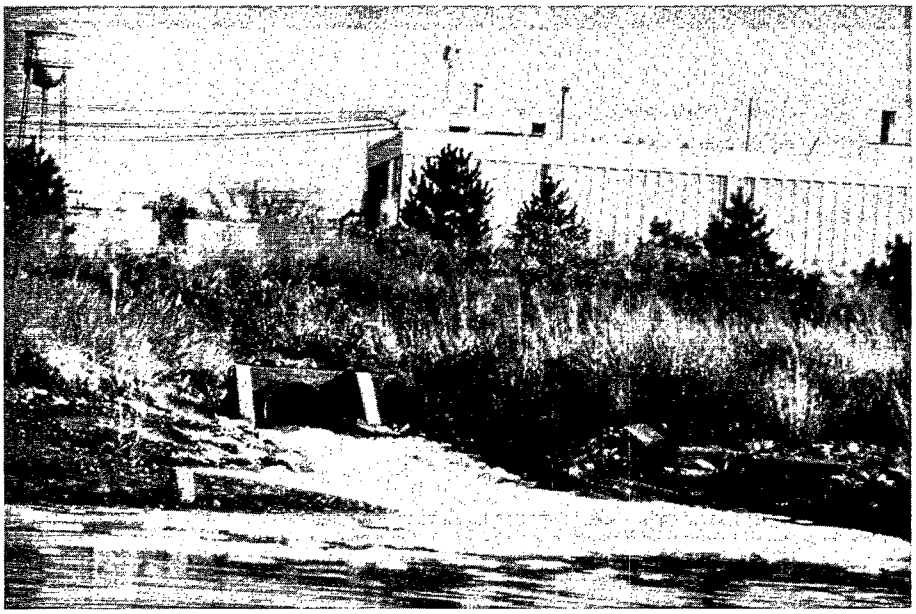
Learning About Estuarine Problems

Each of the 17 estuaries in the NEP is unique, yet the estuaries have similarities (see Table 2). Each is under stress from pollutants and from ever-increasing human activities that take place near its shores. Many of the nation's estuarine ecosystems confront a number of other problems. Particularly along the East Coast and the eastern Gulf of Mexico Coast, problems of low oxygen levels and of eutrophication (excessive plant growth) are prevalent. Toxic substances, as well as toxic "hot spots," are also pervasive in certain areas in many estuaries. Furthermore, when toxicants isolated in bottom sediments are disturbed by dredging or natural processes, the toxicants can be released into the water. Human pathogens from poorly treated or untreated sewage lead to shellfish bed closures. In many places, fish and shellfish are overharvested. Habitats for living creatures, vital parts of estuarine ecosystems, are being disturbed by land development and dredging. Fresh water is being diverted from estuaries, depriving them of a vital component of their natural systems. In the parts of estuarine systems that are relatively pristine, Management Conferences are attempting to prevent degradation. But information pertaining to key problem areas is still being sought. While much has been learned, many uncertainties still exist. The problems of greatest concern that are being investigated by the Management Conferences are grouped as follows: eutrophication, toxic substances and metals, pathogens, and changes in living resources and their habitats.

Eutrophication

Eutrophication is the process through which overabundant plant life chokes a body of water. Excessive nutrients, such as nitrogen and phosphorus, nurture this plant life, exacerbating the problem. While bottom-rooted plant life provides food and shelter for fish and shellfish, surface plants like algae prevent sunlight from penetrating the water and use large amounts of the dissolved oxygen as they die and decompose. Thus fish and shellfish are deprived of oxygen and underwater grasses are deprived of light.

Nutrients enter waterways through sewage treatment plant discharges, stormwater runoff from lawns and agricultural lands, faulty septic systems, and even ground-water discharges. The Delaware Inland Bays, for example, are believed to be seriously affected by nitrates leaching into ground water and discharging to the bays.



Bob Bachhand

Sewage treatment plants are being upgraded.

The Delaware Inland Bays Estuary Program selected eutrophication for further study. Proceeding under the guidance of the STAC, the Management Conference identified critical information gaps and is now beginning to focus research projects to address them. Of particular concern is the capacity of the Inland Bays to assimilate nutrient loading. Research projects are targeting four areas: definition of ground-water contributions of nutrients; development of a mass balance model for nutrient cycling in ground water and the Inland Bays; definition of nutrient transport processes; and development of a strategy for using living resources as indicators of water quality. The Inland Bays project is cooperating and coordinating with federal, state, academic, and private scientists and the public as it moves toward estuary characterization and the development of a CCMP.

Together, through the Management Conference, the Long Island Sound Study (LISS), NOAA, the States of Connecticut and New York, Connecticut and New York counties, and New York City, are focusing on hypoxia—low levels of dissolved oxygen. LISS identified nitrogen as the chief nutrient linked to the causes of hypoxia in the sound. They have learned that discharges from sewage treatment plants and runoff from land are the primary controllable sources of increased nitrogen loadings to the water. During recent summers, hypoxia has been a serious problem, exacerbated by poor water circulation in parts of the sound. The LISS is using this knowledge to address the low dissolved oxygen problem.

Improvements in sewage treatment have greatly reduced the biological oxygen demand and increased the levels of dissolved oxygen in the receiving waters of the Delaware Estuary. Very high nutrient loadings and concentrations of nitrate and phosphate exist in the upper urbanized estuary, but do not translate into algal blooms in this area. Nutrient enrichment has probably resulted in an overall increase in primary production in the lower estuary. Conventional nutrient management, therefore, may not be warranted. However, the processes controlling nutrient cycling and algal production are not fully understood and need further study. The Delaware Estuary Program has also found that it is important to continue to monitor the long-term responses in the estuary to past and future changes in effluent inputs.

Toxics and Metals

Toxic substances and metals have been linked to fish diseases and malformations. These materials not only enter waterways from industrial discharges and runoff from urban streets and farmland, but are also frequently sequestered in bottom sediments, where they can persist for years. Pesticides from lawns and farms, emissions from automobiles, and hazardous waste poured into storm drains are sources of pollution with less understood impacts on waterways.

A USGS program in Massachusetts and Cape Cod bays is designed to describe critical processes influencing the transport and accumulation of fine-grained sediments and their associated contaminants. It is important to understand these processes because of their contribution to the pollution in Boston Harbor and because of plans to construct a major treated-sewage outfall in western Massachusetts Bay. The program includes a map of the sea floor identifying fine-grained sediment areas where pollutants are likely to accumulate; continuous measurements of currents and sediment transport near the proposed ocean outfall; measurements of sediment mixing and accumulation rates, and inventories of

Table 2. National Estuary Program Problems/Causes Matrix

POINT SOURCES						
CAUSES ➡ PROBLEMS	Industrial Sources-Direct	Industrial Sources-Indirect	Sewage Treatment Plants	Combined Sewer Overflows	Storm Water	Animal Feedlots
Toxicants	AP,C,D, G,LIS,M, N,NY,PS, SF,SMB	BT,C,D, G,LIS,M, N,NY,PS, SF,SMB	G,M,N, PS,SF	B,D,LIS, N,NY, PS,SF	C,D,G, N,PS, SF,SMB	AP
Pathogens			B,D,G, LIS,M,N, NY,PS, SMB	AP,C,D, LIS,M,N, NY,PS,S	AP,B,C, D,SIB,I, LIS,M,N, PS,SMB	AP,DIB, G,PS
Eutrophication	AP(1),T	T	AP,BT,C, G,I,LIS, M,NY,PS, S,SMB	LIS,M,N, NY,S	BT,DIB,I, T	DIB
Habitat Loss/ Modification	AP(1),G, M,SF,T	G,SF,T	AP,G,I, M,SF	AP,M, SF	AP,G,I, SF,T	
Changes in Living Resources	AP,C,D, LIS,M,N, NY,PS, SF, T	D,LIS,M N,NY, PS,SF, T	AP,D,G,I, LIS,M,N, NY,SMG	D,LIS, M,N,NY, PS,SF	D,DIB,G, I,M,PS, S,SF, T	DIB
Other				NY(2)		

KEY	
(1)	Phosphate
(2)	Floatables
(3)	Oil and Gas Drilling
(4)	Peet Mining
(5)	Access
(6)	Platforms
(7)	Ocean Dump Site
(8)	301 (h)
(9)	HydrologicModification/Channelization
(10)	Exotic Species, Mangrove Loss
(11)	Impingement/Entrainment
AP:	Albemarle-Pamlico Sounds
B:	Buzzards Bay
BT:	Barataria-Terrebonne Estuarine Complex
C:	Casco Bay
D:	Delaware Estuary
DIB:	Delaware Inland Bays
G:	Galveston Bay
I:	Indian River Lagoon
LIS:	Long Island Sound
M:	Massachusetts Bays
N:	Narragansett Bay
NY:	New York-New Jersey Harbor
PS:	Puget Sound
S:	Sarasota Bay
SF:	San Francisco Estuary
SMB:	Santa Monica Bay
T:	Tampa Bay

NONPOINT SOURCES										
CAUSES ➡ PROBLEMS	Agri-culture	Suburban and Urban	Mining	Silvi-culture	Construc-tion	Septic	Landfills	In-place Sediments	Atmos-phere	Ground Water
Toxicants	AP,B,BT, C,G,PS, SF,T	BT,D,G, LIS,M,N, NY,PS,SF, SMB,T	BT(3)	PS			AP,N,NY, LIS	AP,B,C,D, G,LIS,M,N, NY,PS,SF, SMB,T	AP,G,M, PS	C,G
Pathogens	BT,DIB, G,PS	BT,D,I, LIS,M,N, NY,S, SMB			DIB	AP,B,BT, C,DIB,G,I, M,N,PS, S,T				
Eutrophication	AP,B,BT,C, DIB,G,I, LIS,PS, S,T	BT,I, LIS,N, S,T	AP(1), T(1)		DIB,G,S	B,C,DIB, G,I,M, N,T		M	G,M,N, SMB	DIB,N
Habitat Loss/Modification	AP,G,PS, SF,T	G,I,S,T	AP(4) BT(3), T(1)	PS	AP,D,DIB, G,I,M, PS,S		BT,G			
Changes in Living Resources	AP,DIB,G, SF,T	D,M,NY, S,SF,T			D,DIB,M, S	B,DIB,I PS		B,D,M, N,NY,PS, SF,SMB		DIB
Other		NY(2)					NY(2)			

contaminants; and modeling of tidal exchanges of water and particulates between Boston Harbor and Massachusetts Bay.

Metals in Massachusetts Bay illustrate the impact from sewage, atmospheric deposition, and polluted tributaries. High metal concentrations in the Merrimack River have a significant impact on the bay. As these data are evaluated, the findings are expected to play an important role in the development of the CCMP.

In Narragansett Bay, recent sediment core samples were taken and analyzed to discover the long-term variation in metal inputs and the spatial distribution of metals and to determine whether conditions are getting worse or better. The studies found that most pollutant metal concentrations began to increase during the middle to late 1800s. Concentrations reached their peak in the 1950s. Since the 1950s, there has been a continuous decline in the concentration of most metals, with an average decline of 60 percent. These declines are attributed to improvements in sewage treatment. Concentrations in the upper bay are still an average of nine times greater than those in the lower bay. This finding suggests that controlling pollution at the upper bay will lead to baywide improvements.

Toxic materials such as heavy metals, chlorine, polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), pesticides, dioxin, and other organic compounds have been found in Casco Bay. Heavy metal concentrations in Casco Bay sediments, in fact, are relatively high compared to those in other NEP estuaries. NOAA's flounder liver survey found heavy concentrations of lead, copper, zinc, and silver, as well as PCBs. An early characterization effort by the Casco Bay Estuary Project is focusing on the extent of toxic contaminants in the sediments of the bay.

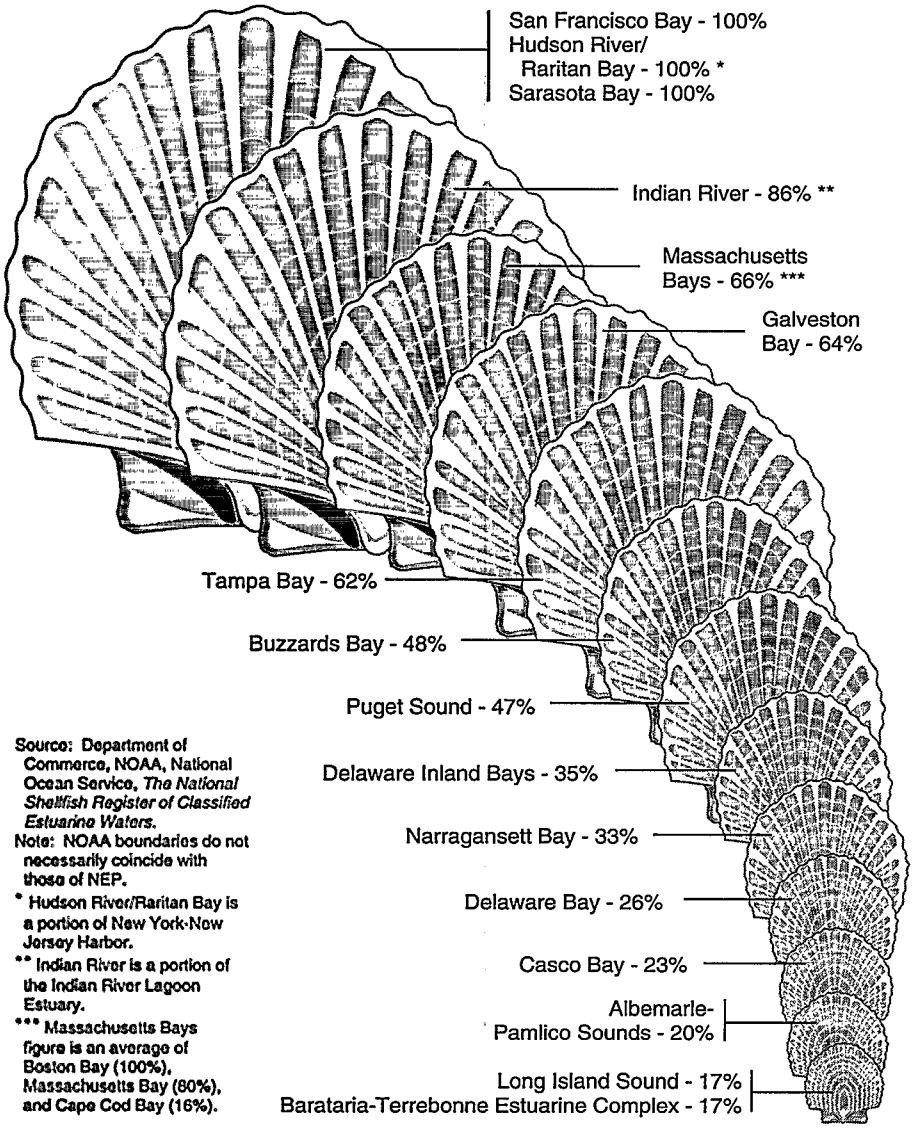
Pathogens

Pathogens are microorganisms that can cause disease in other organisms or in humans, animals, and plants. Pathogens may be bacteria, viruses, or parasites transported in sewage or in runoff from animal farms or areas populated with domestic or wild animals, and carried to waters used for swimming, drinking, and fishing and shellfishing. Fish and shellfish contaminated by pathogens and the contaminated water itself can cause serious illnesses. Because of the risks to swimmers and to consumers of seafood, estuary projects are directing attention to pathogen contamination.

Elevated bacterial indicator levels were discovered in two Santa Monica Bay storm drains, raising concern about the safety of swimming near storm drain outfalls. Additional surf zone and drain runoff samples were taken and analyzed for bacterial indicators. Elevated indicator levels were found in both areas (conclusively in one storm drain); however, data were inadequate for calculating health risk. Based on this study, recommendations were made to investigate the potential sources of human fecal input to the storm drain system where it was conclusively found; conduct sampling at an expanded number of storm drains entering Santa Monica Bay; assess the dispersion of runoff along the shore; and assess the number of people who are exposed to storm drain runoff because they swim near outfalls.

In Indian River Lagoon, there is a growing network of shellfish farms. This network is serving as a monitoring system that alerts scientists and managers to water quality problems, including the presence of pathogens, around the lagoon. It provides an early warning system throughout the region.

	OTHER					
CAUSES ➡ PROBLEMS	Shipping / Marinas	Dredging	Shoreline Development	Freshwater Inflow	Sealevel Rise	Other
Toxicants	C,D,DIB, G,I,M, PS,SMB, T	G,M,NY, SF		BT,M,SF		SMB(7)
Pathogens	C,DIB,G, LIS,M		B,DIB,M, S			SMB(8)
Eutrophication	C,DIB,G	G,T	DIB,M,N	I		SMB(8)
Habitat Loss/Modification	BT,C,G,I, M,PS,S, T	AP,C,DIB, G,I,M, PS,S,SF, T	AP,B,C,D, DIB,G,I,N, NY(6), LIS, M,S,SF,PS,T	AP,BT,G,I, SF,T	AP,BT,G, M,S	BT(9), I(10), S(10)
Changes in Living Resources	C,D,DIB,I, SF,T	AP,DIB,G, M,S,SF, T	B,D,DIB, G,I,N,LIS, M,S,SF,T	BT,G,SF, T	BT,S	NY(7), D(11)
Other	NY(2)	S(5)	S(5)			



Source: Department of Commerce, NOAA, National Ocean Service, *The National Shellfish Register of Classified Estuarine Waters.*
Note: NOAA boundaries do not necessarily coincide with those of NEP.
* Hudson River/Raritan Bay is a portion of New York-New Jersey Harbor.
** Indian River is a portion of the Indian River Lagoon Estuary.
*** Massachusetts Bays figure is an average of Boston Bay (100%), Massachusetts Bay (80%), and Cape Cod Bay (16%).

Figure 6. Estimated Percentage of Harvest-Limited Shellfish-Growing Acres

Living Resources and Their Habitat

Living resources are also affected by problems other than pollutants, like nutrients, toxics, and pathogens. Overharvesting and the loss and modification of habitat have led to a decline in valuable species, an increase in less desirable species, and a decrease in the diversity of living resources. Land development in upland areas increases sedimentation in waterways; building in wetlands destroys this valuable pollution filter and habitat; bulkheading interferes with natural plant and animal shoreline interaction; and dredge and fill operations create turbid waters, destroy habitat, and interfere with natural circulation patterns. In Florida, estuary projects are studying the effects of habitat changes on living resources, as well as impacts from rapid growth and development and the expansion of sewage treatment plants.

Tampa Bay cooperative studies of fish/habitat relationships are being conducted by the Florida Marine Research Institute. Funded by NOAA through the Florida Department of Environmental Regulation, the studies involve fish community structure along the salinity gradient, fish density in seagrass beds and unvegetated habitats, and the use of micro-habitats by economically valuable fish. The result of this work will be a data base valuable for predicting the effects of future habitat modifications to either the structural or physical and chemical environment.

In Sarasota Bay, water quality trends indicate that nutrient and salinity levels and relative alkalinity to acidity concentrations have decreased over time. This decrease reflects a change in land use from agrarian to urban. Studies have not shown whether heavy metal concentrations are increasing with this change in land use.

On the eastern shore of Sarasota Bay, there has been a significant loss of submerged aquatic vegetation. The area most affected is within transport range of a discharge outlet from a sewage treatment plant. Although the total concentration of suspended solids is elevated, no linkage can be found to increased biomass or decreased light resulting from sewage treatment plant discharges. Further studies are investigating another possible cause of decreased vegetation: the natural formation of insoluble calcium carbonate from the soluble biocarbonate present in the wastewater discharge.

Extensive monitoring has been conducted by the Bay Study Group of the City of Tampa. Monitoring of water quality and of various biological indicators in Hillsborough Bay and

middle Tampa Bay has been done since 1978. Monitoring started as a comprehensive study of phytoplankton (tiny plants) productivity, evaluating the effects of wastewater pollution abatement in Hillsborough Bay as the City of Tampa converted from primary to advanced wastewater treatment. Results of the study indicate that several water quality parameters have improved in Hillsborough Bay. There is less nitrogen in the bay because of upgraded wastewater treatment methods that were implemented in 1979. Dissolved oxygen concentrations and water transparency have increased, and chlorophyll and blue-green algae levels have decreased.

Coincidental with this improved water quality, sea grasses have colonized shallow areas around Hillsborough Bay, which had been barren of attached vegetation for several decades. The Bay Study Group began studying sea grass in 1986 to document the progress of sea grass recolonization. The study shows a fourfold increase in the amount of sea grasses since 1986.

Although both historical information and new investigations into estuarine problems have contributed answers to estuary problems, scientific studies conducted by cooperating agencies will need to continue for a long time. The answers that have been found, however, are beginning to provide substantial information and are leading to a greater understanding of estuaries. In addition, this understanding has led to the development of management activities that are addressing estuarine problems.

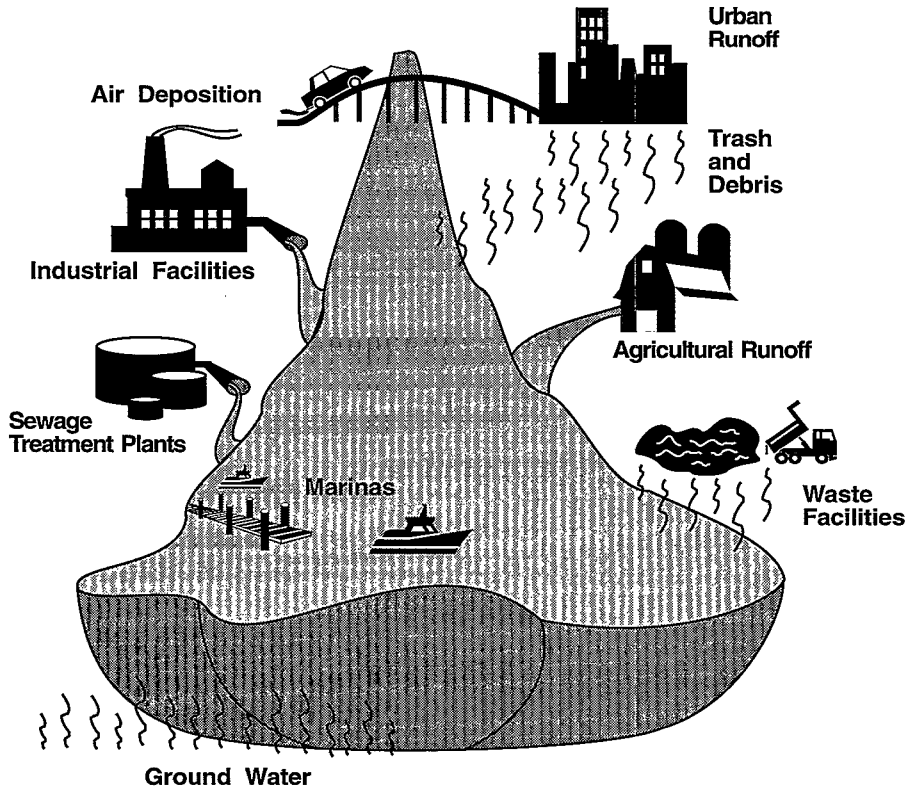


Figure 7. Pollutant Sources

Part III

Managing Estuaries: The Best Methods

Through the characterization effort, each Management Conference discovers the condition of the estuary and defines its most critical problems. This effort leads to the development of actions that are tailored to the specific location, its physical, chemical, and biological problems, and its human needs and uses. In developing these actions, which are the centerpiece of the CCMP, Management Conferences focus on determining the specific problems to address, setting clear goals and objectives aimed at solving the problems, and selecting the best regulatory and nonregulatory methods for meeting the goals.

Because there are limited resources available for solving complex problems, considerable deliberation takes place among all Management Conference parties to determine the most important problems and to select the most efficient and economically, politically, and socially acceptable methods to address them. This deliberation involves substantial cooperation among the estuary users, stewards, and decision makers who comprise the Management Conference.

As part of CCMP development, the Management Conference evaluates existing programs affecting the estuary and determines which existing and new management mechanisms will best address the estuary's problems.

Assessing Base Programs

Because the CCMP depends upon a base of existing federal, state, and local management programs, an early step in producing a CCMP involves examining these base programs. Each Conference identifies all management programs that affect the estuary; determines conflicts, overlaps, gaps, and needs for redirection; and attempts to refocus these programs toward meeting the goals of the estuary project. Representatives who administer many of these programs serve on the Management Conference and can help with the analysis and support needed redirection.

Important participants in Management Conferences typically include representatives from EPA, NOAA, U.S. Fish and Wildlife Service, U.S. Geological Survey, Army Corps of Engineers, Food and Drug Administration, Department of Transportation, U.S. Coast Guard, and Department of Agriculture Soil Conservation Service. Statutes and programs administered by these agencies or delegated to state or local agencies are vital components of CCMP development and implementation.

The Department of Transportation, for example, has some responsibility for conserving marine life, protecting coastal water from litter and pollution, and enforcing fishery laws. The Fish and Wildlife Service (FWS) is the trustee for migratory birds and certain anadromous fish, endangered species, and marine mammals. Also under the authority of FWS are critical marine habitats, barrier islands, and wetlands conservation. The U.S. Geological Survey is working with NEP projects as part of its National Water Quality Assessment Program.

In 1988 NOAA and EPA developed an agreement that outlined actions for cooperation among state coastal zone management programs and NEP estuary projects. In addition to the Coastal Zone Management Act (CZMA), NOAA also administers

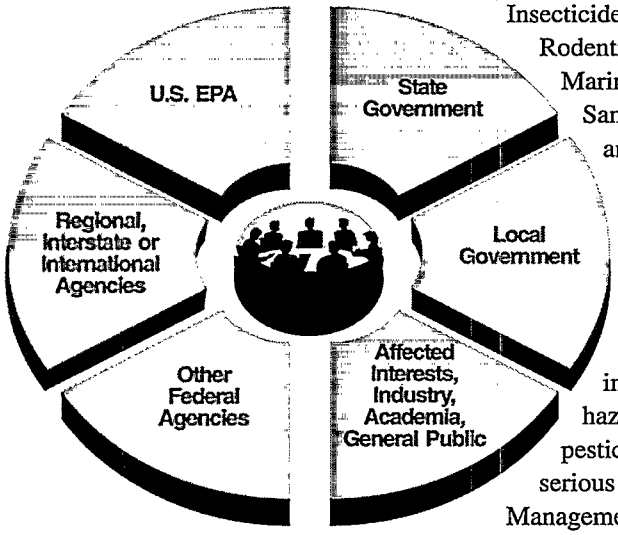


Figure 8. Members of an NEP Management Conference

marine sanctuaries under the Marine Protection, Research, and Sanctuaries Act; some marine sanctuaries are included in the NEP.

The Army Corps of Engineers, responsible in part for wetlands protection, beach nourishment, dredging, ocean dumping, and mitigation of fish and wildlife losses, is also involved with Management Conferences. The Department of Agriculture provides technical assistance to control pollution of surface waters from agricultural runoff. The Department's Soil Conservation Service and local conservation districts play active roles in NEP Management Conferences.

To enhance their ability to control pollution and manage estuarine environments, Management Conferences also use authorities of other EPA programs: Resource Conservation and Recovery Act (Hazardous Waste), Comprehensive Emergency Response, Compensation, and Liability Act (Superfund); Toxic Substances Control Act; Federal Insecticide, Fungicide, and Rodenticide Act (Pesticides); Marine Protection, Research, and Sanctuaries Act; Clean Air Act; and Safe Drinking Water Act. EPA's Toxics Release Inventory and other data bases have served Management Conferences as well. As more evidence surfaces implicating solid and hazardous waste, air deposition, pesticides, and ground water as serious pollution sources, Management Conferences are beginning to assess and integrate control activities under these laws.

Every NEP project depends substantially on Clean Water Act base programs. Wastewater discharge permits under the National Pollutant Discharge Elimination System (NPDES) are critical for limiting industrial and municipal effluents to waterways. NPDES permitting has substantially controlled point (end-of-pipe) sources of pollution. In addition, new EPA stormwater control regulations will require urban and suburban runoff to be controlled under NPDES permits, further tightening controls on pollution sources. Management Conferences have worked to promote stringent enforcement of permit requirements.

Addressing nonpoint (diffuse) sources, Section 319 of the Clean Water Act requires each state to identify and assess the impact of nonpoint source pollution on surface waters and to develop a control program. Recent amendments to the Coastal Zone Management Act charge EPA and NOAA with preventing and controlling nonpoint source pollution in coastal areas. These new programs will enhance existing efforts to control runoff.

In addition to federal actions, state and local regulatory activities like stormwater management, zoning ordinances, construction setbacks, and fishing bans are also assessed. Many nonregulatory approaches to problem solving, such as education, have been integrated with estuary project activities.

Taking Early Action

In the five years during which Management Conferences develop a CCMP, they lay the groundwork for long-term problem solving. Part of this process includes taking early actions to address known problems and to test actions to see if they work before including them as full-scale CCMP activities. The early development of a CCMP also allows coordination with state and local ordinances and programs. Funding processes to ensure long-term commitments can then be developed before the final CCMP is completed.

Since 1988, the National Estuary Program has sponsored over 40 demonstration projects. The purpose of this effort is to focus on problems needing immediate attention and to promote field-testing of innovative corrective measures. The demonstration projects also accelerate the development of overall CCMPs because they help determine the time and resources needed for a particular activity. This information can then be used by others in the same or related projects. Though aimed at specific local priorities, the projects also help define generic concerns like stormwater/urban runoff, agricultural pollution, habitat modification/ preservation, and municipal and industrial pollution. Most of these projects are still under way; yet some

have already begun to yield results. The lessons learned in these action programs will be communicated to all NEP projects.

To help focus Management Conferences on CCMP development and implementation of early actions, the Delaware Inland Bays Estuary Program, Massachusetts Bay Project, and Delaware Estuary Program are among the estuary projects developing an early draft CCMP. The Sarasota Bay National Estuary Program is developing a draft "Framework for Action" document that will serve as a preliminary strategy for bay restoration and management; the document will include a plan for implementation funding. This early draft CCMP technique has also been used successfully by the Puget Sound Estuary Program.

Early action projects, both NEP-sponsored demonstration projects and locally funded efforts, have been applying a range of regulatory and nonregulatory techniques to the unique problems of estuaries. Regulatory tools include standards, permits, enforcement, and local zoning ordinances and building codes. Nonregulatory techniques include public education, agricultural "best management practices," and voluntary actions. Management Conference actions typically address key problems like eutrophication, toxics and metals, pathogens, and changes in living resources and their habitats.

Eutrophication

As the Long Island Sound Study continues to examine the hypoxia problem in the sound, the LISS Management Conference believes that the sound's serious hypoxia problem requires action now. LISS is acting to prevent an increase in nitrogen levels by removing nutrients biologically and by using nonpoint (diffuse) source controls to prevent leaking septic systems, animal waste, and fertilizer from washing into the water. The Management Conference is also looking into technologies such as aeration and tide gates to regulate the flow and circulation of water into and around the sound. The Conference is developing a long-term monitoring program to test the effectiveness of its hypoxia management actions. These early actions to help solve a problem still under investigation are key components of effective estuary management.

Agricultural lands contribute significantly to oxygen depletion and excessive algae in tributaries to the Albemarle-Pamlico Sounds. Partners in the Albemarle-Pamlico Estuarine Study, the States of North Carolina and Virginia, the U.S. Department of Agriculture Soil Conservation Service, and local conservation districts, are testing a variety of techniques to control agricultural runoff, which carries animal wastes, fertilizers, pesticides, and soil. Some traditional techniques are being employed—waste storage lagoons, fencing to protect streams from livestock, and filter strips and other methods to slow runoff and remove pollutants. In addition, some new irrigation techniques will help redirect lagoon-stored animal waste for use as farmland fertilizer.

The Albemarle-Pamlico Estuarine Study is supporting a demonstration project to reduce nutrient pollution by testing two methods of reducing animal waste, which contributes excessive nutrients to this watershed. One method will allow the use of animal waste stored in collection lagoons as a substitute for commercial fertilizer. The waste will be dispersed over grass fields through devices called detachable rinsers. Various tests of soil, topography, water table depth, and vegetation will be conducted as part of this project. In addition, ground water and surface water monitoring, conducted both before and after implementing the system, will determine if nutrient loads are being reduced.

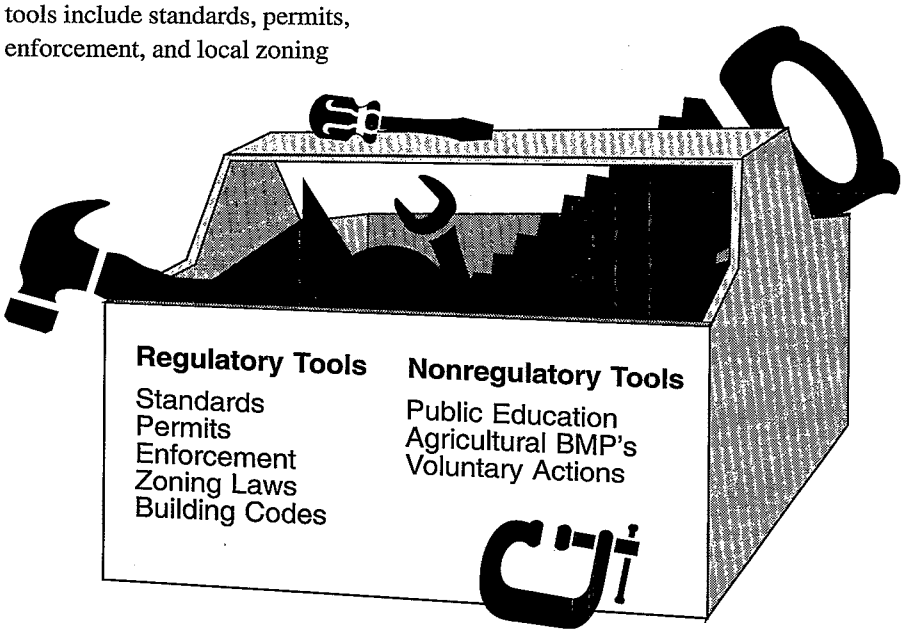


Figure 9. Regulatory and Nonregulatory Tools

Agricultural runoff pollutes waterways.

This stormwater outfall is a source of pollution to the Indian River Lagoon.

The second component of the project will test irrigation systems that include animal waste lagoons. These systems will be designed for about 25 farmers, each of whom will receive instructions and an animal waste utilization plan. The projects are expected to provide a model for effectively managing overflowing lagoons and to demonstrate the nutrient value of manure for crops. Management techniques like those used by the Albemarle-Pamlico Estuary Study, often called "best management practices," promote efficient CCMP development and early action. Local farmers who volunteer on a cost-share basis implement these best management practices.

The Indian River Lagoon National Estuary Program has attempted to evaluate the mitigation alternatives for the problems associated with land drainage runoff—nutrients, mud and discolored ground water, excessive fresh water, suspended solids, and various toxins and pathogens. Watershed runoff control systems, including weirs at channel outfalls and diversion of flow into coastal wetlands, have proven to be effective in simulation experiments.

Toxics and Metals

Early Puget Sound studies showed that many contaminants occurred in urban bay sediments, including heavy metals and organic chemicals such as PCBs and PAHs. Sources of this pollution include releases from Superfund sites, industrial operations, storm drains, and overflows from combined domestic and storm sewers.

In response, a cooperative effort to understand and address these toxicant problems was incorporated into the earliest phases of the Puget Sound Estuary Management Plan. A key feature of this toxic substances control program, the Urban Bay Action Team (UBAT), is the involvement of a broad base of public and private interests in the entire process, from planning through implementation. The sense of local ownership and commitment instilled by the UBAT mechanism has proven vital in the success of the program. The team approach has engendered cooperation among all government levels. Commitments, responsibilities, and accountability among all participants are well defined; innovative, cost-effective solutions to problems are explored before resorting to regulatory and enforcement actions; and knowledge and ideas are transferred among the various UBATs, adding to the entire program's effectiveness. The Puget Sound Estuary Program learned through this effort that success is more

easily attained by bringing resources together to focus on a common problem.

For example, seven Urban Bay Action Teams have been established in Puget Sound and are currently active. Collectively they have conducted more than 675 inspections at 282 sites; issued many warning letters, violation notices, administrative orders; revised NPDES permits; negotiated consent orders and decrees; and completed cleanups of leaking underground storage tanks and other sites. In comparison with the traditional permit program method, the innovative UBAT approach—a focused education, compliance, and enforcement effort—has proven more aggressive, more comprehensive, and more timely.

An EPA Office of Research and Development pilot study is being conducted in New Bedford Harbor, in cooperation with the Buzzards Bay Project, to investigate dredging of contaminated sediments as a remedy to eliminate toxic contamination in the harbor. A monitoring plan is being implemented to determine the effects of this dredging. The resulting data will be used to evaluate the dredging and to modify or terminate the operation if the dredging itself causes unacceptable contamination. The rapid availability of data and their immediate use in the decision-making process has proven to be an effective management approach.

A Delaware Estuary Program Demonstration Project aims to reduce agricultural runoff containing pesticides and conventional pollutants entering Red Clay Creek by implementing best management practices on a mushroom-growing operation. The project tests several disposal methods for spent mushroom compost and educates local agricultural producers about proper pesticide usage and disposal. The management practices to be installed at the mushroom farm include construction of two lined ponds to hold runoff from spent compost piles prior to pick up by a recycling company, which converts spent compost to potting soil, and an irrigation system to spray runoff water from the ponds into hay fields, which are maintained for long-term cultivation. Wastewater spreading rates will depend on soil tests and nutrient analysis of the wastewater to ensure that nutrients are applied at an optimal rate for uptake by the hay. The project is expected to demonstrate an agricultural nonpoint source control program that can be used in other Delaware Estuary watersheds.

Pathogens

Pathogens, which are carried into waterways with poorly treated sewage, contaminate shellfish areas. Two demonstration projects conducted in Buzzards and Santa Monica Bays are taking early action to control pathogen contamination.

Bacterial pollution leads to closed shellfish beds.

A small bay within Buzzards Bay, Buttermilk Bay, is the site of a demonstration project to treat stormwater. Prior to this project, stormwater collected from urban neighborhoods was transported directly to a swimming beach. To prevent this problem, a stormwater detention system was built under a parking lot to allow stormwater to collect, solids to settle, and the remaining liquid to percolate through unsaturated soil where a large percentage of bacteria and viruses are removed. This project has resulted in the removal of a substantial amount of contamination to Buttermilk Bay.

A demonstration project to prevent storm drain pollution from entering Santa Monica Bay is being implemented. The project expands an existing effluent improvement program by testing the effects of ozone treatment on dry weather flows. If successful, ozone treatment may substantially reduce the contaminated effluents entering the bay and also provide a source of partially treated, reclaimed water for irrigation. Ozone is a more powerful disinfectant than chlorine; however, it has never before been applied to stormwater.

Living Resources and Their Habitat

Numerous NEP early action projects are designed to test various approaches to enhance and protect living resources and their habitats. For instance, the Santa Monica Bay Restoration Project is creating new habitats for expanding the breeding of native birds, least terns. The project will create new, protected breeding sites using three techniques: erecting a fence around the site, preparing the nesting area by removing non-native vegetation and spreading oyster shells

or sand on the site, and placing decoys and tapes of tern sounds to attract birds.

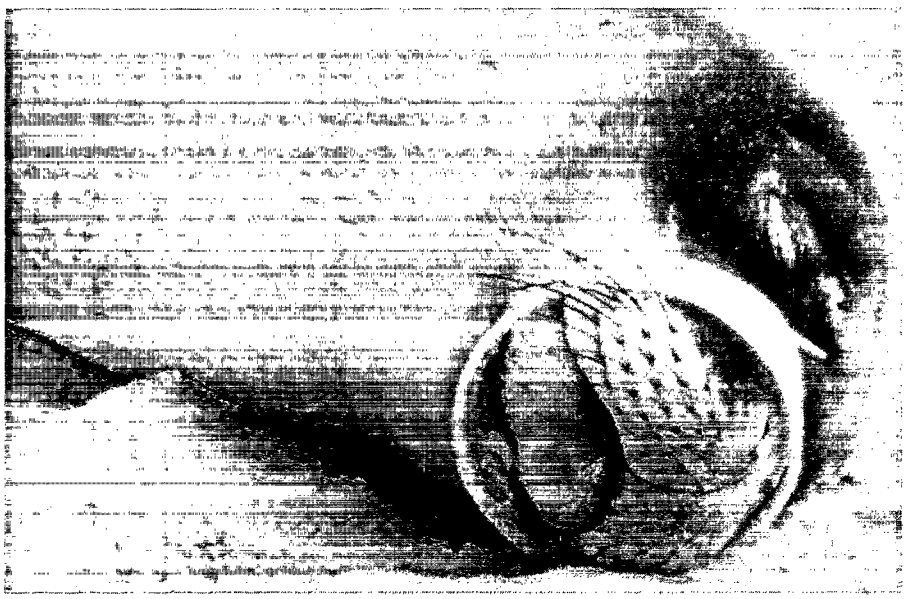
Early in the Galveston Bay National Estuary Program (GBNEP), two areas of Galveston Bay were recognized as particularly significant to the estuary. Those areas, Christmas Bay and Armand Bayou, were seen as geographic portions of the estuary which required greater regulatory protection and management than were available under current programs. Under a GBNEP initiative, the Texas General Land Office and Texas Parks and Wildlife Department have cooperated to designate each of these areas as special Texas Coastal Preserves. This special status will help ensure the ecological integrity of these areas. Management plans for Christmas Bay and Armand Bayou, now being drafted under the guidance of the GBNEP task force, will serve as a model for the development of a CCMP for the entire Galveston Bay.

Past dredging operations in Sarasota Bay have adversely affected the natural bay environment. Changes resulting from dredged channels and spoil islands (sites for dredged materials) include a proliferation of exotic vegetation, loss of habitat, interference with water flow and circulation, and alterations in living resources. Moreover, less than 22 percent of the shoreline remains in its natural state. To maximize the quality of both habitat and appearance there, the Leffis Key Bayside Park Project has been designed to remove the piled dredge material from spoil islands to encourage the growth of native intertidal mangrove habitat and to create shallow tidal lagoons. In addition, native vegetation will be planted, and non-native vegetation that has grown on spoil islands will be removed. These activities are expected to enhance fisheries, maintain biodiversity, and promote tidal exchange.

Dredging and disposal activities in the San Francisco Bay area have been an issue of concern for more than a decade. Aquatic disposal of dredged materials in the bay has been limited to three sites since the mid-1970s. In addition, there is an ocean disposal site designated specifically for dredged material excavated as part of maintenance dredging for the San Francisco Bay entrance channel. The site that receives the most dredged material is located in the bay near Alcatraz Island. In 1982, this site was discovered to have accumulated enough material to present a navigational hazard. The discovery stimulated a debate regarding disposal practices and the overall management of dredged material in San Francisco Bay.

In response to the Alcatraz mounding problem and concerns about the impacts of dredged material on the bay's water quality and biological resources, EPA, the U.S. Army Corps of Engineers, San Francisco Bay Regional Water Quality Control Board, Bay Conservation and Development Commission and other dredging and environmental interests are engaged in a joint effort to develop a long-term management strategy for San Francisco Bay area dredged material. The strategy involves evaluation of dredging needs, disposal options (including selection of ocean, in-bay, and upland sites) and beneficial use. The strategy is scheduled to be completed by 1995. The San Francisco Estuary Project has provided support by publishing a report on dredging and waterway modification and holding a dredging forum for the public.

Floating marine debris—a threat to marine life, aesthetics and economic potentialities—is being addressed around the United States. Efforts include public and industry education on the nature of the problem and control measures, regulation of sources, and monitoring of trends. In



Debris can kill wildlife.

addition, at a local level, some areas are paying increased attention to the problem. One such example is taking place as part of the merged New York-New Jersey Harbor Estuary Program/New York Bight Restoration Plan. Major sources of floatable marine pollution include combined sewer overflows, storm sewers, transfer operations at marine solid waste stations, improper medical waste disposal, river and coastal discharges, nonpoint source pollution, boat discharges, and beach litter. Under the New York Bight Restoration Plan, a short-term marine debris action plan has been developed and implemented to collect and remove debris from the harbor before it can reach recreational or sensitive environmental areas. EPA, Corps of Engineers, Coast Guard, the states of New York and New Jersey, and New York City have cooperated since 1989 to achieve this goal. A final long-term plan was recently issued. Through its own funding, New York City is developing techniques to combat floatables from combined sewer overflows. To minimize the potential for marine debris, significant improvements have also been made to operations involving the transport and transfer of solid waste to the Fresh Kill landfill.

New York and New Jersey also carried out joint pilot projects to show that deposition of marine waste can be reduced through proper handling and recycling at recreational boating marinas. Through these projects, marina users and the public were provided with information about proper disposal methods. The New York project resulted in the installation of bulletin boards to promote vessel waste exchange and recycling and the setting up of highly visible facilities to receive wastes at five recreational marinas. We Care About New York, a nonprofit New York City beautification organization, helped to coordinate the system by providing support at all five areas; local sanitation departments transported and disposed of the waste. At the Oyster Bay marina, a vessel collected trash from other vessels. The New Jersey Department of Environmental Protection administered a pilot recycling project at three recreational marinas, building on the state's mandatory recycling efforts and anti-litter beach campaign and utilizing the campaign's existing resources and contacts with coastal interest groups.

Through the work done in CCMP development, including early action demonstration projects, the NEP has learned a great deal about successfully managing estuarine resources. The CCMP-development process has served as a highly effective catalyst for action. Innovative techniques, a focus on efficient and early intervention, and a sustained reliance on teamwork have helped initiate activities that will have a lasting effect on restoring and maintaining estuary health in the future.

Part IV

Assessing the NEP: What Has Been Learned

During the four years of the National Estuary Program, the estuary projects have tested the NEP approach to estuarine management. It is clear that the NEP four-phased management process and the underlying concepts of collaboration, consensus building, and public participation have advanced estuarine management. More is understood about the functions of estuaries and their complex systems; and more is understood about the application of regulatory, technological, and educational methods for restoring and protecting them.

The CCMP development process was derived from programs to study and manage the Chesapeake Bay and Great Lakes. The evolutionary nature of the NEP, as well as its flexibility, is demonstrated by the Puget Sound Estuary Program and the Buzzards Bay Projects. The two programs have now completed their CCMPs. Though both have followed the NEP approach, each has tailored this approach to reflect state and local needs and priorities. Part IV of this *Report to Congress* outlines the Puget Sound and Buzzards Bay adaptations of the NEP approach to estuarine management. This section also presents some of the significant lessons learned as part of the NEP, under which these two estuary projects matured.

Two Successful Management Conferences

The experiences of the projects in Puget Sound and Buzzards Bay have proven the importance of teamwork in developing CCMPs. The Puget Sound Estuary Program, in partnership with the State of Washington, established firm commitments to early and decisive action. The Buzzards Bay Project, recognizing the need to develop alliances among local governments in Massachusetts, helped create the Buzzards Bay Action Committee, which is committed to CCMP implementation. By focusing initially on a smaller embayment (Buttermilk Bay), the Buzzards Bay Project also showed that a smaller geographical area can serve as a microcosm for the entire estuary project.

The Puget Sound Estuary Program has its roots in a 1983 State of Washington initiative that established the Puget Sound Water Quality Authority. The Authority was charged with identifying pollution-related threats to Puget Sound marine life, assessing pollution threats to human health, and investigating the need for improved coordination among agencies responsible for protecting Puget Sound water quality. In 1985, in cooperation with the Washington Department of Ecology and EPA Region X, the Authority began to coordinate activities for a new Puget Sound Estuary Program, which became part of the NEP in March 1988.

The Buzzards Bay Project, like the Puget Sound Estuary Program, was among the early initiates of the NEP. In Section 320 of the Clean Water Act, Congress directed the Administrator of EPA to give priority consideration for the NEP to Buzzards Bay, Puget Sound, and others. Soon thereafter, the Governors of Massachusetts and Washington nominated Buzzards Bay and Puget Sound, respectively, for NEP inclusion.

Both programs followed NEP guidance and established Management

Conferences with similar committee structures and membership distribution. The two Management Conferences identified the priority problems on which they focused characterization efforts, early actions, and, ultimately, their CCMPs.

The Puget Sound Estuary Program issued its first management plan in 1987 and revised it in 1989. This plan evolved into the 1991 CCMP, now approved by EPA. The final CCMP includes a summary characterization of the estuary and of detailed actions to be taken to address priority problems. The CCMP action plans are focusing on 15 programs that address pollution sources and ecological resources. It also contains an unfinished agenda of issues still to be addressed.

Several changes and additions distinguish the final CCMP from the 1987 plan and its 1989 update. More emphasis has been placed on the role of federal and tribal governments, and several programs have been added or modified. Emphasis has been on the development of action plans that describe how the state goal of no-net-loss/long-term-gain of wetlands will be achieved. Because of their ongoing support, it appears likely that state executive agencies, including the Departments of Ecology, Natural Resources, Fisheries, Wildlife, Transportation, Agriculture, Community Development, Trade and Economic Development, and Commerce, will use their authorities to protect wetlands to the maximum extent possible.

The State of Washington has been and continues to be the moving force behind the Puget Sound Estuary Program. The state has provided over $54 million in five years to support Management Conference activities. In addition, Public Involvement/ Education funding, or PIE Fund, which comes from cigarette taxes, has been dramatically supportive. As CCMP implementation proceeds, the state remains committed to the effort to protect and restore Puget Sound.

Implementation of corrective actions to address known problems continues in areas such as sediment management, dredged sediment disposal, monitoring, additional point source control, and nonpoint source control. An extensive public involvement and education effort continues to be a high priority.

The Puget Sound Water Quality Authority has been extended until 1995 by the Washington legislature to oversee CCMP implementation. Four new state taxes and user fees have been proposed to support the CCMP action programs.

The Buzzards Bay Project was started in 1985 under the joint management of EPA and the Massachusetts Executive Office of Environmental Affairs. It had three objectives: (1) to set up a management structure to coordinate project activities and help achieve long-term goals; (2) to identify and research the priority water quality problems in Buzzards Bay; and (3) to develop a management plan for the protection of bay water quality and valuable resources. In January 1988, the Buzzards Bay Project was officially designated as an NEP estuary of national significance.

The now-completed CCMP is the culmination of research and demonstration projects designed to help investigate the most pressing problems in the bay and to outline solutions. In 11 action plans, the CCMP reflects the project's efforts to manage three priority problems: shellfish bed closures due to pathogen contamination; high nutrient inputs; and fish and shellfish contamination by toxic metals and organic compounds, such as PCBs. Buzzards Bay Project outreach efforts have been supported by the Coalition for Buzzards Bay as well as by the Lloyd Center for Environmental Studies, two independent groups. The Buzzards Bay Project has also awarded mini-grants to assist local efforts to address bay issues.

The Buzzards Bay Project submitted its final CCMP to EPA in November 1991. The major focus of the Buzzards Bay Project and the CCMP is on local responsibility for preserving the bay and its resources. According to the CCMP, the protection of the bay is dependent upon enlightened future land-use management; in the New England tradition of home rule, such management decisions belong to the community and its inhabitants. The Buzzards Bay Advisory Committee of locally elected town selectmen signed a compact, committing themselves to the CCMP action program. The compact led to formation of the Buzzards Bay Action Committee, which is dedicated to CCMP implementation. The Buzzards Bay Action Committee has hired an executive director to oversee implementation of the action program. In its chapter on implementation, the CCMP also solicits federal and state assistance; a fully integrated intergovernmental approach is thought to be optimal. The Massachusetts Coastal Zone Management Office has been the lead state agency supporting the Buzzards Bay Project.

Table 3 outlines key elements of the Puget Sound and Buzzards Bay CCMPs.

Table 3. Comparison of Puget Sound and Buzzards Bay CCMPs

	Puget Sound Estuary Program	Buzzards Bay Project
Priority Problems	• Toxic substances • Wetland/habitat loss • Shellfish bed protection • Nonpoint pollution sources • Spill prevention/response	• Pathogen contamination • Toxic contamination • Increasing nitrogen
Action Programs Addressing Problems	• Estuary Management and Plan Implementation • Fish and Wildlife Habitat Protection • Spill Prevention and Response • Monitoring • Research • Education and Public Involvement • Puget Sound Foundation • Household Hazardous Waste • Nonpoint Source Pollution • Shellfish Protection • Wetlands Protection • Municipal and Industrial Discharges • Contaminated Sediments and Dredging • Stormwater and Combined Sewer Overflows • Laboratory Support	• Nitrogen-Sensitive Embayments • Shellfish Resources • Stormwater Runoff • Sanitary Boat Waste • On-Site Systems • Oil Pollution • Wetlands and Marine Habitat • Shifting Shoreline • Sewage Treatment Facilities • Toxic Pollution • Dredging and Dredged Material Disposal • New Bedford Remediation • Land-Use Management • Embayment Management in Buttermilk Bay
Innovative Laws and Programs	• Puget Sound Foundation (in formative stage) • Local Government Wetland Protection Standards • Wetlands Restoration Program • Stormwater Standards • Growth Management Act • Sediment Management Standards • Public Involvement and Education • Urban Bay Action Program	• Regulatory standards for nitrogen inputs to sensitive embayments • Municipal laws requiring Best Management Practices for stormwater runoff • Marina pumpout facilities • Setbacks for septic systems • Wetlands Conservancy Program • Toxic Use Reduction Act • Town "build-out" analyses to guide growth and development
Monitoring Plans	• Active since 1989, including monitoring for pesticides • Data collected and transferred by federal, state, local, and tribal governments to be compatible with Puget Sound Ambient • Monitoring Program	• Monitoring specific to coastal embayments and open bay • Focus on sewage loading, high fecal coliform counts, and closed shellfish beds • Protocols will be standardized
Financial Plans	• Puget Sound Foundation, developing nonprofit corporation for research and education • Other sources include state and local general funds, Centennial Clean Water Fund (cigarette tax), state revolving fund for low- or interest-free loans for clean water projects, state wastewater discharge permit fees, state superfund, a variety of fees, federal funds (Section 319 of Clean Water Act, Fish and Wildlife Service, Soil Conservation Service, etc.), local fees and utility revenues, and private sector sources (land trusts).	• Identifies most relevant funding source for each action • Presents cost estimation procedures and preliminary cost estimates for stormwater control, on-site septic system improvement, boat pump-out facilities, oil spill containment equipment, and toxic audit teams • Guides local governments on new funding sources since most actions call for local government implementation
Educational Plans	• Continuing education/involvement supported in the short term by a Public Involvement and Education Fund (PIE Fund); long term by Puget Sound Foundation	• Coalition for Buzzards Bay, an independent group of organizations, expected to continue public education efforts on Buzzards Bay
Implementing Agencies	• Puget Sound Water Quality Authority • Washington Departments of Ecology and Natural Resources • Other state, local, tribal, and federal agencies	• Buzzards Bay Action Committee: Local Municipalities • Massachusetts Executive Office of Environmental Affairs, Office of Coastal Zone Management; Department of Environmental Protection • Other state and federal agencies

Resolving Watershed-Wide Conflicts

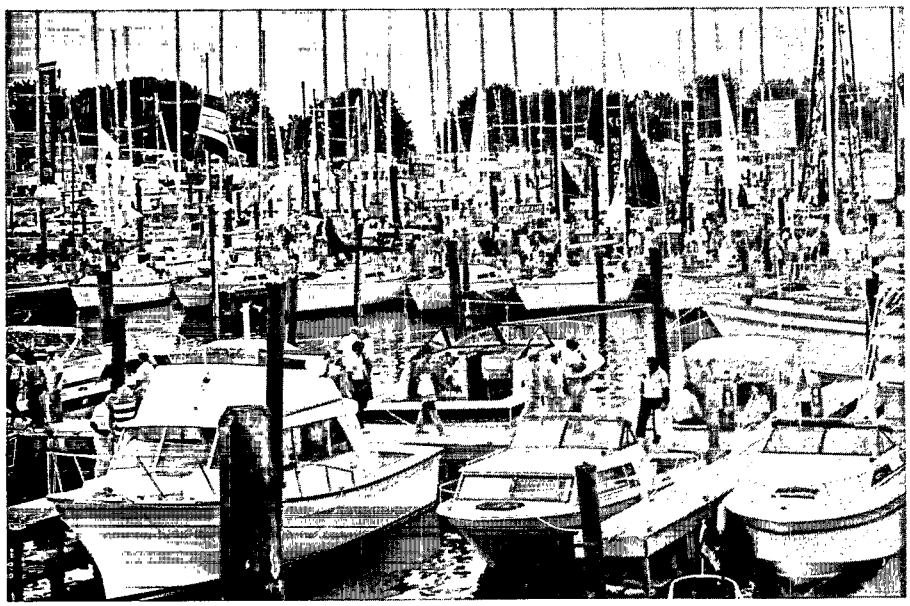
As the Puget Sound and Buzzards Bay projects demonstrate, the NEP has served as a catalyst for state and local short-term action and long-term management. The NEP geographic or watershed approach to resource management looks at the entire system and measures the combined impact of laws, programs, and human behavior. In this way, the need for change can be assessed in relation to the sustainability of the estuary and its living resources. This approach has been instrumental in drawing attention to the conflicts among different human uses and between human uses and natural systems and resources.

These conflicts are amplified in locations where shellfish harvesting is banned. In areas with rapid human population growth or with older sewage treatment systems, the need for improved sewage treatment and septic systems is crucial. These improvements lag behind, largely because sewage treatment is so expensive and requires public funding. Poorly treated sewage entering waterways increases pathogen levels, causing shellfish contamination. This contamination, in turn, requires the closing of shellfishing areas to prevent consumption of contaminated seafood. To exacerbate the issue, a lack of funding to perform required sanitary surveys prevents the reopening of improved shellfish beds. Then the public cannot eat seafood unless it also wants to pay for advanced sewage treatment and sanitary surveys; commercial harvesters are denied their livelihood; recreational clammers are prevented from using the shellfish beds; state officials are harassed for doing their job; and elected officials are caught between the need to protect the public health and the need to raise taxes.

Estuarine problem solving involves grappling with these conflicting human activities and balancing them with the estuary's natural system and resources—a challenge to Management Conferences. Management Conferences must consider the town manager's concern about raising taxes to expand capacity of the sewage treatment plant and the clammer's frustration over closed shellfishing areas. The Conference also must address the recreationist's disappointment about the loss of forest land, open space, and swimmable waters; the farmer's interest in using fertilizer; and the developer's interest in providing housing for a growing population. Though challenging, these divergent interests are being resolved through the deliberations of Management Conferences.

Coordinating and Integrating Scientific and Management Efforts

As discussed in Part I of this report, Management Conferences are the institutional framework through which intergovernmental cooperation and program integration are achieved. As Management Conferences build upon the Clean Water Act base programs and other EPA, federal, state, and local authorities and programs, existing watershed-related efforts are being redirected to meet Conference goals and objectives. Moreover, the NEP process engenders new laws and programs. The State of Washington, for example, recently adopted a regulation which sets minimum stormwater standards for new development. Local governments in Washington will be required to adopt stormwater programs that include these new standards, a major step in controlling pollutant discharges in the Puget Sound watershed.



Neil Wynne

Marinas also contribute to pollution.

Through the cooperative, intergovernmental efforts of Management Conferences, research into estuary functions is under way, and the status and trends of estuarine water quality and living resources are being defined. The NEP stimulates other public agency research efforts and encourages the use of existing studies and available data through both public and private institutions. The NEP helps to identify needed research and facilitates interaction between scientists who perform the research and managers who use the research results.

Monitoring Estuaries

An important lesson learned in the last four years is the value of monitoring. Monitoring data are crucial in helping both to define estuary functions and to note any changes resulting from management actions. To assess the success of management actions, each Management Conference must design a long-term monitoring strategy.

The Puget Sound Water Quality Authority began a comprehensive long-term monitoring program in 1989 to measure the ecosystem of the Puget Sound. The monitoring program will characterize the condition of the water, sediment, plants, animals, and habitats in Puget Sound and its watershed. The program has begun to collect and record information to document the status and trends in contamination, the effects of contamination on natural resources, and any changes in the Puget Sound ecosystem due to natural causes. Another key lesson learned in Puget Sound has been recognition of the need to establish and use standardized procedures for the collection and analysis of various types of environmental samples. The *Puget Sound Estuary Program Protocols and Guidelines* was developed to standardize sample collection and analysis within the sound, allowing for comparability of data and determination of long-term trends.

Puget Sound experiences have served as a model to the other NEP projects, which are developing monitoring programs, and to the NEP, which is developing monitoring guidelines to help Management Conference.

NEP Monitoring Guidelines

As CCMPs are implemented, monitoring will help determine the effectiveness of the actions taken. Though each project may target a different problem or fill a different information need, the NEP advocates that all monitoring programs within a watershed use comparable methods and measurement strategies and be based on the same scientific principles.

To this end, EPA is providing guidelines on the design, implementation, and evaluation of the required monitoring programs. The interim final guidance document differentiates between the sampling done as part of characterization and the long-term monitoring that is part of CCMP implementation. Sampling during characterization is done to fill data gaps, provide baseline data on pollutant loadings, and estimate the degree of variability over both space and time. The monitoring conducted during the implementation of action plans is designed to be part of a long-term program to evaluate trends, link observed patterns to management actions, and provide information that can be used to redirect or refocus the management plan if necessary.

The guidance document describes each of the steps to be taken in designing a long-term monitoring program: (1) State the objectives; (2) establish requirements to meet the objectives; (3) select analytical methods and sampling designs; (4) evaluate anticipated results for adequacy; and (5) implement the program, with periodic assessments. According to the interim guidelines, development of a monitoring program should begin during the first two years of the Management Conference and should be an integral part of a CCMP.

Educating and Involving the Public

The NEP has from its beginning encouraged public education and public participation in estuary projects. Volunteer monitoring, recognized by EPA as an important public education and involvement mechanism, is used to achieve a better understanding of an estuary's functions and to enlist citizen support in identifying and managing estuarine problems. Experience has shown that properly trained volunteers can perform basic sampling and simple analytic tasks with accuracy and reliability while keeping expenses low. This program has proved to be an excellent method for educating students, as well as older citizens, and for developing stewardship of estuaries.

To promote citizen monitoring programs in NEP projects, EPA sponsored national workshops on volunteer monitoring in 1988 and 1989. A national volunteer monitoring network was formed as a result of these workshops. To foster the network, EPA published a directory of

volunteer monitoring groups, helped produce a guide to volunteer monitoring for state agency use, and trained volunteers. EPA currently sponsors a newsletter for citizen volunteers.

Albemarle-Pamlico Sounds, Narragansett Bay, Puget Sound, San Francisco Bay, and Tampa Bay projects have well-established programs for volunteer monitoring. Planning for volunteer monitoring efforts is now taking place in Galveston Bay, Sarasota Bay, Casco Bay, Indian River Lagoon, and Delaware Inland Bays. The Delaware Inland Bays Estuary Program has awarded a grant to the Delaware Sea Grant Program to develop a citizen monitoring program, train volunteers, and manage the program in the Inland Bays.

An integral element of the NEP approach to estuarine management is public participation and education. The goal of public participation is to involve citizens with diverse interests in helping to influence decisions concerning their communities, waterways, and estuarine environments. The purpose of public education is to teach people about their environment, the role they play in polluting it, and the role they can have in restoring and protecting it. Through public participation and education programs, citizens of the estuarine watershed become its stewards and protect the estuary and its resources for future generations.

To further encourage public involvement in CCMP development, the NEP ensures that each Management Conference has a representative, active citizens committee and an effective public participation strategy, and it ensures that the voices of the citizens are heard. The San Francisco Estuary Project, like all the NEP projects, supports a strong public participation component. In addition to a Technical Advisory Committee, the project relies on the advice of a Public Advisory Committee consisting of 57 representatives from various public and private interest groups. The project reaches out to the public through workshops, conferences, and publications as part of its effort to educate citizens about the San Francisco Bay-Delta Estuary and the environmental problems it faces.

Recently this estuary project, in cooperation with the Aquatic Habitat Institute, held a three-day technical and public education conference that focused on the impact of fresh water flows on estuarine wetlands, biological resources, hydrodynamics and circulation, and water chemistry. Discussions of how scientific data are used in developing policy and presentations on the state of the estuary were key components of the conference. Such educational opportunities help to foster a partnership among scientists, managers, and the public to restore and protect our estuaries for future generations.

Public education is a nonregulatory mechanism Management Conferences use for controlling pollution sources and protecting resources. Some educational efforts aim to stop the dumping of trash and motor oil into sewer drains. Others ask citizens to "adopt" estuarine tributaries, beaches, and even highway segments in an effort to help keep them litter-free.

The Sarasota Bay National Estuary Program succeeded in reclaiming a four-and-a-half-mile site as part of its ongoing effort to restore natural habitats along the bay. A new trash-free park is now framed by boardwalks, nature trails, and mangroves. Volunteers planted about 21,000 marsh grass plugs, 300 mangrove trees, and dozens of sea grape plants in the park, transforming the estuary.

As part of the Buzzards Bay Project CCMP, the Management Conference has called on local governments to control growth and development, using zoning, public health authorities, and conservation easements. In addition, a citizen coalition recently handed out report cards to twelve municipalities. The report cards were based in part on questionnaires sent to elected officials and to conservation, health, planning, and zoning board members. The questions covered stormwater runoff, septic system maintenance, shellfish bed closures, wetlands protection, growth plans, and other issues. One community was rated an "A"; four were "B"; and the others were rated "C," with three of these rated "C-." The report cards are given annually to encourage the towns to be better stewards of the bay.

Education is the key technique used by the Delaware Estuary Program to address suburban nonpoint source pollution and water conservation issues. As part of a Demonstration Project, the Delaware Estuary Program has established a comprehensive "Clean Water Works" program. The program encompasses three initiatives: evaluation of watershed management alternatives; education of homeowners, landscapers, and students; and implementation of activities that include a citizen Watershed Watch group.

The Narragansett Bay Project is helping to prevent further pollution to the bay by establishing the Hazardous Waste Reduction Project, a waste

Learning about estuarine resources.

reduction public education and technical assistance program for Rhode Island's electroplating industry. Initially, the project has focused on reducing toxic wastes from those electroplating firms discharging to the Field's Point sewage treatment plant. If successful, the project could be expanded to other Rhode Island treatment facilities and other types of businesses; it should also provide a model for other states.

This project includes two main procedures. First, a series of workshops are offered, targeted at a broad audience within the electroplating industry. These workshops provide information on waste reduction technologies and management practices. Second, hazardous waste audits are conducted at industry sites. Trained technical staff visit electroplating plants to observe and evaluate their standing inventories, materials handling, manufacturing processes, and pretreatment programs. Audit reports show plant managers opportunities to reduce waste and improve pretreatment techniques. The project aims to complete approximately 20 audits each year.

The Galveston Bay National Estuary Program has utilized public education and involvement as a substantial force for improving the stewardship of estuarine resources. For example, a major annual "Bay Day" festival was recently organized, which drew approximately 15,000 participants in the first such effort. Bay Day, co-sponsored by the Galveston Bay Foundation, involved exhibitions in theme pavilions which highlighted the significance of bay resources and their use and management. Some 55 resource agencies, companies, and groups provided displays and handed out literature related to the estuarine environment. The increased awareness, cooperation, and involvement resulting from this successful effort are seen by the GBNEP as vital in providing for effective implementation of future management.

New estuary projects—Barataria-Terrebonne National Estuary Program and Casco Bay Estuary Project—are just beginning to realize the benefits of involving the public to help protect their estuaries. Citizens around the Barataria-Terrebonne Estuarine Complex are being invited to participate in initial activities to help define and select priority problems. Mailing lists are now being developed, and public outreach and involvement efforts are under way. A major goal of the Casco Bay Estuary Project is to educate as many people as possible and involve them in efforts to protect Casco Bay resources. A newsletter of the Casco Bay Estuary Program is already being widely distributed. New Management Conferences have many fine NEP models from which to draw experiences with public outreach programs.

Financing CCMP Implementation

Because CCMPs must be implemented to be successful, the NEP requires that CCMP financial plans be part of the final CCMP submittal to EPA for approval. Funding for CCMP actions is raised primarily from state and local sources by the Management Conference.

The Puget Sound Estuary Program's CCMP contains a discussion of four proposed new state taxes recommended by the Puget Sound Finance Committee: A one-time fee charged to motor vehicle manufacturers for new registration of

vehicles in the state; an increase in the state foodfish and shellfish tax, and extension of the tax to finfish aquaculture; a new tax on marina use fuels (currently exempt from the motor vehicle fuel tax); and a surcharge on the state leasehold excise tax assessed on public lands (including aquatic lands) leased to private parties in the Puget Sound region. These new taxes, in combination with a Puget Sound regional fee (an annual fee that would be charged to households and businesses in the Puget Sound basin), a nonprofit foundation, and increased reliance on the state general fund, would raise needed revenues to implement the CCMP.

The Buzzards Bay project developed a guidebook to help local governments develop financial mechanisms suited to local implementation of CCMP actions such as on-site septic system maintenance, stormwater management, boat pump-out programs, and comprehensive water quality programs. Mechanisms discussed in the guidebook include establishing special districts and levying rates, charges, and special assessments. The guidebook also suggests using enterprise funds supported by user fees and local bond banks that reduce costs through lower municipal bond interest rates.

Since a dominant focus of the Long Island Sound Study (LISS) is the reduction of nutrient loadings to the sound, the project has developed a draft financing report that suggests taxes and fees on uses that contribute to nutrient loadings. Possible new sources of revenue for consideration include a fee on water use, a tax on nitrogen-containing fertilizers, a head charge on livestock and poultry, and a tax on household and industrial cleaning products. Additional suggested sources of revenue focus on boaters who use the sound: boat registration fees, slip fees, and a marine fuel tax. LISS's finance committee is exploring all potential revenue sources.

The Narragansett Bay Project has developed several experimental financing plans to help pay for implementation activities. They include using stormwater management utilities to fund local soil erosion, sedimentation control, and stormwater management programs.

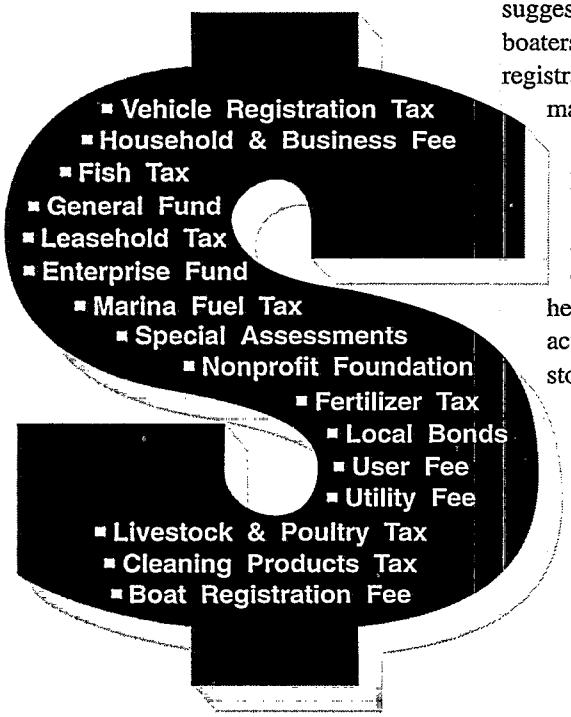


Figure 10. Financing CCMP Implementation

Applying NEP Lessons

As NEP projects move forward, they learn from their own experiences and from the experiences of other projects. Through technology transfer conferences, science symposia, guidance documents, and other publications, the NEP facilitates the exchange of information, experiences, and technologies.

The NEP has supported 17 estuary projects, inspired other resource management programs, and catalyzed the local action needed to protect estuaries. It has been the instrument through which new research has been undertaken, new technologies have developed, new regulatory mechanisms have evolved, and further public attention and funding have been focused on estuarine watersheds.

Demonstrating Science Advisory Board Recommendations

EPA programs are reassessed on an ongoing basis, and new priorities and approaches to environmental management are devised. Recently the Agency's Science Advisory Board made ten recommendations in its report, *Reducing Risk: Setting Priorities and Strategies for Environmental Protection.* Recommendations that have been adopted by the Administrator and form the basis of the new EPA policy directions reinforce the importance of geographic targeting to achieve the greatest reduction of environmental risk. Geographic targeting and other approaches are already reflected in the NEP approach and philosophy.

Targeting greatest risks. As part of the CCMP process, each Management Conference studies its estuary's problems and, with the guidance of its scientific and technical advisors, selects priority problems in that watershed to be addressed in its CCMP.

Considering ecological risk as much as human health. The NEP, in its earliest projects, has focused attention on the need to protect and enhance living resources and their habitat.

Emphasizing pollution prevention. The CCMP is a long-term problem-solving approach to estuarine management. Preventing pollution is inherent in these strategies designed to protect resources. In addition, early actions like Narragansett Bay's educational effort for industries demonstrate the NEP commitment to pollution prevention.

Integrating CCMPs into public policy. When the Management Conference—with a strong institutional framework that is locally based—endorses and firmly commits its resources to the CCMP and begins to carry it out, the CCMP *is* public policy.

Continuing to develop public understanding. As this report shows, public education is key to the work of a Management Conference, its CCMP development, and, most of all, the long-term restoration and protection of the entire estuarine watershed.

The NEP and the 17 estuary projects are at the forefront of environmental resource management. Some challenges have yet to be met, but it is clear that the NEP formula is working.

Part V

Looking to the Future: Trends and Needs

As we approach the end of this century, it is heartening to observe the pollution control advances that have been made. Under the Clean Water Act, many regulatory controls have evolved to control point sources. These control programs include National Pollutant Discharge Elimination System (NPDES) permits, recently expanded to cover urban stormwater runoff, and pretreatment programs, which require treatment of industrial effluents before they are transported to municipal sewage treatment plants. In addition, sewage treatment technologies have gained in sophistication and effectiveness. In combination, these conventional and new methods and technologies have led to some improvements in estuarine water quality, particularly with respect to reduced toxic discharges.

In spite of these advances, some problems remain important challenges for us all: pollution from the air, waste sites, and ground water; runoff from the land and urban streets; and the loss of wetlands and other vital habitats. The keys to meeting these challenges can be found more easily as we further consolidate our alliances with other federal, state, and local government agencies, the scientific community, and the public.

Closer Integration with EPA Programs

As mentioned in Part II of this report, there is mounting concern about the impacts on estuaries from air deposition, solid and hazardous waste, and ground water. The Long Island Sound Study is investigating the role of vehicle emissions to pollution contributions to the sound. Studies of Chesapeake Bay have already established clear links to vehicle emissions. Work at Superfund sites in Puget Sound and Buzzards Bay have been coordinated with those estuary projects, but even closer ties between remediation activities at waste sites and estuary projects are needed. The problems caused by solid waste are being addressed by the New York-New Jersey Harbor Estuary Program, yet few projects are directly dealing with trash by encouraging household recycling and waste reduction efforts. The Narragansett Bay Project is, in cooperation with Rhode Island businesses, performing hazardous waste audits and encouraging source reduction, recycling, and safer chemical substitution. The Delaware Inland Bays project is looking at ground water as a major contributor to its nutrient problem, recognizing that more must be understood to manage the problem. Though much interaction among EPA's base programs is under way, more effort is needed among EPA Headquarters and Regional Offices and in the estuary projects to closely integrate with these and other EPA base programs.

Future Research Needs

The NEP will continue to rely on the support of EPA's Office of Research and Development (ORD) and NOAA, as well as other federal and state agency and private research arms. The results of NOAA's Status and Trends Program and ORD's EMAP Near Coastal efforts are expected to provide assessments of the conditions of estuaries and information on whether they are degrading or improving, adding to the assessments and

information produced by individual NEP project monitoring efforts. Status and Trends information is already being used by a number of Management Conferences.

There are also a number of areas where new research is needed:

- How significant is the problem of contaminated sediments? What are their impacts on bottom-dwelling communities? Can remediation reduce risks? If so, what kind of remediation?
- How significant a problem is atmospheric deposition as a source of toxic substances to estuaries?
- What are the effects of exotic species on the ecological integrity of the ecosystems? What attributes of exotic species make them successful invaders? How can we ensure the diversity of species in estuarine ecosystems?
- What are the processes controlling nutrient cycling and algal production? What intervention is effective in controlling phytophankton growth?

A Scientific/Management/Public Partnership

Using the scientific knowledge gathered and interpreted during the characterization phase, the Management Conference ensures that the public, elected officials, and special interest groups—all part of the Management Conference—understand the problems of the estuary and are prepared to support the measures needed to correct the problems.

This process is simple in theory; in practice, it is complex. Scientists do not always agree on what causes a problem or what should be done to solve it. Furthermore, scientists and managers do not always communicate well with each other. In the NEP, managers operate on a five-year plan; scientists rarely do. Under the auspices of Management Conferences, however, scientists are focusing their research and applying their findings, understanding project managers' needs and time constraints. Managers are challenging scientists to direct their studies to meet Management Conference needs for short-term answers. Communications between scientists and managers are enhanced through Management Conferences, resulting in better solutions to management issues.

Members of the public often express concerns about a highly visible problem, yet this issue may not be the most important problem for the Management Conference to consider. In fact, spending resources on a highly visible but relatively insignificant problem could divert attention from a crucial matter. It is imperative, therefore, that scientific findings be widely communicated and form the basis for public education efforts.

Faced with diverse constituencies, each with a different idea of what constitutes a monitoring program appropriate for Santa Monica Bay, the Santa Monica Restoration Program held a two-day consensus-building conference for scientists, managers, dischargers, regulators, and public interest group representa-tives. The conference goal was to outline monitoring objectives that would guide the development of detailed hypotheses and sampling and analysis plans. Conference participants were led through a set of structured exercises that focused on the overall concerns driving the regulatory/monitoring system, agreement on a monitoring philosophy for the bay, and a determination of which bay resources were the most highly valued. These exercises were followed by a decision-making process through which specific monitoring objectives were developed. The selected objectives reflected and harmonized management goals, scientific knowledge, and public concerns.

Every estuary program in the NEP has a public participation and education component. Solutions to pollution problems are grounded in scientific information, but protection of habitats and commitments to action are dependent upon public education. Through education and participation, the public gains an understanding of the estuary and its problems, the will to act to solve immediate problems, and the desire to be stewards of the ecosystem for the future.

Priority Concerns

The public, in partnership with scientists and government managers, is facing enormous challenges, especially since coastal population growth is expected to continue to increase well into the 21st century. To protect our coastal resources, this growth will need to be much better managed in the future. Critical management areas that must be addressed include, among others, general growth and development, nonpoint sources, and natural habitats.

Growth and Development

Coastal population growth and development patterns are causing the disruption of the natural processes of coastal ecosystems and threatening both the ecological and economic values of estuaries. As we approach the year 2000, we must continue to use and improve conventional pollution

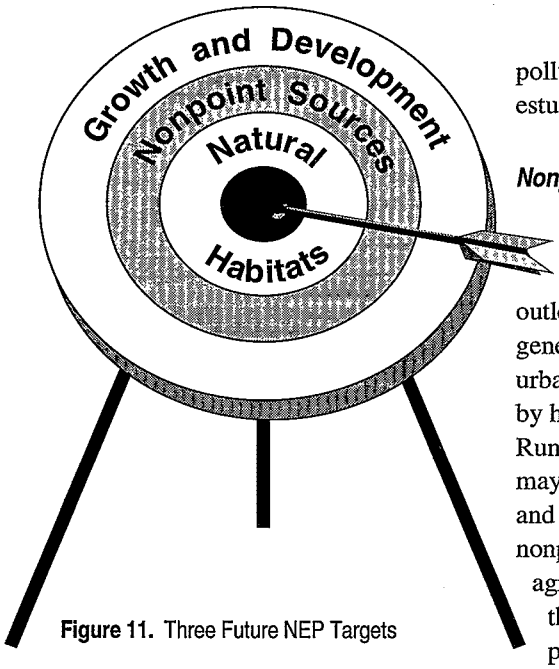


Figure 11. Three Future NEP Targets

controls and to accelerate enforcement actions as needed. However, new strategies are required to solve the more complex problems brought about by increasing pressure to develop land in rural areas and in sensitive and pristine areas.

As land development takes place, forested lands and wetlands and other vegetative covered places are often stripped away, leaving the land bare, without protection from erosion. Furthermore, as concrete and other nonporous surfaces cover the land, there is less opportunity for rainwater to seep into the ground and replenish ground water. Without wetlands and forests, stormwater carries pollutants directly into our waterways. Development near shorelines often damages life-sustaining habitats of shore birds and animals. It also increases sedimentation in shallow water, choking underwater grasses and threatening fish and shellfish habitats. Looking ahead, two of the major challenges facing the NEP are controlling nonpoint, or diffuse, pollution sources and protecting estuarine habitats.

Nonpoint Source Control

Nonpoint sources are diffuse pollution sources that do not have a single point or discharge outlet, like a pipe. The pollutants are generally washed off the land and urban and suburban streets and roads by heavy rains and melting snow. Runoff from agricultural land, which may carry soil, pesticides, fertilizers, and manure, is a prime example of a nonpoint source. Reducing agricultural nonpoint source pollution through changes in farming practices, more efficient use of fertilizers and better irrigation practices, and reduced reliance on environmentally harmful pesticides remains a challenge.

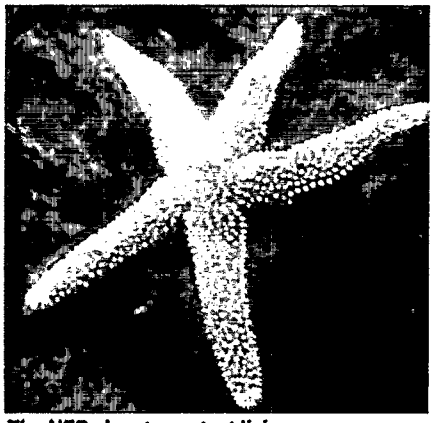
Currently, voluntary management practices are being used to control diffuse sources from both urban and agricultural sites. In some areas, state and local governments have issued regulations requiring that these practices be used. Section 319 of the Clean Water Act provides funding for some of these nonpoint source control projects.

Recent amendments to the Coastal Zone Management Act (CZMA) require states with federally approved coastal zone management programs to develop nonpoint source pollution control programs in coastal areas. These programs will bring together for the first time authorities and capabilities within state coastal zone management and nonpoint source control agencies to address the problem of coastal nonpoint source pollution. In consultation with NOAA and other federal agencies, EPA proposed guidelines in May 1991 specifying measures to be used by states to control nonpoint source pollution of coastal waters. In October 1991, EPA and NOAA jointly proposed additional guidelines to further help states develop these programs; final guidelines are expected to be issued in 1992. The new coastal nonpoint source pollution control programs will be developed and implemented through existing state coastal zone management programs administered by NOAA under section 306 of the CZMA and through existing state nonpoint source control management programs under Section 319 of the Clean Water Act.

New EPA regulations will require urban storm drainage systems and runoff from various industrial and commercial sites to be permitted under the NPDES program. The rule applies to 173 cities and 47 urbanized counties with populations of 100,000 or more, plus some smaller cities that use the storm sewer systems of these jurisdictions. It also applies to industries that discharge stormwater runoff into municipal storm sewers or directly into waterways. The regulation provides a mechanism for stopping illegal connections to storm drains. While many communities have already acted to check urban stormwater runoff, the new requirements are expected to further reduce this pollution source.

Habitat Protection

As growing human populations encroach upon sensitive habitats like wetlands, NEP projects have begun to address habitat protection. Many questions about the relationships among pollutant concentrations, habitat, and living resources are still unanswered. Estuary projects are



Bob Bachand

The NEP aims to protect living resources.

beginning to look beyond traditional approaches toward strategies that address total estuarine ecosystem health. These strategies are considering the protection of living resources and their habitats and are trying to understand how ecosystems function. Long-term strategies like these require the further coordination of research and monitoring activities of EPA and NOAA with those of individual NEP projects and with the efforts of marine academic institutions.

While long-term strategies are being developed, Management Conferences are acting locally to address immediate threats to estuarine habitats. For example, they are limiting fish harvesting, replanting underwater grasses, seeking building restrictions like setbacks, creating land conservation areas, planning construction projects to minimize erosion, sparing or replanting trees, protecting and restoring wetlands, stabilizing shorelines, and curbing harmful uses of waterways. Such efforts are not yet occurring in all areas, however, and will likely be more widely practiced in the future.

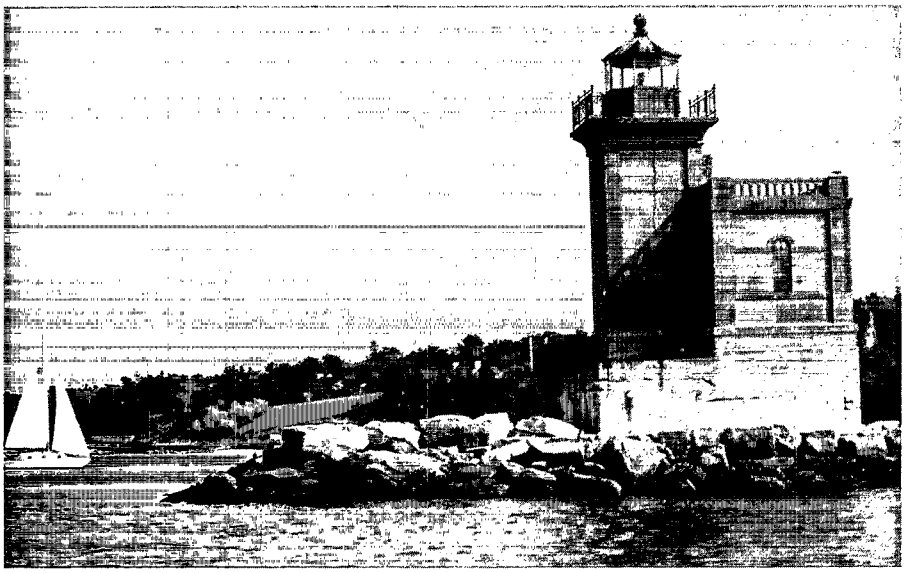
Management Conferences will need to work even more closely with agencies such as the Fish and Wildlife Service and Corps of Engineers to better understand and mitigate some of these problems and to develop and expand new technologies. Stabilizing shorelines using grasses instead of bulkheads, removing dams blocking fish migrations, creating new wetlands, eliminating freshwater diversions, and developing aquaculture projects are some examples of activities expected to be expanded in the future.

Steps in the Right Direction

The NEP moves forward with the recognition that it has a long way to go in meeting Congress' directive to restore and protect estuaries of national significance. Completely fulfilling this charge will take a long time—probably decades.

In the short term, however, many important steps have been taken, and many more are under way. Each estuary project in the NEP is focusing on the key environmental problems in the estuary; integrating efforts with other federal, state, and local programs; considering air and land pollution sources, as well as controlling direct water discharges; developing restoration and protection strategies; and fostering stewardship of estuarine ecosystems.

These accomplishments are just some of the fruits of the NEP's first four years. The following section provides details of the progress being made in each of the 17 NEP projects.



Lloyd's Neck Lighthouse.

PartVI

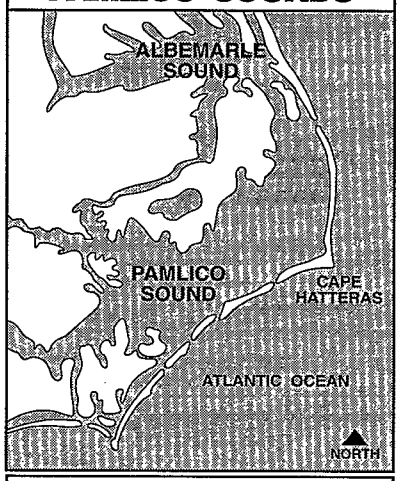
Moving Ahead: The NEP Projects

The Seventeen NEP Projects

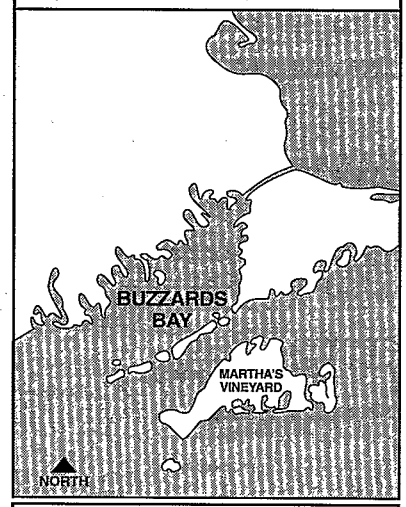
The 17 estuaries are at various stages between initiation and completion. Tier 1 Management Conferences were convened by June 1988. They include estuary projects in Albemarle-Pamlico Sounds, Buzzards Bay, Long Island Sound, Narragansett Bay, Puget Sound, and San Francisco Estuary. The Puget Sound Estuary Program and the Buzzards Bay Project have submitted their final CCMPs to the EPA Administrator. Tier 2 projects include additional estuaries: Delaware Estuary, Delaware Inland Bays, Galveston Bay, New York-New Jersey Harbor, Santa Monica Bay, and Sarasota Bay. Tier 3 Management Conferences are the most recent additions to the NEP. Following are descriptions and progress reports on all 17 NEP Projects.

Tier 1

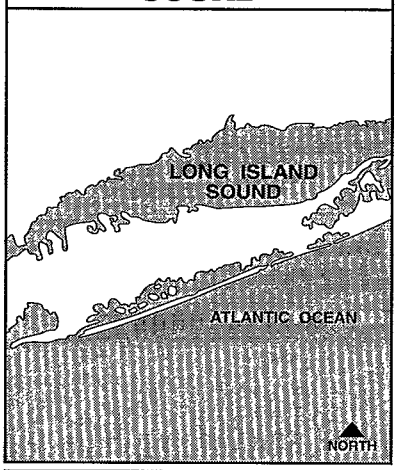
ALBEMARLE-PAMLICO SOUNDS



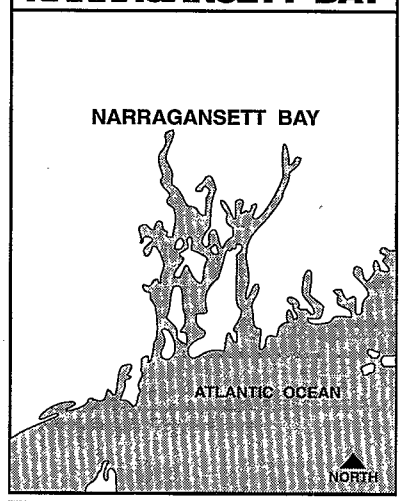
BUZZARDS BAY



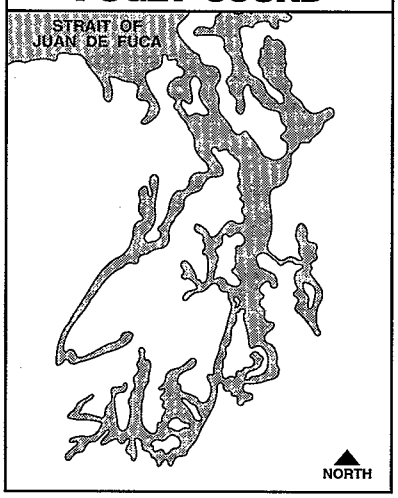
LONG ISLAND SOUND



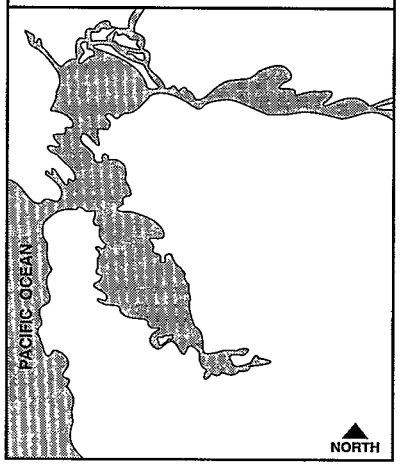
NARRAGANSETT BAY

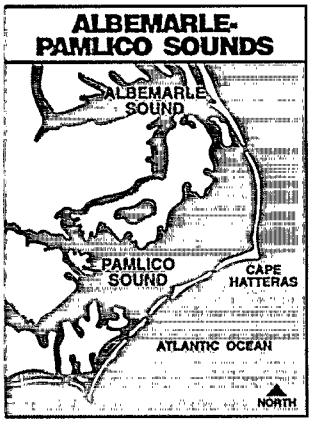


PUGET SOUND



SAN FRANCISCO ESTUARY





Albemarle-Pamlico Sounds

Introduction

The Albemarle-Pamlico Sounds of North Carolina form the second largest estuarine complex in the United States and the third largest in North America. Spectacular surroundings and abundant wildlife are major attractions for hunters and nature lovers. For instance, snow geese, tundra swans, and sea ducks winter in the estuary's varied habitat. Many fur-bearing animals also live here, including river otter, raccoon, mink, muskrat, opossum, and nutria. Revenues from estuary-related activities such as fishing, tourism, recreation, and resort development are expanding. In the next few years, tourism will probably surpass the textile, furniture, and tobacco industries in regional economic importance. Ten percent of the local workforce is presently in the business of directly serving tourists. Boat registrations are also indicators of increased usage of coastal waters. Between 1970 and 1984, the number of registered boats in the Albemarle-Pamlico Sounds increased 155 percent; between 1970 and 1991, the number of marinas increased almost 300 percent.

Significant agricultural and industrial activities also take place here. Agricultural development in the region generates $1.5 billion annually. Counties neighboring the Albemarle-Pamlico Sounds contain 45 percent of the state's cropland and contribute 50 and 40 percent of the state's swine and chicken production, respectively. North Carolina's extensive phosphate reserves are an important resource for international fertilizer markets, and one phosphate mine is located beside estuary waters. The U.S. Department of Defense greatly influences the area, with 19 facilities occupying 97,000 acres near the estuary.

Chief Threats to the Albemarle-Pamlico Sounds

Signs of environmental stress in the Albemarle-Pamlico Sounds are not hard to find. Widespread blooms of noxious blue-green algae in the Chowan River occurred in 1972, 1978, 1983, and 1987. There are now 21,600 acres of productive shellfish waters closed to harvest in North Carolina. Striped bass, shad, and river herring fisheries collapsed in the mid-1970s, and outbreaks of fish and crab disease have affected other commercially important species as well.

Various types of pollutants are directly or indirectly responsible for the situations mentioned above. Algal blooms are caused by excess nutrients in the estuary. The blooms contribute to a loss of dissolved oxygen in estuarine waters, harming fish and other marine life. Nitrogen and phosphate (found in fertilizers), as well as human and animal wastes, are the primary contributors of nutrients to the Albemarle-Pamlico Sounds. Agricultural runoff into the sounds carries fertilizer and animal waste from nearby farms. In addition, the sounds receive direct discharges of nutrients associated with a phosphate mining and processing facility and numerous municipal wastewater discharges.

Studies suggest that several fish and crab diseases are related to poor water quality. Although toxic contamination is not yet a systemwide problem, several potential sources of toxics cause concern, including a metal-plating operation on the Neuse

River; textile manufacturing on the Pamlico, Roanoke, Chowan, and Neuse Rivers; pulp and paper manufacturing on the Roanoke, Chowan, and Neuse Rivers; and Department of Defense activities at Cherry Point Marine Air Station.

Another well-known water quality problem threatening marine life is bacterial contamination. Bacteria from agricultural runoff and sewage treatment plant discharges have forced shellfish beds to close.

Construction projects and channel maintenance that dig up sediments or fill in marshes and other parts of the estuary can disrupt reproduction, migration, and feeding patterns for many animals.

A last threat to fish populations in the sounds is increased fishing pressure. The recreational catch probably exceeds the commercial catch for bluefish, spotted seatrout, red drum, and Spanish mackerel. This direct competition for fishery resources is greatly attributed to fishing gear usage. Since 1980, 53 percent of commercially licensed vessels have actually been pleasure vessels allowed to use commercial gear to take fish for personal consumption.

The Albemarle-Pamlico Estuarine Study

The Albemarle-Pamlico Estuarine Study (APES) was formally accepted into the NEP in 1987. Municipal and state government, academic institutions, Congress, citizen groups, and several federal agencies are represented on the Policy Committee. Public participation is an essential part of the study, and activities such as local leadership development workshops, presentations to local governments, and public meetings that include tours of APES-funded projects have been very successful.

APES has completed its characterization report and is developing a draft CCMP. A final CCMP is due November 1992.

Priority Problems

APES formulated an extensive list of environmental concerns, which can be grouped into the following priority issues:

- ☐ declines in fisheries productivity
- ☐ health of aquatic resources
- ☐ impairment of nursery area function
- ☐ eutrophication
- ☐ anoxia-related fish kills
- ☐ habitat loss
- ☐ shellfish closures
- ☐ changes in distribution of bottom dwelling organisms

Scientific Research

The Albemarle-Pamlico Estuarine Study funded 18 technical projects in fiscal year 1990. The projects addressed fishery, water quality, habitat, and human environment issues. One set of investigations identified five distinct nursery ground habitats. This information could lead to recommendations for extending the boundaries of primary nursery areas and improved monitoring of their functional and geographic integrity. Blue crab and fish diseases such as ulcerative mycosis have also been studied.

APES-sponsored studies provide information that influences management decisions. Assessments of marine fish stocks guided the North Carolina Division of Marine Fisheries in formulating management goals. In addition, an analysis of development patterns around the estuary is helping APES set regional priorities for resource protection. Fifteen research projects were funded in fiscal year

Paul Nurnberg, 1990

Learning from generation to generation.

1991, five of which are continuations of 1990 projects.

Monitoring

A 1988 monitoring plan expanded the state's baseline monitoring within the Albemarle-Pamlico Sounds area. The goals of this plan are to evaluate long-term trends and assess the effectiveness of improved management actions. The plan was revised in June 1989 and now includes seven components to achieve the two stated goals. The seven components include implementation of a citizens' water quality monitoring program with more than 60 monitors, development of emergency response capabilities to chronicle episodic events, expansion of existing Division of Environmental Management ambient water quality sites from 74 to 99 sites along with continuous monitoring of 37 open water sites maintained by the U.S. Geological Survey, a survey of fish tissue and sediment toxicants, a one-time synoptic basinwide water quality study, and measurements of sediment oxygen demand in critical areas.

Investigations and monitoring of water and sediment quality in the past several years have produced valuable information. This work has documented that low dissolved oxygen water masses can occur and dissipate very rapidly during a 24-hour period. Nitrogen plays the major role in algal growth, but phosphorus is more important at some times of the year. Sediment samples show that sediments in the Pamlico and Neuse River Estuarine Systems in the vicinity of known point source discharges have specific trace metal enrichment levels greater than 100 times higher than sediment samples from other sites. These investigations have significantly increased scientists' knowledge of toxicants in the estuary. Study findings have caused 10 sites in the Pamlico River and 17 sites in the Neuse River to be suggested as "areas of concern" because of heavy metal concentrations.

Melva O'Keen, 1989

Television programs help the public protect the sounds.

Management Tools

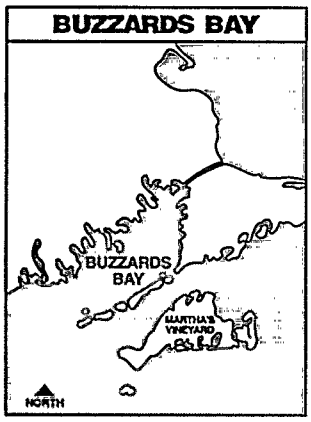
APES is reviewing and implementing improved mechanisms that address both point and nonpoint sources of nutrients entering the Albemarle-Pamlico Sounds. The North Carolina Division of Environmental Management (DEM) has proposed several regulatory measures to reduce point source pollution. One measure is a compliance order to greatly reduce discharges by renovating the phosphate mining and processing facility on the Pamlico River. Others include continued statewide phosphate detergent bans, limits on nutrients in water treatment plant discharges, and comprehensive basinwide permitting and pollution control.

As nutrient limits on point source discharges are implemented, most nutrients will enter the estuary from nonpoint sources such as agricultural runoff. An APES-sponsored project in the Merchants Millpond watershed demonstrates the type of coordinated effort needed to address problems of nonpoint source pollution. This watershed is within the Chowan River basin, where the need for improvements in animal waste management has been known but poorly addressed. The Gates County Soil and Water District is working with the Division of Soil and Water Conservation to offer cost-share funds to farmers in the area who want to implement best management practices (BMPs). In the long run, BMPs such as proper waste management, sediment control, and erosion control save money as well as reduce nutrient runoff, but there are initial set-up expenses. Seventy-five percent of these

expenses are defrayed by the cost-sharing program. The project also provides technical assistance in implementing the BMPs. To date, results of this project include four waste management systems and eight stream protection systems that have been installed as alternatives to traditional free-ranging livestock methods. These systems serve as educational demonstrations for other farmers, and monitoring will indicate what impact the systems have on the amount of nutrients entering Merchants Millpond.

As part of a pilot project, an urban stormwater detention basin will receive runoff from 200 acres of downtown Greenville, North Carolina, and will reduce the amount of nutrients, heavy metals, and sediment that reach the Tar River. This area is typical, both geographically and culturally, of a number of other small cities within the Albemarle-Pamlico Sounds area. This type of BMP for developed areas should therefore have widespread applicability.

In an effort to alleviate wetlands loss, APES is also sponsoring a marsh construction project. Building inexpensive breakwaters and planting marsh grass will provide vital habitat, prevent erosion, and filter pollutants. The breakwaters will be low enough so that they are not destroyed in severe storms and do not affect water quality, but high enough to buffer eroded shorelines from damaging wave action and protect marsh grass planted behind them. The marsh, in turn, will increase estuarine habitat while further reducing shoreline erosion. APES will share construction costs with each landowner, each of whom will allow periodic access to the project for public education purposes. Landowners and contractors will perform the construction themselves, building local conservation skills and broadening public knowledge about the project.



Buzzards Bay

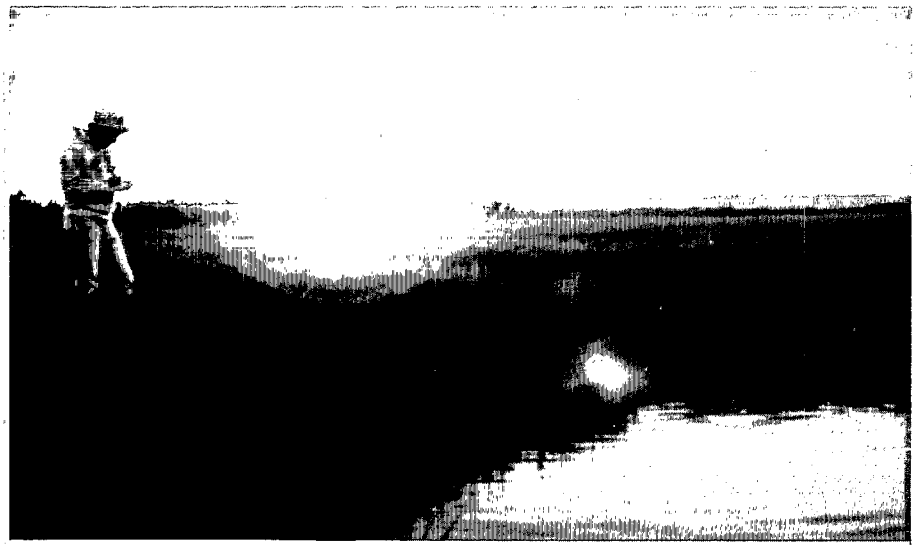
Introduction

Buzzards Bay is bounded by the western edge of Cape Cod, southeastern Massachusetts, and the Elizabeth Islands. The bay has a 426-square-mile drainage basin that includes 233,000 inhabitants in four counties. One of these, Barnstable County, is the fastest-growing county in New England. Many local residents are employed by the commercial fishing, shellfishing, and lobstering industries. In 1988, the commercial shellfish harvest alone was worth $4.5 million. The bay also serves as a crucial transit route for the New Bedford fishing fleet and for shipping through the Cape Cod Canal. Nearly 20,000 vessels pass through Cape Cod Canal yearly, and during the summer over 10,000 boats anchor in Buzzards Bay. The bay's ragged coastline attracts thousands of tourists who enjoy fishing, boating, and swimming along the shore. Home to a unique mix of semitropical and arcadian species including harbor seals, ospreys (called buzzards by the colonists), and roseate terns, the area offers many research opportunities for local laboratories and academic institutions.

Chief Threats to Buzzards Bay

A legacy of industrial pollution from New Bedford Harbor, coupled with current development activities and the bay's poor flushing capabilities, create pollution problems in Buzzards Bay. Conflicting uses of the bay exacerbate these problems. For example, the same harbor or embayment is often used for swimming and harvesting shellfish, as well as for discharging industrial and residential wastewater.

Over 37 million gallons of sanitary waste are discharged from sewage treatment plants into the bay each day. This waste is a primary source of disease-causing bacteria and viruses (pathogens). Other sources of pathogens include sewage discharges from boats, failing residential cesspools and septic systems, and stormwater runoff from urban and agricultural areas. As of April 1990, 13,200 acres of shellfish areas were closed due to pathogen contamination.



Buzzards Bay at sunset.

Toxic contamination from PCBs, PAHs, pesticides, and trace metals is also beginning to affect marine organisms and the food chain. Osprey populations decreased 50 percent during the 1940s and 1950s because of DDT-related reproductive failure. Today, 18,000 acres around New Bedford Harbor are closed to lobstering, finfishing, and shellfishing because of high PCB levels. Some samples from outside New Bedford Harbor also show PCB levels that are dangerously close to Food and Drug Administration limits. Toxic contamination comes from a variety of sources including industrial discharges, boat paints, oil spills, atmospheric transport, and pesticides in stormwater runoff.

Septic systems, sewage treatment facilities, and runoff contribute nutrients as well as pathogens. Excess nutrients cause algae to thrive, preventing sunlight from reaching important submerged eelgrass habitat. Moreover, the death and decay of algae causes hypoxia—reduced amounts of dissolved oxygen in the water that can harm fish and other marine organisms. Although good circulation in Buzzards Bay has prevented severe hypoxia, several highly developed areas are showing signs of excessive nutrient loading.

The Buzzards Bay Project

One of the first estuary protection programs in the country, the Buzzards Bay Project (BBP) began in 1985 under the joint management of EPA and the Massachusetts Executive Office of Environmental Affairs (EOEA). In January 1988, the project joined the NEP. The Buzzards Bay Project is administered by the Massachusetts Office of Coastal Zone Management (MCZM) in conjunction with EPA Region I. Its final CCMP was submitted in November 1991.

Coastsweep Cleanup.

Priority Problems

Based on studies and results from prior research and scientific investigations, the Management Conference, through a consensus-building process, identified three priority problems in Buzzards Bay:

- pathogen contamination
- toxic contamination
- increasing nitrogen

Scientific Research

In 1985, the Buzzards Bay Project began collecting and evaluating historical information; conducting baywide surveys of water, sediment, and biota quality; and investigating relationships between land use practices, nutrient enrichment, and the closure of shellfish beds. Between 1985 and 1989, the project funded a number of studies to assess and characterize existing conditions in the bay, including the status of water quality, sediments, and living resources. The Massachusetts Division of Marine Fisheries recently completed surveys in Buzzards Bay under the Shellfish Sanitation Program to identify various discharge pipes and their contribution of fecal coliforms to the bay.

Monitoring

Continued monitoring of water quality, sediment quality, and living resources is necessary to determine whether management actions are successful. However, future monitoring must be carried out with existing resources because new funds are limited. The project has completed a draft monitoring plan that will be implemented beginning in 1991. The plan will assess effects of specific management actions, determine trends in environmental quality, and detect early signs of changes that could harm important living resources. To conserve funds, monitoring efforts of the Massachusetts Department of Environmental Protection and the

Division of Marine Fisheries will be coordinated with needs and goals stated in the CCMP. In addition, the Buzzards Bay Project and EOEA will jointly design and implement a marine data management system to organize monitoring program information.

Management Tools

The Buzzards Bay Project is initiating a program that addresses pathogen pollution from septic systems and marine craft discharges. This program utilizes several management tools including public education, community training, analysis of existing regulations, and implementation of best management practices.

In summer 1990, the Barnstable County Health and Environmental Department developed a manual that educates local communities about the environmental advantages of proper siting of septic systems. Activities and workshops are providing follow-up explanation and information about implementing septic system regulations to ensure effectiveness.

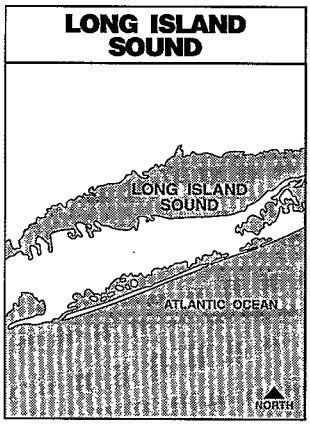
The program is also training residents and boaters about proper disposal and control of sewage and other marine craft wastes. The training addresses topics such as effective operation and maintenance of septic systems and pump-out facilities, procedures for pumping and hauling, and financing management operations. In a related effort, Massachusetts Coastal Zone Management (MCZM) staff will work with a selected marina to provide a pump-out facility and ensure its usage through education and enforcement. MCZM staff will also provide mobile pump-out facilities to several towns that will develop management plans to direct their use. These areas will then be proposed to EPA as no-discharge zones.

Finally, the program is investigating the effectiveness of biologically pretreating septage, boat wastes, and leachate in a solar greenhouse before discharging it to a sewage treatment plant. Constructed wetlands and selected plants, animals, algae, and bacteria will be used to cleanse the waste stream before discharge.

To further address human-related nitrogen additions that are overwhelming coastal embayments, the Buzzards Bay Project developed a comprehensive strategy for managing human nitrogen inputs to the Buttermilk Bay drainage basin. Recently adopted by the three towns surrounding the embayment—Plymouth, Bourne, and Wareham—the Buttermilk Bay Nitrogen Management Strategy is composed of four major steps:

1. Delineation of the drainage area;
2. Calculation of the nitrogen contribution from existing development including "grandfathered" lots within the drainage basin;
3. Calculation of the potential additional nitrogen contributions under existing zoning within the drainage basin; and
4. Comparison of the total nitrogen contribution from steps 2 and 3 with the acceptable contribution limit of 115,617 pounds per year.

This effort by the Buzzards Bay Program is the first nitrogen management strategy of its kind in the nation.



Long Island Sound

Introduction

Long Island Sound, bordered on the north by Connecticut, and on the south by Long Island, New York, lies within the most densely populated region of the United States. The sound, 110 miles long, stretches westward from the Race to the East River. More than 14.5 million people live in counties directly bordering the sound. Shipping, transportation, recreation, fishing, and dredged material disposal all take place here. A total of 600 miles of coastline, including 248 miles of beaches, attract swimmers, boaters, and nature enthusiasts. Six million people visited state-owned beaches in 1988. With over 200,000 vessels, Long Island Sound is home to one of the largest fleets of recreational boats of any coastal body in the world. In addition, over 750,000 recreational fishermen are registered in the Long Island Sound area. In 1987, sport fisheries were worth $70 to $130 million, and commercial fisheries were worth $36 to $40 million.

Chief Threats to Long Island Sound

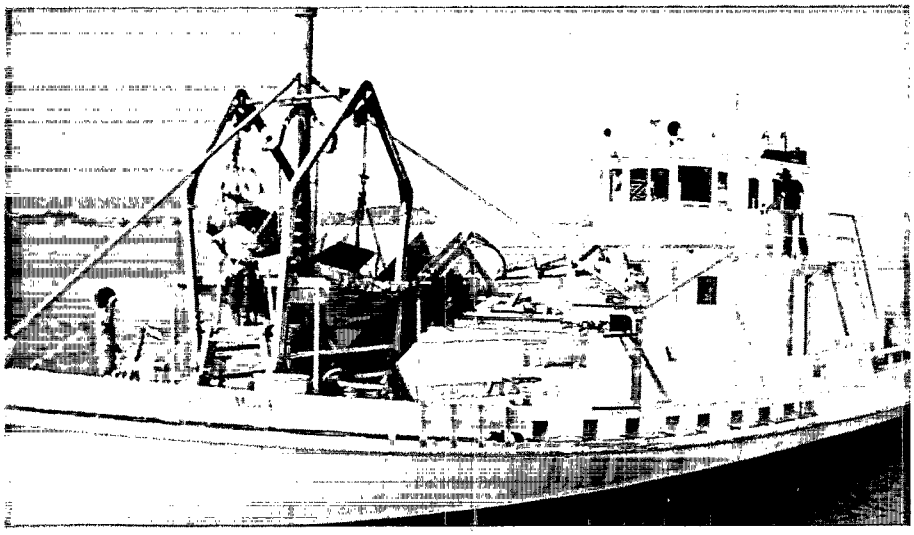
Hypoxia, or low levels of dissolved oxygen in the water, is the primary concern in Long Island Sound. Though the sound has experienced some hypoxia in the past, there is evidence that suggests oxygen levels might have dropped further in recent years. In 1987, for example, certain areas of the sound were completely without oxygen. Stormwater runoff, atmospheric deposition, and sewage treatment plant discharges bring nutrients such as nitrogen and phosphorus into the sound. Studies have shown that nitrogen is the nutrient most directly linked to low oxygen conditions. Long Island Sound has experienced numerous fish kills and migrations due to hypoxia, which is particularly severe in the western portion of the sound. In 1987, hypoxic conditions reduced the total catch of finfish in the western sound by 56 percent from 1986.

Toxic and pathogen contamination are also problems in Long Island Sound. Toxic substances are carried into the sound by stormwater runoff, sewage treatment plants, and atmospheric deposition. These toxic substances come from metals, pesticides, industry or household chemicals, and petroleum compounds. Some liver damage in winter flounder is attributed to toxic contamination. Sewage discharges from New York City and the surrounding area contribute to the pathogen problem. High levels of fecal coliforms, indicating pathogen contamination, periodically close beaches in Mamaroneck Harbor.

Although human inputs, particularly discharges from treatment plants, are the major cause of Long Island Sound's pollution problems, nature plays a role as well. Natural currents through the East River carry pollutants, including sewage discharge and floatable wastes, into Long Island Sound from New York-New Jersey Harbor. Upper layers of polluted water flow in from the harbor, while lower, cleaner water layers flow out from the sound.

The Long Island Sound Study

The Long Island Sound Study (LISS) began in 1985 when Congress asked EPA, in cooperation with the states of Connecticut and New York, to sponsor a study of the estuary. LISS officially became part of the NEP in 1987. The LISS Policy Committee has overall



LISS is trying to protect the oystering industry.

responsibility for the study, including approval of goals and the CCMP. The committee includes the Regional Administrators from EPA Regions I and II, the New York State Commissioner of Environmental Conservation, and the Connecticut Commissioner of Environmental Protection. The Management Committee, Technical Advisory Committee, and Citizens Advisory Committee include participants from federal agencies such as NOAA and the Army Corps of Engineers, as well as from state and local agencies, academic institutions, local governments, and various citizen groups.

In November 1990, the LISS Policy Committee approved release of a status report announcing interim actions for hypoxia management. The plan identifies five immediate management actions to be undertaken by the appropriate agencies of New York and Connecticut. Recommended actions include completing renovations and construction necessary for all municipal facilities in the LISS study area to meet existing state and federal standards for secondary treatment levels; implementing a "no net increase" policy for nitrogen by prohibiting increases in current nitrogen loadings from point source discharges; providing technical and financial assistance to encourage existing facilities to retrofit their plants for biological nutrient removal; planning for potential nutrient controls in additional portions of the sound's tributary drainage areas and verifying actual nutrient loadings; and planning for long-term reductions in nitrogen loadings by documenting the degree of nitrogen removal that can be achieved at affected facilities.

LISS is proceeding with interim actions that will prevent increases in nitrogen loading to the sound while planning for long-term nitrogen reductions. Specifically, the states of New York and Connecticut, along with EPA, have agreed to prevent increases in point source discharges by capping them at 1990 levels. Plans and recommendations aimed at achieving no-net-increase in nonpoint sources of nitrogen are being developed.

Characterization reports on toxic materials, pathogens, and floatable debris have been completed. The CCMP is due to EPA in 1993.

Priority Problems

The following priority concerns were identified for Long Island Sound by the LISS Management Conference:

- ☐ hypoxia
- ☐ toxic contamination
- ☐ pathogens
- ☐ floatable debris
- ☐ living marine resources

Scientific Research

LISS has developed a complex computer model to identify the limiting nutrient, the causes of decreased oxygen levels, the extent to which the problem is caused by human activities, the likelihood that the problem will worsen, and the nature of possible solutions. This model actually consists of coupled water quality and hydrodynamic models of the sound. The water quality model describes relationships between carbon, nutrients, phytoplankton populations, and dissolved oxygen concentrations. It calculates variations in water quality along the length of the sound and vertically according to depth. Preliminary results indicate that almost 75 percent of the decrease in dissolved oxygen in the western narrows, the most threatened location in the sound, results from nutrient inputs, specifically nitrogen. The model also suggests that lowering nitrogen inputs could increase levels of dissolved oxygen enough to alleviate hypoxia, although improvements will not be apparent for some time.

The hydrodynamic model is being developed by NOAA to mathematically describe circulation of water in the sound. With information generated by the coupled model, LISS will be able to identify the most important sources of nutrients, target cleanup funds where they will have the greatest impact, and develop recommendations for the CCMP. Both models are based on actual field data and are refined according to new monitoring information.

Major sites of oxygen depletion are also the subject of scientific research. The University of Connecticut's Marine Sciences Institute is studying processes in the surface, intermediate, and lower water levels and their effect on net amounts of dissolved oxygen. The State University of New York's Marine Sciences Research Center is examining the uptake of oxygen by sediments due to the decay of organic matter.

Another critical research effort will characterize the principal living marine resources of the sound, their habitats, and the effects of hypoxia and other water quality problems on their health. This information is needed to evaluate the likely benefits from improved dissolved oxygen levels.

Monitoring

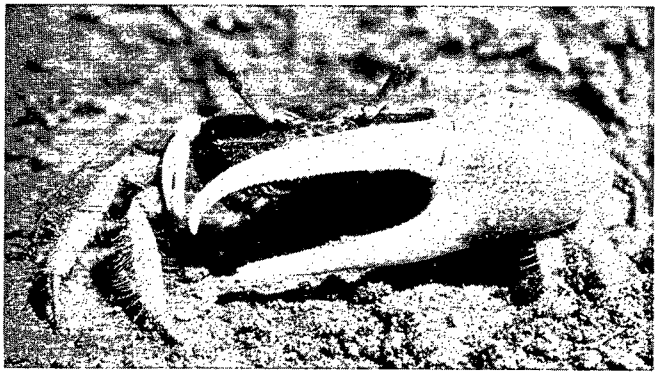
Many monitoring activities in Long Island Sound are related to the hypoxia problem. Since 1986, LISS has conducted a comprehensive field program to provide data for the computer models described previously. The program has measured water quality, production and use of oxygen in the water column and sediments, waste input, and water movement. The Connecticut Department of Environmental Protection and the New York State Department of Environmental Conservation monitor effluents at sewage treatment plants that discharge to the sound, testing for nitrogen and phosphorus.

The presence of toxic and pathogenic contaminants is also monitored in the sound. NOAA has measured concentrations of more than 70 toxic contaminants throughout Long Island Sound since 1984. NOAA's National Status and Trends Program for Marine Environmental Quality has two projects that measure levels of contaminants in various biological tissues at several sites and depths in the sound. In the eastern basin each fall, the Benthic Surveillance Project monitors contaminants in the livers of winter flounder and examines the food in their stomachs. Also in the fall, the Mussel Watch Project measures contaminant concentrations in blue mussels at ten sites.

Management Tools

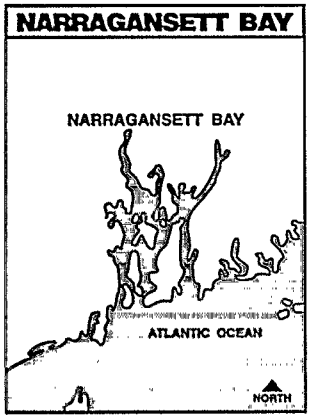
Deteriorated sanitary sewer systems and stormwater runoff are the major sources of bacteria and other pathogens entering Long Island Sound after rainstorms. As part of a demonstration project in Mamaroneck Harbor, New York, LISS is trying to find out how much pathogen contamination comes exclusively from stormwater runoff. This information will help permit writers to establish safe bacterial limits for stormwater discharges.

Two other demonstration programs are testing management tools to improve dissolved oxygen levels in Long Island Sound by reducing nutrient discharges. The Housatonic River is the second-largest river draining into the sound, carrying thousands of tons of nitrogen and other nutrients. Many of these nutrients are washed into the river from fertilized crop fields. The first demonstration program has targeted 27 farms in the Housatonic watershed to reduce fertilizer loss into runoff waters. Farmers will work with the Department of Agriculture's Soil Conservation Service and the Cooperative Extension Service to implement techniques such as concrete manure pits and contour plowing. A second program is testing biological nutrient removal systems that remove nutrients from wastewater. Low-cost retrofitted devices have been installed in New York City's Tallman Island treatment plant and the Stamford, Connecticut, treatment plant. While conventional treatment processes remove 5 to 20 percent of total nitrogen and phosphorus, previous testing indicates that biological nutrient removal will remove as much as 75 percent.



Bob Bachand

Sand fiddler.



Narragansett Bay

Introduction

Narragansett Bay, which lies in the heart of Rhode Island, is composed of three drowned river valleys. The bay is fed by five major rivers that drain 1,849 square miles of land including the urban centers of Providence, Rhode Island; Worcester, Massachusetts; and Fall River, Massachusetts. These water bodies together provide a playground, workplace, wildlife habitat, highway, and dumping ground for local residents. Bay-related activities contribute significantly to the regional economy. Pleasure boating was a $64 million business in 1987, and tourism generated $1.4 billion in 1989. The total value (primary and secondary) of quahogs harvested in 1989 was over $70 million. Revenues from other commercial fisheries in 1989 were valued at $28 million. Historically a center of industrial activity, the bay still supports various types of manufacturing businesses. The bay is also a haven for local wildlife populations, providing a winter home for harbor seals and a habitat for over 100 species of fish and 20 kinds of shore birds.

Chief Threats to Narragansett Bay

Analysis of sediment layers gives insight into the history of pollution problems in Narragansett Bay. Bacterial (pathogen) contamination began around 1750 as the area became increasingly urbanized. The presence of toxic metals increased in the mid-1800s, coinciding with the Industrial Revolution, while toxic organic chemical pollution became prominent in the early 1900s due to rising petroleum use. Today, these three classes of contaminants still cause concern.

By the year 2010, Rhode Island's population is expected to grow by 10 percent. Of this growth, 47 percent is predicted to occur in coastal cities and towns. Continued development forced by this growth will increase strain on the state's sewage disposal systems. During a rainfall, existing sewage treatment plants cannot handle the volume of stormwater that is added to the normal sewage loads. The system releases a mixture of untreated sewage and polluted stormwater into the estuary from more than 100 combined sewer overflows. These discharges may contain pathogens that accumulate in bottom-feeding animals, like clams, causing disease when ingested raw by humans. Today, up to 40 percent of bay shellfish beds and several beaches are periodically closed due to sewage contamination.

The Blackstone River corridor is a prime source of contaminated "in place" sediments from 19th- and 20th-century textile, dye-works, and metal finishing industries. These sediments are eroded during high river flow, resuspending trace metals and other pollutants harmful to marine life and humans. In addition, Worcester, Fall River, Woonsocket, and Providence are still centers of industry and manufacturing. Some companies in these cities continue to discharge wastes directly into the estuary; many sites contain wastes that are not adequately stored, resulting in seepage into ground water that eventually passes into the bay. This industrial waste often contains trace metals and organic chemical residues. Data from 1985 through 1989 showed that concentrations of nickel and copper in the Seekonk and Providence Rivers exceeded EPA and Rhode Island water quality standards. Data from 1986 and 1989 showed that concentrations of

lead, nickel, copper, cadmium, chromium, and PCBs in the Blackstone River beginning at the state line exceeded water quality criteria.

Stormwater runoff from urban areas carries motor oil, pesticides, and combustion by-products into the estuary. These and other materials contain toxic organic pollutants such as PAHs and PCBs. Riverine runoff is the primary source of PCBs. Toxic organic pollutants cause reproduction problems in invertebrates, fishes, and birds, as well as a broad spectrum of health problems in humans. Although production of PCBs was banned in 1979, PCBs remain a problem since they persist in the environment and can accumulate in animal tissues. PCBs in the Blackstone and Woonasquatucket Rivers also currently exceed EPA and Rhode Island water quality standards.

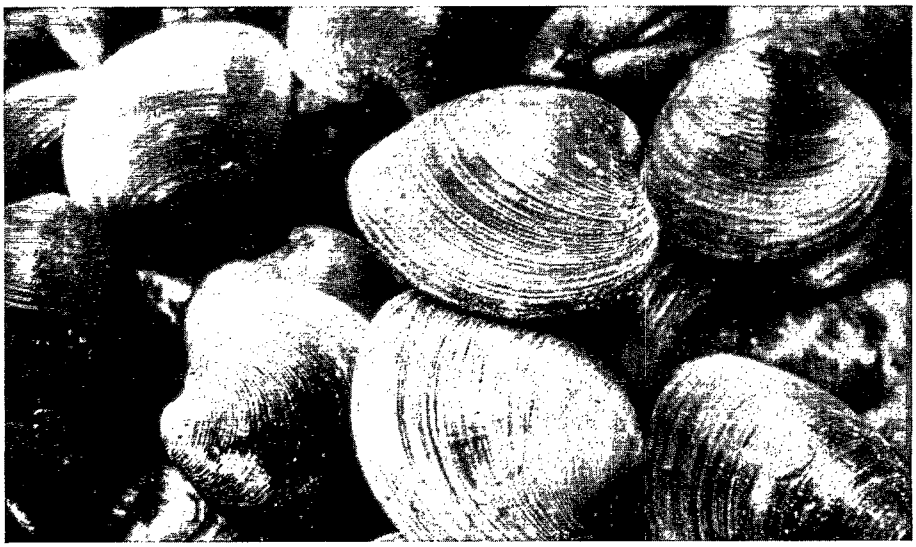
The Narragansett Bay Project

The Narragansett Bay Project (NBP) was created in 1985 to administer a five-year conservation and management study of the bay. The project is jointly sponsored by EPA and the Rhode Island Department of Environmental Management. NBP formally became part of the NEP in March 1988. EPA and NOAA are represented on the Management Committee, as are many state and local agencies and organizations including user groups, fishermen's organizations, boaters, trade organizations, environmentalists, scientists, and planners. Public participation has been the driving force behind many NBP activities, which include surveys, workshops, the newsletter *Currents*, "Round Table" discussions, and publication of the *Clean Water Shopping Guide.*

In 1987, NBP commissioned a series of status and trends reports to assess the state of the bay. The reports examined pollutants in water and sediments as well as pollutants accumulated by animals. Based on characterization studies like these, the project is now developing management initiatives to be implemented through the CCMP.

The CCMP will provide for technically sound, regionwide protection of Narragansett Bay water quality and living marine resources. NBP staff are currently drafting CCMP chapters for Management Committee consideration. Each issue area is covered by a briefing paper compiling six years of research information and proposing alternative recommendations to alleviate specific pollution problems. The Management Committee will discuss the issues and select draft recommendations. When all issue areas have been addressed, the Management Committee will prioritize CCMP recommendations and assign funding mechanisms where necessary. The draft CCMP was completed in December 1991. This draft will be subject to public comment and review in a series of regional public information meetings scheduled for the beginning of 1992. Public comments will go to the Management Committee for consideration, and the Management Committee will then produce a final version for Executive approval. When the Executive Committee endorses it, the plan will be submitted to the EPA and the States of Rhode Island and Massachusetts.

After EPA and state approval is given, CCMP recommendations will become policy that in part governs the bay. Preliminary recommendations include abating combined sewer overflow discharges, establishing wastewater management districts, eliminating illegal sewer connections to storm drains, increasing the number and geographic distribution of marina pump-out facilities, establishing state seafood inspection programs, and declaring no-discharge zones in certain coastal waters. Extensive mitigation efforts are also recommended for Mount Hope Bay—the largest shared resource of the states of Rhode Island and Massachusetts. Future monitoring of Narragansett Bay will help gauge



Tom Morrissey

The Narragansett Bay Project aims to protect quahogs.

the effectiveness of CCMP recommendations on bay water quality. The public will help implement the CCMP by serving as advocates for its implementation and by overseeing its progress.

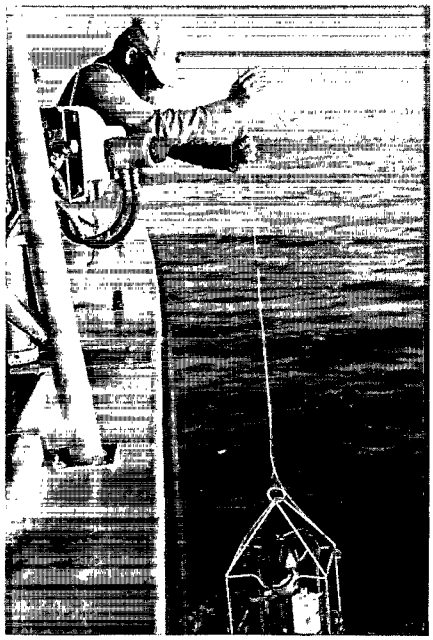
Priority Problems

General issues of concern were identified through an assessment process in which a wide range of interested individuals and organizations participated. The Management Committee then held an Issues Workshop where agreement was reached to address the following list of seven concerns:

- management of fisheries
- nutrients
- impacts of toxic contaminants
- health and abundance of living marine resources
- health risk to consumers of contaminated seafood
- land use
- recreational uses

Scientific Research

Research conducted under NBP sponsorship has produced findings concerning bay pollution, its effects on living organisms, and the potential public health risk that it may cause. In general, research has shown that concentrations of toxic metals, fecal coliforms, and organic contaminants are highest in the more industrialized areas around the upper bay and decrease in the lower bay toward Rhode Island Sound. As shown by the sediment record and analysis of historical water quality data, there are encouraging signs that bay pollution levels are improving. Recent evidence



Jenny Martin, 1988

Learning about Narragansett Bay.

of deteriorating water quality in some local bays like Greenwich Bay, however, is discouraging.

To measure the impacts of both sewage and toxic pollutants during rainstorms and the impacts of combined sewer overflows, a wet weather study was sponsored by the NBP. This study ranked the major sources of pollution to the Providence River under a series of wet weather conditions. Results show that the Blackstone and Pawtuxet Rivers contributed more overall riverine contamination to the Providence River in both wet and dry weather than did any of the other tributaries. In addition, the Blackstone River ranked first as the source for PCBs, and the Pawtuxet River ranked first as a source for petroleum hydrocarbons.

Other NBP-sponsored studies include SINBADD (a baywide water quality study investigating the sources and distributions of nutrients and trace metals entering Narragansett Bay), SPRAY (a study investigating the relationship between pollutants and dissolved oxygen in the Providence and Seekonk Rivers during the summer months), and a sediment analysis. The sediment study involves the compiling of a history of pollution in the bay through sediment analysis.

Monitoring

A variety of monitoring and baseline assessment programs have been conducted and are ongoing throughout the Narragansett Bay watershed. For example, measurements have been taken of baywide water quality, trace metals in quahogs, and toxic substances in sediments. However, most of these programs have been limited spatially and temporally. Thus, few baywide long-term monitoring data sets exist.

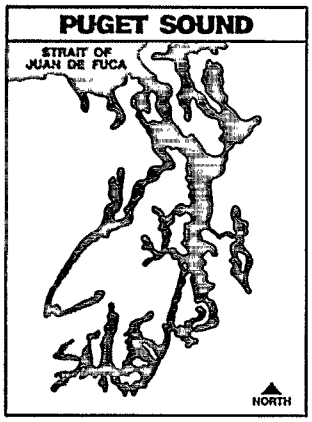
To address this problem, the Narragansett Bay Project is currently drafting a long-term monitoring plan. A final version will be presented to the Management Committee for inclusion in the CCMP. Once in place, the plan will assess management actions recommended in the CCMP and provide information useful to a wide range of groups including decision makers and managers, the general public, and the scientific community. The monitoring plan will also coordinate various ongoing monitoring efforts conducted by NOAA, EPA, the State of Rhode Island, and the State of Massachusetts.

Management Tools

Many pollutants in Narragansett Bay come from diffuse, nonpoint sources rather than from easily identifiable outfalls and other point discharges. A sister organization to the NBP, the Land Management Project (LMP), has been created as an experimental effort to demonstrate the effects of land use on water quality and to help communities manage nonpoint source pollution in conjunction with related development or pollution control planning. LMP activities and services include drafting model ordinances, providing technical assistance, and giving workshops and presentations. Through these activities, LMP educates local and state agencies, private firms, agricultural operators, and interest groups about a range of environmentally sound management practices. These practices, including proper siting, limitations on nonporous area, and provisions for on-site infiltration, provide amenity and water quality benefits as well as cost savings.

The Hazardous Waste Reduction Project (HWRP) is investigating management tools that will address the problem of hazardous wastes in Narragansett Bay. The project is developing a technical assistance information exchange system, which may include newsletters, workshops, and a waste information "hotline." Working with the Department of Economic Development in performing hazardous waste audits on ten Rhode Island companies, the project is building an in-house capability to perform hazardous waste audits. Finally, HWRP will provide information to Rhode Island businesses on source reduction, recycling, and chemical substitution-disposal alternatives.

NBP is also sponsoring a wasteload allocation (WLA) project that will measure dissolved oxygen and toxic metals in the Providence River and upper bay. Based on research findings, the project will identify, recommend, and implement preferred abatement strategies for pollution reduction. WLA work will provide the basis for permit limitations for individual direct dischargers and could lead to more stringent pretreatment limits for indirect dischargers. The project will also consider nonpoint pollution sources and control strategies other than permit limits.



Puget Sound

Introduction

Approximately 3.2 million people live, work, and play on or near the complexly carved shores of Puget Sound. This number is rapidly rising. Of Washington state's ten fastest-growing counties, nine surround the sound. The regional population is expected to grow to 3.8 million by the year 2000 and to nearly 4.4 million by 2010—nearly a 40-percent increase. A variety of valuable commercial and recreational activities made possible by the sound's abundant and diverse resources encourages this dramatic growth. Commercial fish and shellfish harvests worth about $125 million were claimed in 1987, with salmon contributing the most to that figure. Puget Sound's ports handled goods valued near $38 billion in 1986, driven by recent rises in foreign trade. In that same year, sales of recreational boats alone added $700 million to the local economy. Over a million recreational anglers and shellfishers enjoy the estuary's bounty annually. Finally, one study showed that travelers spent $2.75 billion in a single year in the basin, providing a livelihood for numerous shoreline restaurants, small cruise boats, marinas, and other water-dependent recreational businesses.

Chief Threats to Puget Sound

Despite clear economic benefits generated by the sound's popularity, the pressures of mounting population have taken their toll on this body of water. Rapid urbanization over the past 50 years has transformed thousands of farmland and forest acres into residential or commercial developments. These projects have filled in or drained crucial habitats such as estuarine and freshwater wetlands. In Puget Sound, 60 percent of estuarine wetland area, as well as a high proportion of freshwater wetlands in the sound's watersheds, has been lost, and the loss continues with development. At the same time, the new hardened land surfaces do not soak up rainwater and in fact help stormwater carry pollutants into the estuarine system. This runoff contributes to flooding, erosion, and further losses of fish and shellfish habitat.

Urban runoff from stormwater outfalls and combined sewer overflows (CSOs) is also a major source of toxic chemical pollution. During severe storms, stormwater outfalls and CSOs discharge toxic-laden industrial wastewater, sanitary sewage, and stormwater directly into the sound without treatment. Additionally, small amounts of toxic substances that accumulate in the sediments are still discharged from permitted industries and municipal sewage treatment plants. Dredging and disposal of contaminated sediments, dumping of industrial and household toxics into storm drains, agricultural runoff, air pollution, accidental oil and chemical spills, and landfill leachate all contribute their own toxic challenges. Toxic substances can persist in the sound's sediments for decades, disrupting biological systems and contaminating seafood.

Bacteria and viruses that may cause diseases including typhoid, cholera, and hepatitis are introduced from diffuse sources in rural as well as urban areas. Failing septic systems, animal wastes, sewage treatment plants, stormwater outfalls, and CSOs are sources of these microscopic organisms and are linked to increasing development, grazing, logging, and other human activities in rural

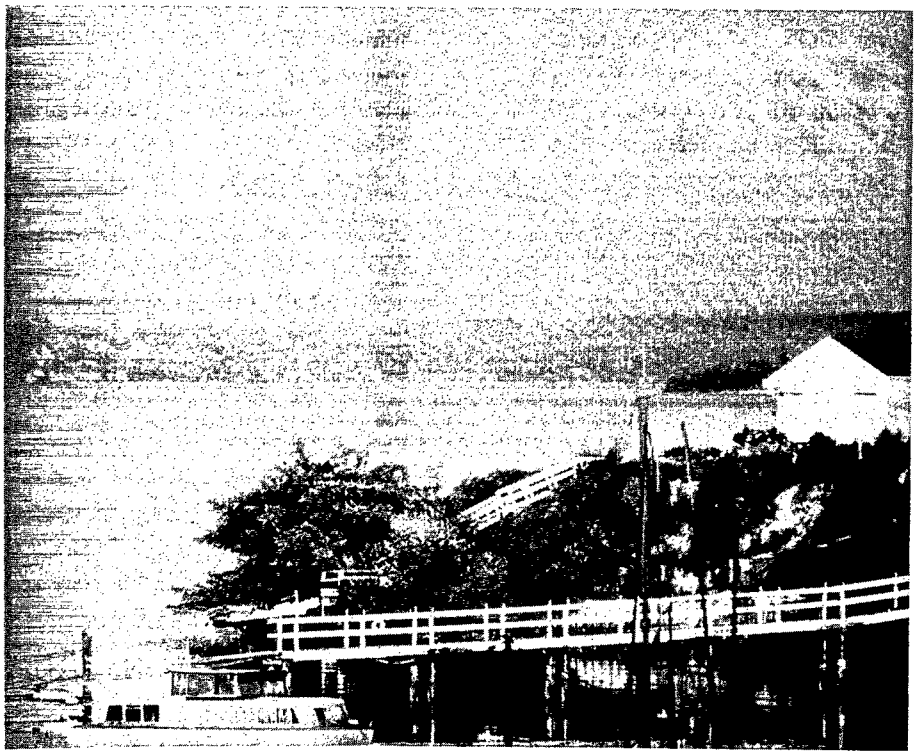
watersheds. One measure of this nonpoint pollution is the closure of many commercial and recreational shellfish beds in the past decade because of contamination by enteric bacteria. This degradation of shellfish habitat is consistent with the national trend, which shows no signs of reversal.

The Puget Sound Estuary Program

A management framework to clean up Puget Sound existed even before its introduction into the National Estuary Program. The State of Washington established the Puget Sound Water Quality Authority in 1983 to identify pollution-related threats to the sound's marine life, to evaluate pollution threats to human health, and to investigate the need for coordination among agencies responsible for protecting Puget Sound's water quality. In 1985, following passage of the Puget Sound Water Quality Authority Act, the Authority was charged with developing and overseeing implementation of the Puget Sound Water Quality Management Plan, which it has done from the outset with cooperation from the state Department of Ecology and EPA Region X.

After extensive study and public review, the Authority issued its first management plan in 1987, followed by a 1989 revised plan. Meanwhile, in March 1988, the Puget Sound Estuary Program (PSEP) became a charter member of the NEP. Under an agreement with EPA, the Authority's 1987 and 1989 management plans were considered partial CCMPs. The 1991 plan was developed to meet the requirements of an NEP CCMP, addressing for the first time the need for consistency among federal actions related to CCMP goals and affecting the sound. The Authority's enabling legislation originally called for the agency to disband following issuance of the 1991 management plan. However, because of the 1991 plan's enhanced role, as well as the state's increased commitment to the sound, the legislature recently extended the Authority's work until 1995.

PSEP became the first estuary program to formally submit a final CCMP when it presented its 1991 management plan to the EPA Administrator on February 22, 1991. The Administrator approved the CCMP on May 6. Of course, the Authority has already overseen implementation of a number of actions from the 1987 and 1989 plans; the 1991 plan targets new initiatives as well as modifies 1989 plan elements.



Armstrong

A view of Mount Rainier from Filuce Bay.

Priority Problems

A number of studies conducted by EPA, NOAA, state agencies, and academic institutions both before and after the program's induction into the NEP have characterized conditions in Puget Sound. In 1986, the Authority prepared nine issue papers on Puget Sound concerns and in 1989 prepared three additional papers for public comment. As a result of these actions, PSEP has identified the following broad priorities in the watershed:

- ☐ cleanup toxic substances where sources are controlled
- ☐ control sources of toxic substances
- ☐ protect and stop loss of wetlands and other aquatic habitats
- ☐ increase protection of shellfish beds
- ☐ improve control and cleanup of nonpoint source pollution

- support long-term research
- support and improve public involvement and education
- prevent spills and enhance response capability
- continue and maintain established programs

Scientific Research

Although significant research has been done to support the 1987 and 1989 management plans, many questions remain unanswered. For instance, little was known about the sound's shallow nearshore zone, southern and northern portions, and small bays; about natural variability in the sound's living populations; and about biological and geochemical processes transforming the sound's toxic chemicals and controlling their fate and toxicity. Accordingly, PSEP and other organizations have sponsored conferences and workshops to communicate previously gathered scientific data and to help clarify research priorities for the future. Past meetings have discussed general Puget Sound research on toxic substances, sediments, status and management of biological resources, sea-surface microlayer contamination, and many other topics.

The research program described in the 1991 Puget Sound Water Quality Management Plan depends on the establishment of the Puget Sound Foundation as a long-term funding and implementation tool. The Foundation will be a public, nonprofit corporation charged with coordinating and funding research and education efforts. The 1991 research program elements to be carried out by the Authority, and eventually the Foundation, include setting future research needs and priorities, developing a stable funding base, initiating a competitive research grants program, translating and disseminating research results, improving data management, coordinating with outside research activities, and investigating geographic areas for designation as NOAA National Estuarine Research Reserves.

Monitoring

Before 1988, Puget Sound had no long-term, comprehensive monitoring program. Various federal, state, and local agencies have intermittently monitored water quality, sediments, and biological resources in particular regions of the sound. Yet these programs have generally not sampled conditions across the entire body of water or coordinated their efforts and results. To correct this problem, the Authority approved a Puget Sound Ambient Monitoring Program (PSAMP) in 1988. Managed by a steering committee, PSAMP integrates existing monitoring programs undertaken by different agencies in the sound, attempting to prevent overlap and duplication of effort. PSAMP has also guided new or expanded monitoring ventures, such as the Department of Ecology's field sampling and laboratory analysis of sediments, the Department of Fisheries' investigation of toxic contamination of bottomfish and recreational fish, the Department of Health's monitoring of shellfish bacterial and chemical contamination, and the Authority's citizens' monitoring pilot projects. Among other elements, the 1991 management plan calls for finalizing a central data management system, issuance of monitoring reports, use of standard protocols and data formats, and establishment of a pesticides monitoring subcommittee; these projects are all under way.

Management Tools

The management plan's nonpoint source pollution program contains the first fully integrated, watershed-based approach to nonpoint source pollution control in the United States. Under Washington's "Nonpoint Rule," counties identify and rank their priority watersheds, then develop and implement action plans through watershed committees. These committees are assisted by an interagency technical group and the *Nonpoint Source Handbook* for local governments. Out of 12 early action watershed plans, 10 have been approved and are now in various stages of implementation with funding from the Department of Ecology. Plans are currently being developed by the committees for 14 more watersheds.

Substantial progress has been made in addressing the issue of contaminated sediments in the sound. The State Department of Ecology recently adopted a sediment management standards regulation that establishes standards for 47 chemical contaminants and also establishes a process to identify and prioritize contaminated sites for cleanup. The primary affected parties, including ports, industry, federal and other state agencies, tribes, municipalities, and environmental groups participated in the regulation's development. Washington is the first state in the United States to have legally enforceable sediment standards.

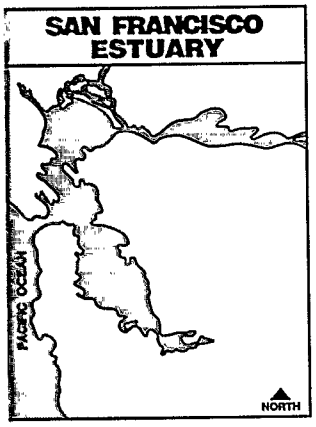
Rylko

Wetland restoration planting.

With its CCMP activities in nonpoint sources and in 14 other program areas so far advanced, the Puget Sound Estuary Program has tried to find creative funding sources in the face of state and local government budget constraints. In 1986, the state legislature passed an 8-cents-per-pack tax on tobacco products to create the Centennial Clean Water Fund (CCWF). Providing annually about $45 million in grants statewide, the fund pays for 50 percent of the cost of building local sewage treatment plants and other water quality facilities and up to 75 percent of other activities related to water quality, such as watershed planning. Over the past four years, the fund has also provided $2 million for the Authority's Public Involvement and Education (PIE) fund, which has informed over one million community residents as diverse as builders, farmers, and schoolchildren.

The CCWF is also the primary source of funding for the development and implementation of the local nonpoint watershed action plans. At the local level, many municipalities have created self-supporting stormwater utilities both to build stormwater management facilities, such as detention ponds and infiltration basins, and to begin education programs aimed at reducing sources of stormwater pollution. In most cases, businesses or households pay monthly utility fees based on their amount of impervious land surfaces promoting stormwater runoff.

These innovative state and local funding efforts, and the new Puget Sound Foundation, will still fail to finance all cleanup and restoration efforts essential for Puget Sound. As a result of a financing strategy, developed partially with EPA support, the program has proposed two new funding sources in its 1991 plan: a commercial marine fuels tax and a motor vehicle manufacturers fee for each new car or truck registered in the state, neither of which the legislature has yet approved.



San Francisco Estuary

Introduction

The San Francisco Bay-Delta Estuary, also known as the San Francisco Estuary, comprises the 1,153-square-mile Sacramento-San Joaquin Delta and the four embayments of the San Francisco Bay. It is the largest estuarine system on the Pacific Coast of the Americas. A total of 7.5 million people live in the 12 surrounding counties, making the region the fourth most populous metropolitan area in the nation. Of critical importance are the uses made of the estuary's freshwater. Some two thirds of California's 30 million people obtain their drinking water from the estuary's freshwater supply, while farmers rely on the estuary to irrigate 4.5 million acres of agricultural land. Ports in the estuary provide jobs, an important tax base, and a link to world trade. Local residents and visitors enjoy swimming, water skiing, fishing, and sailing at 290 shoreline recreation areas and over 300 marinas. The bay and delta also sustain rich communities of crabs, clams, fish, birds, and other aquatic life. The estuary provides an essential resting spot for 75 percent of the hundreds of thousands of Pacific Coast shorebirds that migrate south in winter. In addition, wetlands serve as nursery grounds for salmon, herring, crab, and oysters, fueling the region's multimillion-dollar fisheries.

Chief Threats to San Francisco Estuary

Since the San Francisco Gold Rush of 1849, human activity has greatly affected the bay and delta, making the San Francisco Estuary the most modified large estuary in the nation. Less than 45,000 acres of the estuary's historic tidal marshes remain intact, a reduction of 92 percent. Freshwater has been diverted from the estuary since 1890, and waterways have been physically altered for navigation, water export, and flood control purposes. More recently, water quality has declined as pathogens and toxic chemicals from urban and agricultural runoff and over 100 municipal and industrial sources enter the estuary.

Biological resources have undergone major changes. Populations of Chinook salmon, striped bass, and Delta smelt have declined drastically. About 275,000 salmon spawn in the estuary watershed today, down from 900,000 at the turn of the century. The number of adult striped bass is less than one million, a reduction of 66 percent from 1960 levels. Habitat loss, water diversion, pollution, and dredging activities may all contribute to the decline of fish populations. Bird populations are also down, affected by the loss of wetlands and riparian areas.

More than 50 percent of the current average annual inflow of fresh water to the estuary is diverted for agricultural, industrial, and municipal use. As more and more fresh water is pumped out, salt water moves in to take its place. Drinking water, habitats, and crops can be adversely affected. In addition, millions of young salmon and striped bass are killed each year when they are sucked into the strong pumps of state and federal water projects.

Pollutants from runoff and wastewater discharges affect the food chain. Bacterial contamination has caused a once-thriving shellfish industry to collapse. PCBs are probably responsible for reproductive problems in starry flounder, while PCBs and DDE (a DDT derivative) have reduced embryo size and shell thickness of Black-Crowned Night Heron eggs. Moreover, high levels of

mercury in fish tissues prompted the California Department of Health Services to issue a health advisory concerning fish consumption.

The San Francisco Estuary Project

The San Francisco Estuary Project (SFEP) is cosponsored by EPA Region IX, the California State Water Resources Control Board, and the Regional Water Quality Control Boards of the San Francisco Bay and Central Valley regions. SFEP became part of the NEP in 1987. NOAA's National Marine Fisheries Service participates on the project's Management and Technical Advisory Committees. SFEP has over 100 participants, who represent diverse environmental, social, and economic interests, and who serve on one or more of the project's committees. To promote participation, management issue subcommittees have been formed to help develop status and trends reports, program goals, and possible management actions. SFEP completed a characterization report and will complete the CCMP by November 1992.

Priority Problems

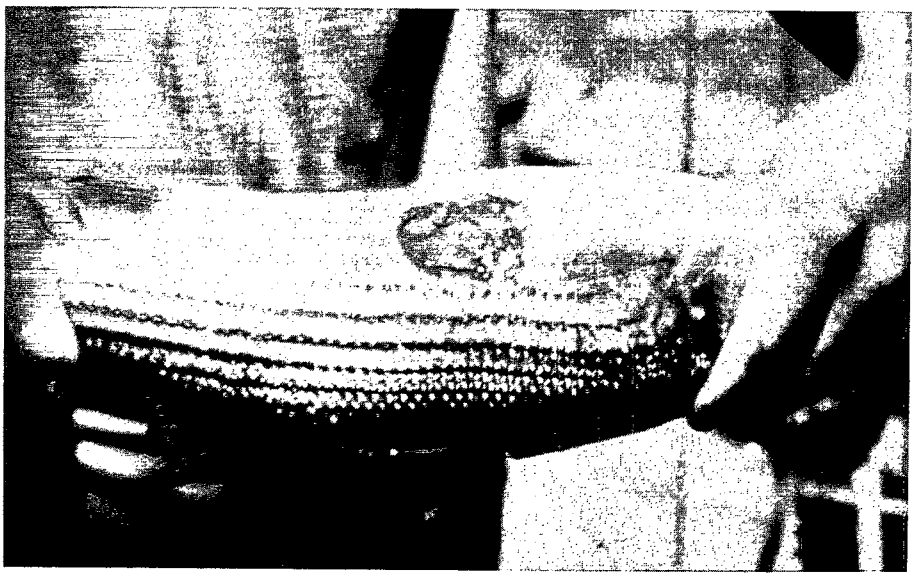
An initial list of 189 problems cited by various committee members was pared down to the following five management issues:

- decline of biological resources
- increased pollutants
- freshwater diversions and altered flow regime
- dredging and waterway modification
- intensified land use

Scientific Research

Status and trends reports are currently addressing issues of dredging and waterway modification, land use and population, effects of land use intensification, pollutants, aquatic resources, wildlife, and wetlands and other habitats.

SFEP has developed a data and information management system, which is now maintained by the Aquatic Habitat Institute (AHI) and serves as a clearinghouse of scientific information on the estuary. SFEP is also funding projects that encourage local academic involvement and address key gaps in knowledge. In addition, a report describing and evaluating the responsibilities and activities of the many agencies that manage the estuary's water quality and living resources will identify actions necessary to improve that management.



Striped bass with lesions – Striped bass population is down two-thirds.

Monitoring

Many monitoring programs are conducted in the San Francisco Estuary. To date, however, there has been no comprehensive, coordinated, long-term monitoring of the entire body of water. In response, SFEP will develop a regional monitoring strategy that will track the long-term health of the estuary and measure progress toward CCMP management objectives. This strategy will include agreed upon monitoring goals and objectives and, to the extent possible, will incorporate current monitoring programs.

Information from monitoring is often used for different purposes, each with its own data requirements. Ideally, the type of monitoring conducted is determined by various information needs. To ensure monitoring efficiency, strategy designers will decide on monitoring goals and data quality objectives. Once agreement is reached on the quality and type of monitoring needed, an assessment plan will be devised to ensure that all monitoring meets information needs and quality standards.

Marsh waterfowl – 88 percent of wetlands are lost.

Management Tools

During the past three years, SFEP has spent considerable time and effort in assembling technical information on the estuary's major management issues. With the project's technical documents completed or well under way, most of the management issues subcommittees have begun to formulate goals and potential actions for possible inclusion in the CCMP. In addition, several demonstration projects are under way to help develop effective management tools.

For example, the California State Coastal Conservancy, with funding from SFEP, is conducting five wetlands enhancement projects in the San Francisco Bay area. The projects are creating new wetlands, enhancing existing ones, improving wetland vegetation and hydrology, and providing natural flood control. Several of the projects involve constructing nature trails and conducting public education activities. A final report will evaluate the various ways to conserve wetlands—acquisition, restoration, preservation, and enhancement. The project will serve as a model for what will probably be an important CCMP action plan.

Artificial wetlands are known to effectively filter pollutants from municipal wastewater, but their use on nonpoint source pollution has not been investigated. A SFEP demonstration project is now testing the ability of wetlands to trap stormwater pollutants such as floatable contaminants, hydrocarbons, toxic contaminants, inert settleable solids, and nutrients. The project site is a 55-acre marsh built 10 years ago for stormwater flow research. Scientists are currently collecting water column, sediment, and plant tissue data to determine the wetland's effectiveness in trapping pollutants. SFEP will then estimate the cost of constructing and operating artificial wetland treatment sites for the entire estuary and will report its results.

Three additional demonstration projects include testing the feasibility of using dredge materials to create wetlands, developing a wasteload allocation model for south San Francisco Bay, and developing a model local wetlands protection ordinance.

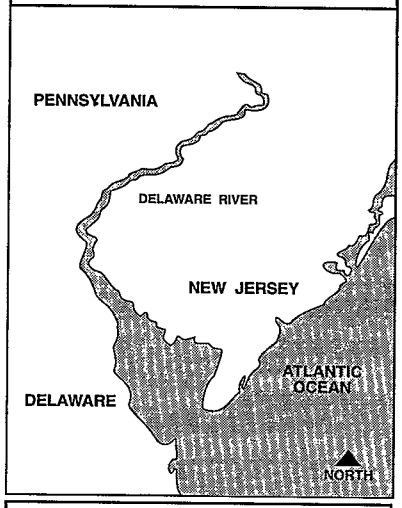
No program would be complete without a strong public education and involvement component. Working closely with its Public Advisory Committee, the San Francisco Estuary Project has developed information sheets, slide shows, public forums, and tours to educate citizens about the value of the San Francisco Bay-Delta and threats to its integrity. A bimonthly newsletter keeps constituents informed of project activities and coming events.

Planning for future generations, the SFEP is developing a curriculum for use in Bay-Delta K-12 schools. The curriculum will focus on eight estuarine habitats and highlight a selected species for each habitat.

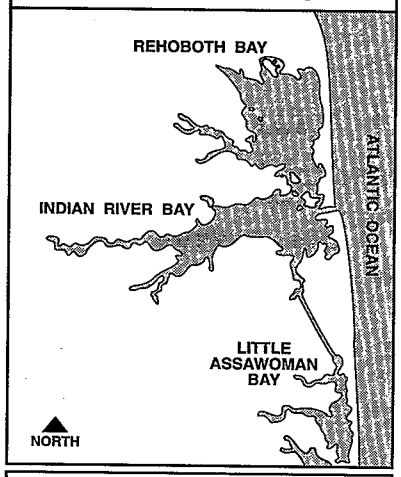
In spring 1991, SFEP sponsored a three-day "State of the Estuary" conference with more than 50 other organizations. Technical sessions, policy discussions, and public education workshops focused on the project's priority management issues. Findings from the project's technical studies were presented in a State of the Estuary report. The event provided a focus for public, legislative, and media attention on the threats to the San Francisco Estuary and the goals and actions of the San Francisco Estuary Project.

Tier 2

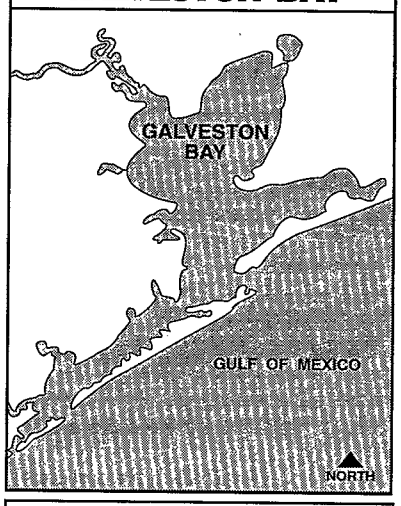
DELAWARE ESTUARY



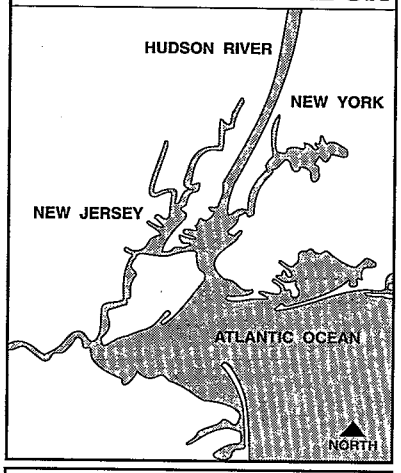
DELAWARE INLAND BAYS



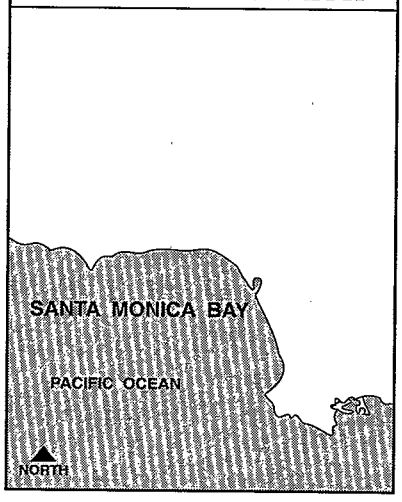
GALVESTON BAY



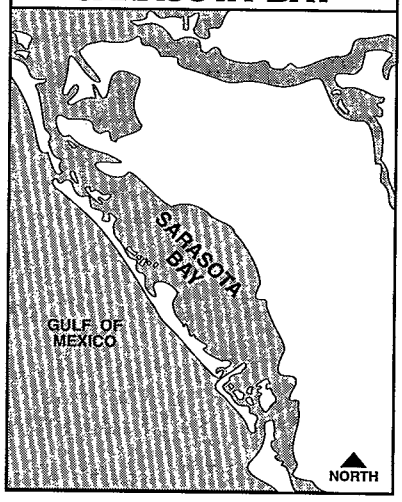
NEW YORK-NEW JERSEY HARBOR

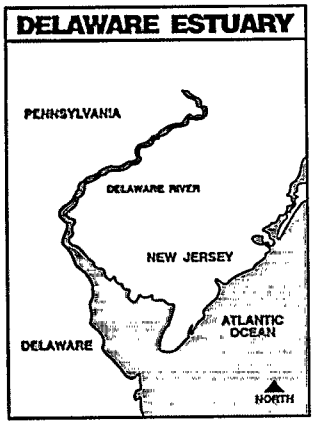


SANTA MONICA BAY



SARASOTA BAY





Delaware Estuary

Introduction

Delaware Estuary, bordered by Delaware, Pennsylvania, and New Jersey, is comprised of Delaware Bay and the tidal portion of the Delaware River. It extends from the head of tide in the Delaware River near Trenton, New Jersey, to the mouth of Delaware Bay between Cape May, New Jersey, and Cape Henlopen, Delaware. Farming is a primary economic activity in many counties bordering the estuary, producing corn, soy beans, and other important crops. Northern portions of the estuary are heavily industrialized. Over 120 chemical manufacturing plants and the country's second-largest concentration of petrochemical plants lie along the Delaware Estuary's shores. The area is also densely inhabited—over 40 percent of the nation's population lives within a day's ride of the Delaware Estuary. The Delaware Estuary also hosts the largest heron, egret, and ibis rookery on the East Coast; is the second major staging site for shore birds in North America; and is the principal mating area for horseshoe crabs on the East Coast.

Delaware Estuary served as a primary source of food and as a major transportation route for the early inhabitants of its shores. The estuary continues to support these uses today through commercial fishing and shipping activities. The modern Port of Philadelphia, including berths in Pennsylvania, New Jersey, and Delaware, is the largest freshwater port in the world. Over 9,000 manufacturing concerns and 100,000 jobs are dependent on port activities. Commercial finfishing and shellfishing are economically significant as well. The Delaware blue crab catch from May to October 1989, for example, exceeded $2 million. Tourism and recreation are also supported by the estuary. Visitors enjoy swimming, boating, and fishing, while nature lovers are attracted by fascinating wildlife such as peregrine falcons, bald eagles, and thousands of migrating shore birds.

Chief Threats to Delaware Estuary

As early as 1670, boatyards along the Appoquinimink River in Delaware were closed because of excessive silt from deforestation. By the late 1800s, pollution was causing typhoid epidemics in Philadelphia and Camden. In the 1930s, dissolved oxygen levels in the area were low enough to trigger massive fish kills that threatened to destroy entire fish populations. Septic gases from the estuary were so pervasive in the 1940s and 1950s that white houses turned yellow and dock workers and sailors became ill from exposure to the gases.

Fortunately, the situation has improved over the past four decades. Water quality standards have been set, sewage treatment plants have been upgraded, and studies have focused attention on environmental issues in the estuary. Results of these efforts can already be seen. In the past 20 years, federal and state pollution control efforts have reduced the discharge of oxygen-demanding wastes by 76 percent. Decreased pathogen concentrations have allowed public health officials to reopen many areas for shellfishing and swimming. Today, the estuary supports year-round fish populations. Shad and herring migrate upriver in increasing numbers, once again sustained by the water's oxygen.

Despite these recent successes, many problems remain. Urban and suburban nonpoint source pollution

still enter the estuary from combined sewer overflows and stormwater drains. These discharges contain toxic substances, bacteria, and other harmful contaminants. Saltwater intrusion, freshwater withdrawals and diversions, and general contamination threaten important supplies of drinking water. Dredging and filling activities associated with development continue to destroy wetlands—habitats vital to marine productivity. A total of 184 acres of estuary wetlands has been lost in Pennsylvania alone since the 1970s. In addition, petroleum transport through the estuary poses a risk of oil spills.

Pollution, destroyed habitat, parasites, decreased levels of dissolved oxygen, and overfishing have caused declines in several fish and shellfish populations. Weakfish and clam fisheries have almost disappeared because of population declines. Contamination of fish and shellfish threatens human health. Levels of PCBs found in catfish have been high enough that officials have questioned the safety of eating them. Further, New Jersey has closed the Camden area for fishing due to chlordane contamination.

Off-loading tanker in Delaware Bay.

The Delaware Estuary Program

In April 1988, the governors of Delaware, Pennsylvania, and New Jersey publicly committed themselves to restoring and protecting the Delaware Estuary, supporting plans to preserve the estuary's environmental quality and realize its full economic potential. All three states and EPA Regions II and III signed a NEP Conference Agreement in June 1989. According to this agreement, the CCMP is due in October 1994.

A strong committee structure is a key element of the Delaware Estuary Program. Each committee oversees specific workplan elements to meet objectives of the Conference Agreement. The Policy Committee, which sets the program's overall direction, includes the secretaries of the three state environmental agencies and the EPA Regional Administrators for Regions II and III. The Management Committee, responsible for running the program's day-to-day affairs, consists of state, regional, and federal agency representatives including EPA, NOAA, Fish and Wildlife Service, and the Army Corps of Engineers. The Science and Technical Advisory Committee (STAC) includes experts from academic and private institutions as well as industry and government agencies. The STAC provides guidance on efforts to identify, evaluate, and address environmental problems in the estuary. The Citizens Advisory Committee (CAC) represents a broad spectrum of major user and interest groups. It implements a public participation strategy that includes a quarterly newsletter and mini-grants to grassroots organizations. The Local Governments Committee (LGC), whose members represent various levels of local government, oversees projects that inventory and assess existing regulatory, monitoring, and land use management programs. The LGC also publishes a bimonthly newsletter, *The Rising Tide*. The newly formed Financial Planning Committee has the task of finding funding to conduct studies during the five-year program period and to implement the CCMP.

During every year of the program, Pennsylvania, Delaware, and New Jersey each provide approximately one year of staff support. Additional staff support is being provided by EPA Regions II and III and the Delaware River Basin Commission (DRBC).

Priority Problems

A list of issue areas was formulated through a series of public and tri-state workshops held in February and April of 1989. The list will be further defined in 1991 based on the inventory of point and nonpoint loadings and incoming status and trends data. Concerns include these:

- ☐ water quality
- ☐ habitat
- ☐ water supply
- ☐ living resources

In May 1991, the Management Conference formulated a list of objectives with substantial public input. Action steps are currently being generated for each of the objectives. Together, the objectives and action steps will guide development of a CCMP meeting the specific needs of the Delaware Estuary, as well as promote early implementation. The objectives cover these areas: harvested finfish and invertebrate species; bird populations; estuarine-dependent amphibians, reptiles, and mammals;

ecological balance for a diverse indigenous biota; habitat; air quality; water quality; water supply; sediments; recreation; commerce; cultural heritage; and pollution prevention.

Scientific Research

Several STAC activities have worked toward developing an agenda for scientific characterization and research. The "State of the Delaware Estuary" workshop in October 1989 helped make a preliminary assessment of the extent of scientific and technical knowledge of the estuary. In March 1990, citizen participants identified the uses and values they desire for the Delaware Estuary in the year 2020. A follow-up workshop in May 1990 identified the new scientific and technical information required to ensure that the estuary can sustain these uses and values in 2020. The Management Committee participated in a field trip on the estuary to acquaint members with its resources and some of its problems.

In terms of specific research, the STAC has supervised several studies to determine the state of the estuary for the key issues. Scientists have examined existing data sets for water quality, metals, living resources, and habitat loss and alteration. Characterization studies this year will compile a long-term history of the estuary, an assessment of phytoplankton species, fisheries landings records, and the effects of transportation on the estuary. Future research activities will examine factors limiting primary production, metals speciation and behavior in tidal reaches, and long-term river flow and circulation. The STAC has also proposed more extensive research on wetlands, the influence of storm sewers and atmospheric inputs, and the distribution and diversity of estuarine animals.

David Carter

Black-crowned night heron.

Monitoring

In the future, the Delaware Estuary Program will devise a monitoring plan that may incorporate various state monitoring programs. The STAC has identified various monitoring needs. Because water quality in the tidal river region of the estuary has improved, surveys of fish and benthos in a stretch of the estuary extending from the head of the tides to the C & D Canal is planned for next year's STAC projects. Surveys of metals and organics in sediments and in the tissue of selected estuary organisms are also planned.

Management Tools

The following demonstration projects represent management tools for early implementation.

Alcyon Lake in Gloucester County, New Jersey, is so contaminated by various nonpoint sources that local health agencies have prohibited public contact with its waters. The Delaware Estuary Program is conducting a "Clean Water Works" demonstration project at Alcyon Lake to test a three-pronged approach for reducing nonpoint source pollution and reviving the lake as a recreational resource. First, the Gloucester Planning Department will identify and rate best management practices (BMPs), including ordinances, enforcement, model landscaping, and decreased water consumption. The selected practices, implemented by local governments, should reduce pollutant inflow to the lake and preserve water quality. Second, a hands-on education program will show school-age children, residents, and professionals how they can help clean up the lake. Third, a Watershed Watch group made up of citizen volunteers, local officials, academic representatives, and federal managers will monitor water quality

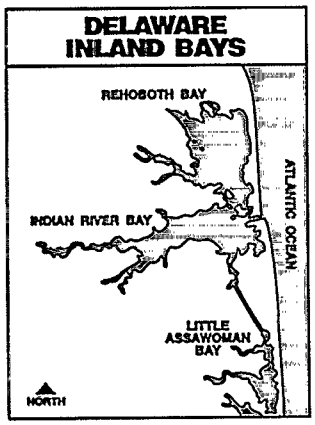
and hold watershed cleanups. The group will also promote passage of model ordinances, encourage schools to adopt the education program, identify sources of funding for the BMPs, and evaluate the overall Clean Water Works program. If successful, the program will be duplicated throughout the estuary.

The Red Clay Creek demonstration project, conducted by the Chester County, Delaware, Conservation District, addresses nonpoint source pollution in that body of water. Organic compounds such as diazinon and formaldehyde, and other conventional pollutants such as phosphorus and coliforms are brought to the creek by runoff from nearby agricultural land. To decrease this pollution inflow, the project will install BMPs on the basin's mushroom compost and educate local agricultural producers about proper pesticide usage and disposal.

In 1957, the parasite MSX almost wiped out the entire estuarine oyster population. In New Jersey, the Maurice River Oyster Culture Foundation and Rutgers University are developing techniques through a demonstration project to grow commercially significant numbers of MSX-resistant oysters. These techniques will provide economic benefits by increasing oyster harvesting in the estuary.

The Cumberland County, New Jersey, Department of Planning and Development has developed a rare, threatened, and endangered species demonstration project. The project will identify and map critical habitat areas for such species in southern Cumberland County. The project will then synthesize this information in a local planning database to help local governments develop environmentally sound land use regulations.

In addition to demonstration projects, the Delaware Estuary Program is developing a preliminary CCMP that is scheduled for completion and for early implementation in 1992.



Delaware Inland Bays

Introduction

The Delaware Inland Bays in Sussex County, Delaware, consist of Rehoboth, Indian River, and Little Assawoman Bays. They are surrounded by barrier islands to the east and fringing marshes to the north, south, and west. Agriculture dominates the local economy: 47 percent of the land surrounding Delaware Inland Bays is used for agricultural production. The state produces $200 million broiler chickens each year, most of which come from the Inland Bays area. The recreation industry is vital to the region, with day-trip accessibility to nearly 40 percent of the nation's population; recreation provides substantial employment in Sussex County (12.3 percent). Popular as a summer vacation resort, the bays attract wind surfers, water skiers, swimmers, nature lovers, and hunters. The bays support an abundance of wildlife and wildlife habitat, including an important nesting area for osprey and a year-round home for black ducks. More than 750,000 people visited 4,900 acres of state park land around the Inland Bays in 1986 alone. Other valued activities include recreational and commercial fishing and shellfishing.

Chief Threats to the Delaware Inland Bays

A myriad of environmental stresses are threatening this shallow estuarine system. Agricultural runoff, urban runoff, wastewater outfalls, septic systems, wide-ranging recreational activities, and the effects of increased development all contribute to environmental stresses and deteriorating water quality in the Inland Bays watershed.

The bay's primary source of fresh water is ground water, which contains high levels of nitrogen. Ground water nitrogen sources are poultry and other agricultural operations, as well as numerous on-site wastewater systems operating in sandy, porous soils. Once excess nutrients reach the bays, they cause algal blooms. When this algae dies and decays, dissolved oxygen is removed from the water, resulting in fish kills.

Bacterial and viral contamination of surface waters and shellfish areas is also a concern. Swimmers can ingest contaminated water, and disease-causing bacteria and viruses build up in the tissues of filter-feeding organisms such as clams, making them dangerous to eat. Over the past two decades, the number of shellfish beds closed to harvest due to bacterial contamination has increased by 75 percent.

Poor planning and environmentally insensitive development have altered or destroyed habitat in and around the estuary. Seventeen percent of the wetlands around the bays have disappeared since 1950. Such extensive destruction threatens the entire estuary because both uplands and wetlands provide important habitat for living resources and help filter pollutants. Without wetlands, erosion also becomes more of a problem, threatening to destroy valuable real estate and covering productive shallow habitat with sediments.

The Delaware Inland Bays Estuary Program

Building on past efforts, the Inland Bays Estuary Program Management Conference was convened in July 1988. Goals and objectives were established by March 1989 with the

help of public input, and a five-year conference agreement with EPA was signed in June 1989. A characterization and status and trends report will be complete in 1992, with the CCMP due to EPA in 1993. An early action agenda—the Inland Bays Recovery Initiative—is currently in place.

The Inland Bays Estuary Program (IBEP) recently sponsored a workshop to identify specific actions to be included in the CCMP. Aimed at combatting nutrient overenrichment and habitat loss, recommendations included managing poultry manure and dead bird disposal, setting numerical goals for nutrient reduction from point sources, linking new development to central sewer systems that use land treatment, adding county planning personnel, developing county land-use and development goals, and preventing construction at the water line. Other results from the workshop were a recommended outline for an early draft CCMP and a timetable and process for CCMP preparation.

Priority Problems

The program has developed a problem-ranking matrix that focuses on the following major concerns:

- ☐ nutrient overenrichment
- ☐ loss and alteration of habitats
- ☐ land-use planning

Scientific Research

Wasteload allocations, which identify the nutrients entering the bays and determine their amounts and sources, were conducted in 1978 and again in 1986. Both showed that nonpoint sources, including ground water and stormwater runoff, are the major contributors to total pollutant loadings. Future research and modeling will update and refine loading estimates and will determine allowable loads.

The University of Delaware's College of Marine Studies (CMS) and College of Agriculture have performed much research related to the Inland Bays. The University of Delaware Sea Grant College Program has provided primary funding for many studies. The Sea Grant College Marine Advisory Service is currently evaluating the bays' capacity to support recreational uses.

View of the bays looking east toward the Atlantic Ocean.

Monitoring

Since 1972, the State of Delaware has routinely monitored water quality at 27 stations in the Inland Bays. Traditional chemical testing is now supplemented by an innovative biological monitoring program. Combined with wildlife surveys by the Delaware Department of Natural Resources and Environmental Control (DNREC) Division of Fish and Wildlife, these efforts will ensure that program initiatives are improving water quality as well as restoring a diverse and healthy biological community. A citizen monitoring program has begun under the direction of the University of Delaware Sea Grant College Marine Advisory Service.

Management Tools

An early management step for the IBEP was to find out whether and how the Sussex County taxpayers use the bays and to determine how these taxpayers would protect the bays. A questionnaire and a series of workshops showed that 93 percent of the citizens interviewed considered it important just to know that the bays are there; 54 percent recognized that the bays' water quality is deteriorating; and more than 80 percent favored controlling uses of the bays. Citizens called for tough enforcement of point source permits; restrictions on septic systems and stormwater runoff from urban, agricultural, and developing areas; and limits on bay shoreline

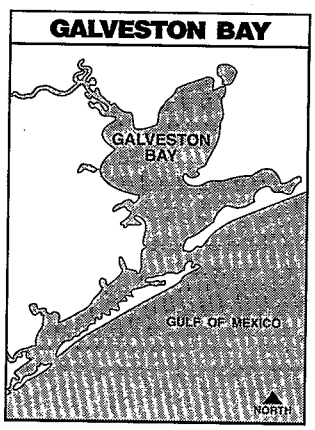
Students examining a seine net during Inland Bays Appreciation Day.

development. This input is being used in CCMP development.

The Inland Bays Estuary Program is currently conducting a demonstration project to highlight the value of artificial wetlands as a stormwater management tool. In other studies, properly designed artificial wetlands have proven to be 40- to 60-percent effective in eliminating nitrogen, 60- to 80-percent effective for phosphorus, 80-percent effective for sediments, and 60-percent effective for trace metals. The Inland Bays project site, located in the Sussex County Industrial Park, was approved by the Sussex County Council in October 1990, and planning for pond construction is now under way. DNREC will administer project funds, provide technical assistance, and monitor water quality before and during construction, and for two years after project completion. This demonstration project will serve as a model for implementing similar techniques in estuary-wide watershed management.

The Delaware Inland Bays Estuary Program is also testing another management tool that involves finding alternative erosion stabilization methods. Traditional stabilization techniques used to combat erosion, especially vertical bulkheading, harm habitats and facilitate erosion of nearby unprotected shoreline. The Inland Bays program is sponsoring a project to demonstrate the benefits of alternative stabilization methods. The project, led by the Wetlands and Aquatic Protection Branch of DNREC, has chosen two eroded shoreline sites to stabilize with a combination of native vegetation and rock groins. The project will educate landowners, the public, and professional marine contractors, and it could encourage state legislators to initiate a tax incentive program to promote natural erosion control measures. To evaluate the success of the program, DNREC will conduct quarterly monitoring surveys for at least two years. Construction will begin in 1991, and educational materials for the general public, contractors, consultants, and other interested parties will be available in 1992.

The knowledge and experience gained from the scientific research and syntheses and from the implementation of the Recovery Initiative and demonstration projects will be used by the Management Conference to develop a CCMP that will effectively address the major problems degrading the water quality and surrounding habitats, leading to true environmental improvements in the Inland Bays.



Galveston Bay

Introduction

Galveston Bay is the seventh-largest estuary (600 square miles) and one of the most highly productive estuaries in the United States. The bay lies southeast of the Houston metropolitan area in the northwest Gulf of Mexico, with a watershed entirely within Texas that also encompasses Dallas and Fort Worth. As home to the largest petrochemical complex in the nation, 30 percent of the nation's refining and nearly half of the U.S. chemical production takes place on the shoreline of Galveston Bay. The estuary is characterized by its seafood productivity, its role as a major recreational resource, and its multibillion-dollar contribution to the economy as the sixth-largest port in the world. Galveston Bay is also a repository for half of the permitted wastewater discharges in Texas.

Chief Threats to Galveston Bay

Historically, Galveston Bay has had severe water quality problems, particularly in the industrialized upper estuary portion of the Houston Ship Channel. Both point and nonpoint sources of wastewater have contributed toxic substances to water and sediments. Some toxic compounds have found their way into the food chain and have been measured in marine organisms (seafood) and birds. Because of industrial input of dioxin, seafood contamination advisories and fishery closures have been issued for some portions of the bay. As a result of bacterial contamination, fully half of the estuary is subject to regulatory closure to shellfishing because of risk to public health. Besides human health concerns, poor water quality has greatly reduced the natural diversity and productivity in portions of the bay and has caused nutrient enrichment and low oxygen levels.

Development pressures and land subsidence (sinking due to ground water and petroleum extraction) have led to a loss of 16 percent of Galveston Bay's coastal wetlands between 1956 and 1979. Additional losses since 1979 are now being determined and are expected to be significant. These losses are a major management concern because wetlands are essential to the survival of living resources in Galveston Bay, including economically significant recreational and commercial species. Wetlands are critical in supplying food and shelter for larval and juvenile fish and shellfish; they also serve an important role in natural nutrient cycling and in buffering runoff and wastewater entering the estuary.

Other threats to Galveston Bay include alteration of the natural physical features of the system. Changes in the amount and timing of freshwater inflow from reservoirs on both the Trinity and the San Jacinto Rivers have resulted in alteration of the salinity patterns in the bay. Dredging of navigation channels up to 40 feet deep in this shallow bay (with an average depth of only about 9 feet), have resulted in the intrusion of saline Gulf waters into the fresher portions of the upper estuary. This change is important because some species, like oysters, depend upon the freshwater mix for a food supply and to escape marine predators and disease organisms that cannot survive in fresh water. Dredging also raises concerns of reintroduction of toxic substances bound in the dredged sediments. The huge volume of ship traffic, especially involving transport of toxic petroleum compounds, creates a risk of spills

Galveston Bay is home to the largest petrochemical complex in the world.

from collisions and other accidents. These accidents occur regularly in Galveston Bay, as illustrated by two major incidents in the summer of 1990 that resulted in major impacts to the marine system.

The Galveston Bay National Estuary Program

Accepted into the NEP in July 1988, the Galveston Bay National Estuary Program (GBNEP) has formed six committees: Policy, Management, Local Government Advisory, Scientific/Technical Advisory, Citizens Advisory Steering Committee, and the Galveston Bay Public Forum (formerly the Citizen's Advisory committee). State and local agencies, universities, user groups, and private citizens are all represented on various program committees. The committees also include federal agency representatives from NOAA's National Marine Fisheries Service (NMFS), EPA, Fish and Wildlife Service, Geological Survey, Department of Agriculture Soil Conservation Service, Coast Guard, and Army Corps of Engineers. The characterization report has been completed; the CCMP is to be completed by September 1994.

Priority Problems

Based on public and Management Conference consensus, the following list was adopted in fall 1990. The four major problems are ranked in order of importance. Subcategories that may contribute to or interact with other listed problems were also developed for each major problem:

- ☐ reduction/alteration of living resources
- ☐ public health issues
- ☐ resource management issues
- ☐ shoreline erosion

Scientific Research

Water quality studies have focused on combined effects of pollution from point sources (end of pipe) and nonpoint sources (land runoff). Unauthorized discharges of water were identified in a shoreline survey that included both aerial and boat investigations. When combined with a study using historical water quality monitoring data for the estuary itself, these studies will represent the first ecosystem-level review of water quality.

Management of living resources, a high priority for Galveston Bay, will be based on population studies of key finfish, bird, and amphibian species, as well as on historical trends and the causes for those trends. Trends for the habitats upon which these species depend—particularly wetlands—will be determined by using a geographic information system based on computer analysis and field verification of aerial photos. Oysters, as a key species in the bay, are being surveyed with state-of-the-art sonar, combined with health studies of individual oysters and entire reefs. By-catch (the incidental catch of species other than shrimp by shrimp trawls) and other sources of incidental mortality caused by human activity are also being investigated.

Public health issues in Galveston Bay are closely linked to both living resources and water quality. A study is being conducted, for example, on chemical contamination of key seafood species and resulting levels of risk to seafood consumers. Historical data concerning shellfish (oyster) regulation and bacterial contamination of water and seafood will help the program conduct a baywide analysis of these critical public health factors. Toxic and bacterial contamination of seafood has been a particularly controversial concern in the Houston area.

Other work is aimed at characterizing dredging impacts and at determining the complexities of sediment characteristics and bottom-dwelling organisms for bay management. Combined, the GBNEP scientific studies of water quality, living resources, and public health will provide a solid foundation for management action plans in the CCMP.

Monitoring

Because Texas has so many agency jurisdictions related to Galveston Bay, designing an effective ecosystem monitoring strategy is both necessary and difficult. Among the state programs, the Texas Water Commission monitors traditional parameters and some toxic compounds

at a series of stations in Galveston Bay and its tributaries. These measurements are primarily for water quality, but they include some consideration of sediment and tissue contaminants.

Living resources are the responsibility of the Texas Parks and Wildlife Department, which has historically emphasized commercially and recreationally important species such as oysters, shrimp, blue crabs, red drum, and speckled trout. The Texas Department of Health monitors rainfall runoff to determine potential contamination threats to oyster reefs and determines human health risks and regulatory actions associated with toxic contamination of edible species.

Physical parameters are monitored by a variety of agencies; for example, tides are measured by the Texas Water Department Board and the U.S. Army Corps of Engineers. The U.S. Geological Survey records freshwater flow into Galveston Bay, while NOAA's Status and Trends program contributes data on concentrations of toxic substances in oysters.

Although these programs provide substantial data for Galveston Bay, they are considered too fragmented for effective ecosystem management under the NEP. The GBNEP is designing a goal-directed monitoring strategy that will redirect current efforts through a coordinated approach. Using comparable technologies, samples will be gathered and analyzed to answer key management questions. Sound scientific principles will be used in future monitoring to measure how well management practices are succeeding. The first step in this process is optimal segmentation of Galveston Bay (that is, geographic subdivision of the bay for sampling). Under this project, various existing regulatory boundaries will be compared with natural biological and hydrological boundaries in the bay.

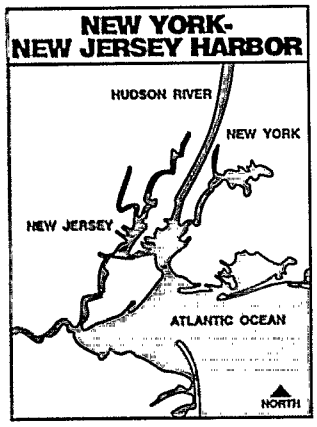
Management Tools

Recognizing the need for immediate action in preserving critical habitats in Galveston Bay, the GBNEP secured Texas Coastal Preserve status for Christmas Bay and Armand Bayou in February 1990. Under this program, administered by the Texas Parks and Wildlife Department and General Land Office, the GBNEP has initiated long-range protection, enhancement, and public use of these unique estuarine resources. As a tool, preserve status involves drafting management plans involving multiple resource agencies.

Critical information needs for management are being addressed with a coordinated data and information management system. This system centralizes useful information for managers and the public at Galveston Bay Information Center on the campus of Texas A&M University of Galveston. The Center houses a collection of reports, books, videos, maps, and other information on the bay. The Center also has a comprehensive computer-searchable bibliography. More than 3,000 references on Galveston Bay are readily available with this system, soon to be accessible by phone.

GBNEP aims to reverse trends toward declining living resources.

The Information Center will also house two other key management tools. The first is a Galveston Bay Data Base Inventory, a computer file of data set descriptions that completely specify the data available for the estuary. This system allows managers, scientists, and the public to focus immediately on information related to key management topics. Complete descriptions of the data and the name of contact sources for the actual data are also available on the system. The second tool is COMPAS, NOAA's Coastal Ocean Management, Planning, and Assessment System. This microcomputer-based system provides critical graphical information derived from raw data. COMPAS should be helpful in providing information to managers and the public, without the need for time-consuming technical data analysis.



New York-New Jersey Harbor Estuary

Introduction

The New York-New Jersey Harbor Estuary consists of the New York Bight Apex north of the Sandy Hook-Rockaway Transect, including tidal portions of the Hackensack, Passaic, Raritan, Navesink, Shrewsbury, Kill Van Kull, and Arthur Kill Rivers in New Jersey and the Hudson and East Rivers in New York. The estuary serves as a recreational resource available to over 16 million residents and 17.4 million visitors to the New York-New Jersey metropolitan area. Oceanfront tourism in New Jersey alone generates $4 billion in annual revenues. Among the area's attractions are beautiful beaches, abundant wildlife (particularly in the Hackensack Meadowlands), the Manhattan skyline, Battery Park, and the Statue of Liberty. Although this urban area is densely inhabited, there are also many resident populations of birds and mammals including whales, harbor seals, osprey, bald eagles, and snowy egrets. In addition to tourism, the Port of New York and New Jersey plays a major role in the regional economy. In 1985, this world class port handled 51 million tons of cargo valued at $49 billion. Port activities generate $14 billion per year in economic activity in the metropolitan area and support 200,000 jobs.

Chief Threats to the New York-New Jersey Harbor Estuary

The major threat to the New York-New Jersey Harbor Estuary is its increasing population density, resulting in pollution and overuse. Each day, municipal sewage treatment plants in New York and New Jersey discharge more than 2.6 billion gallons of wastewater into the estuary. Much of this wastewater receives secondary treatment that removes 85 percent of organic pollutants, but some wastewater still receives only primary treatment. Moreover, malfunctions or overloads in the system can result in discharges of untreated sewage. Untreated wastewater is a primary source of toxic metals, organic chemicals, pathogens, nutrients, and floatable debris.

Construction practices, such as deepening channels, building bulkheads against erosion, and filling water areas to expand development have also taken a toll on the health of the New York-New Jersey Harbor Estuary. Filling and draining wetlands eradicates important habitats and disrupts the self-cleaning mechanism of the estuary. Dredging channels resuspends sediments that are often contaminated by toxic chemicals and organic materials.

Effects of pollution and contamination can be seen everywhere. New Jersey has lost 75 percent of its wetlands since 1925. Public beaches have been closed in both states because of bacterial contamination or floatable debris. New York and New Jersey have issued advisories limiting consumption of bluefish, striped bass, and American eel because concentrations of toxic chemicals and pathogens in the fish are often above Food and Drug Administration limits. Pollution has an economic effect as well. In 1988, business in many areas of New Jersey declined by 80 percent because of beach pollution. The Army Corps of Engineers estimated that in 1987, 17,800 vessels in the harbor were damaged by floating debris at a cost of $48 million.

The New York-New Jersey Harbor Estuary Program

Formally established in July 1988, the New York-New Jersey Harbor Estuary Program (HEP) has formed committees, all with open membership. The Management Committee includes representatives from local, state, and federal agencies such as EPA, NOAA, and the Army Corps of Engineers. Overall, the Management Committee has 20 members, including four from the Citizens Advisory Committee, two from local governments, and two from the Scientific and Technical Advisory Committee. The Management Committee has accepted the responsibility for management and coordination of the New York Bight Restoration Program. The Scientific and Technical Advisory Committee (STAC), consisting of researchers and scientists from academia and state and local agencies, is presently conducting characterization analyses. The CCMP will be organized according to "problem modules" and will describe precise actions and time frames for controlling pollution. The CCMP will be submitted in 1994; prior to this, a preliminary CCMP will be issued.

Priority Problems

HEP has organized high-priority problems into the following modules:

- ☐ pathogen contamination
- ☐ floatable debris
- ☐ toxic contamination
- ☐ nutrient and organic enrichment
- ☐ habitat loss and alteration/living resources

Scientific Research

Shell disease, which affects lobster, crab, and shrimp, has been investigated by a working group reporting to EPA and NOAA as part of the Bight Restoration Program. The group concluded that the disease is a natural occurrence, but that it is more widespread and severe in polluted areas. Follow-up studies on this problem are needed.

A major effort of the Harbor Estuary Program (HEP) for this past year has been to address wasteload allocations for eight toxic metals, including mercury, copper, lead, nickel, silver, zinc, arsenic, and cadmium. Based on data currently being collected, limits will be set on point-source discharges of those metals found to contribute to the exceeding of water quality standards. This evaluation will be completed in 1992.

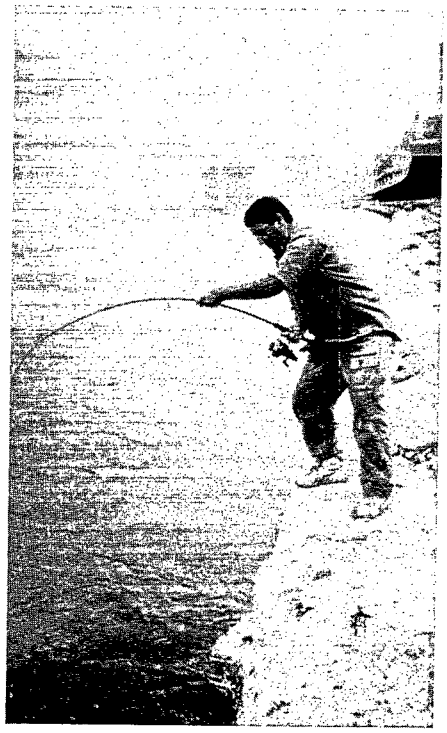
Monitoring

Scientists are currently monitoring the presence of trace metals in sediments and ambient water. Samples are taken from a variety of locations to test discharge from both point and nonpoint sources. The data collected will be used to calibrate toxic models. A secondary monitoring effort will expand on this work. Many long-term monitoring efforts in harbor areas have significant data sets. As part of this study, interlab comparability studies are being conducted to evaluate past procedures as compared with current "clean" analyses.

In the future, HEP plans to monitor the movement of sediments and suspended sediments in the harbor. Measurements will be taken in various tidal conditions and at different times of the year. A regionwide biomonitoring program that includes the harbor, Long Island Sound, and the New York Bight is also part of future monitoring goals.

Management Tools

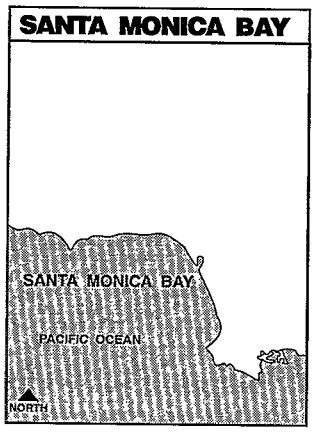
HEP is developing a New York-New Jersey Environmental Lifestyle Guide as a pollution prevention tool. The project recognizes that in an area of dense urban population, citizen behavior can have a significant impact on the environment. In 1989, for example, 164 garbage slicks plagued the harbor from Upper Bay to Raritan Bay. Much of this garbage came from careless disposal of common trash. The Lifestyle Guide outlines positive steps residents can take at home and in the workplace to prevent pollution. Flexibility is the guide's strong point. Because the information will have



Fishing in the shadows of New York City.

greater impact if it is tailored to each reader's particular situation, the format allows for interchangeable sections such as oil recycling, water conservation and boater pollution.

Coordination with other conservation and restoration organizations has been a major aspect of HEP's management strategy. Under the United States-Japan Fishery Agreement Approval Act of 1987, the Administrator of EPA, in consultation with NOAA and other federal, state, and interstate agencies, directs the New York Bight Restoration Plan. Since pollutants in the New York-New Jersey Harbor Estuary affect the New York Bight, efforts of the two programs are intertwined. The same Management Conference coordinates both the New York Bight Restoration Plan and the Harbor Estuary Program. Also, New York State has established the Hudson River Estuary Management Program, which is concerned with river conditions from Troy to the Verrazano Narrows. This study overlaps somewhat with HEP's study area. While the Hudson River Plan is primarily focused on living resources, appropriate HEP recommendations will be included in the Hudson River Plan, and HEP will consider recommendations of the Hudson River Plan in developing its CCMP.



Santa Monica Bay

Introduction

Santa Monica Bay is a relatively small (266 square mile), open embayment on the central part of the southern California coast. The bay lies adjacent to one of the nation's most populous and urbanized coastal communities. About 8.5 million people currently live in Los Angeles County, with over 10 million residents projected by 2010. Much of this population is drawn to the bay's temperate Mediterranean climate and rich marine resources, which promote a variety of activities. Swimming, surfing, sunbathing, and sailing are all popular, providing significant income for coastal communities. Residents and tourists enjoyed an estimated 44 million beach-user-days along the entire coastline in 1987. With commercial fishing restricted to outer portions of the bay, sport fishing from shore and vessels is also widespread. Santa Monica Bay still provides some essential nesting and foraging habitats despite harmful human influences. At least five endangered species are among the bay's residents and transients, including the California least tern, brown pelican, and gray whale.

Chief Threats to Santa Monica Bay

Until the mid-1970s, the bay's greatest pollution problem was the nearly 800 million gallons of treated sewage discharged per day by two municipal wastewater treatment plants. Among other contaminants, municipal effluent had contained considerable amounts of DDT and PCBs. Today, tighter source controls, refined treatment technology, and discharge monitoring have considerably reduced the effects of sewage discharges, although DDT and other contaminants persist in bay sediments and in local fish tissue. Municipal flows also contain suspended solids, oil and grease, and heavy metals. Industrial discharges to the bay consist of seawater heated in three power plant coolant processes and treated industrial wastewater from an El Segundo oil refinery.

With the threat from municipal discharges now reduced, storm drain runoff is seen as a serious residual issue. Untreated flows from about 60 storm drains wash large amounts of automobile wastes, oil (more than 10 barrels per day), litter, gardening and household chemicals, and metals into the bay. Further, heavy rainfalls greatly increase the volume of these discharges and periodically cause raw sewage to spill into Ballona Creek and other parts of the estuarine system. Chemical and bacterial pollutants can also cause serious problems such as actual human health threats and damage to the bay's few remaining wetlands or simply public fear or concern over possibly tainted seafood and temporary beach closures. Like the storm drains, hard-to-control nonpoint sources such as air emissions, ocean dumping, vessel operation, oil seeps and spills, and marine debris contribute their own diverse set of pollutants.

The Santa Monica Bay Restoration Project

The Santa Monica Bay Restoration Project formally joined the NEP in July 1988. EPA Region IX, the State Water Resources Control Board, and the Los Angeles Regional Water Resources Control Board lead the Management Conference. The project expects to complete its CCMP by 1994. To this end, the members of the Management Conference recently participated in a

successful day-long workshop to initiate CCMP development. During the workshop, the newly formed management subcommittees (on nonpoint source pollution, point source pollution, marine habitat, wetlands, and watershed management) held their first meetings to begin the process of identifying the action plans that will form the core of the CCMP.

Priority Problems

Soon after the bay's induction into the NEP, a two-volume *State of the Bay* report was produced. The report analyzes an extensive collection of data to ascertain the kinds, sources, and levels of contamination present in the bay, as well as its potential ecosystem and human effects. As a result of this and other studies, the Santa Monica Bay Restoration Project (SMBRP) has identified the following areas of concern:

- human health risks associated with eating contaminated seafood
- human health risks associated with disease-causing pathogens in the surfzone
- loss and degradation of wetlands
- impact of pollution on the benthic (bottom-dwelling) community
- impact of pollution on the pelagic (open-ocean) community

Scientific Research

A number of studies are or will be under way to investigate these key problems. For example, the Southern California Coastal Water Research Project (SCCWRP) is analyzing white croaker and rock crab samples to clarify the extent of bay seafood contamination. In a complementary study, other researchers will survey recreational fishermen to gauge their catch and fish consumption patterns. Through these efforts, the Management Conference should better understand the human health risks associated with consuming local seafood.

Santa Monica Bay Restoration Project is protecting the California least tern.

In a joint study, the environmental interest group Heal the Bay, Los Angeles' Hyperion Monitoring Division, and the County Sanitation Districts' Virus Laboratory have discovered pathogen contamination in Santa Monica's Pico-Kenter storm drain. Such disease-carrying bacteria might harm swimmers and surfers. A second phase of the study will attempt to locate the pathogen sources.

Another effort is under way to study the nonpoint source contaminants of stormdrains in the Los Angeles area. The research will assess existing data, define goals of a monitoring plan, and recommend best management practices. Studies are also being sponsored by the SMBRP to identify the extent of contaminated sediments on the sea floor and to analyze the biological effects of these sediment toxins on the bay's biota.

Monitoring

Numerous agencies and organizations currently monitor bay environmental quality, resource status and use, and human impacts. For instance, NOAA's National Marine Fisheries Service, the California Department of Fish and Game, and the Scripps Institution of Oceanography conduct quarterly surveys of fish stocks and physical/chemical parameters. All NPDES-permitted dischargers in the bay are required to monitor water quality and benthic populations. The two municipal wastewater treatment plants also monitor daily for bacterial contamination at various beach stations

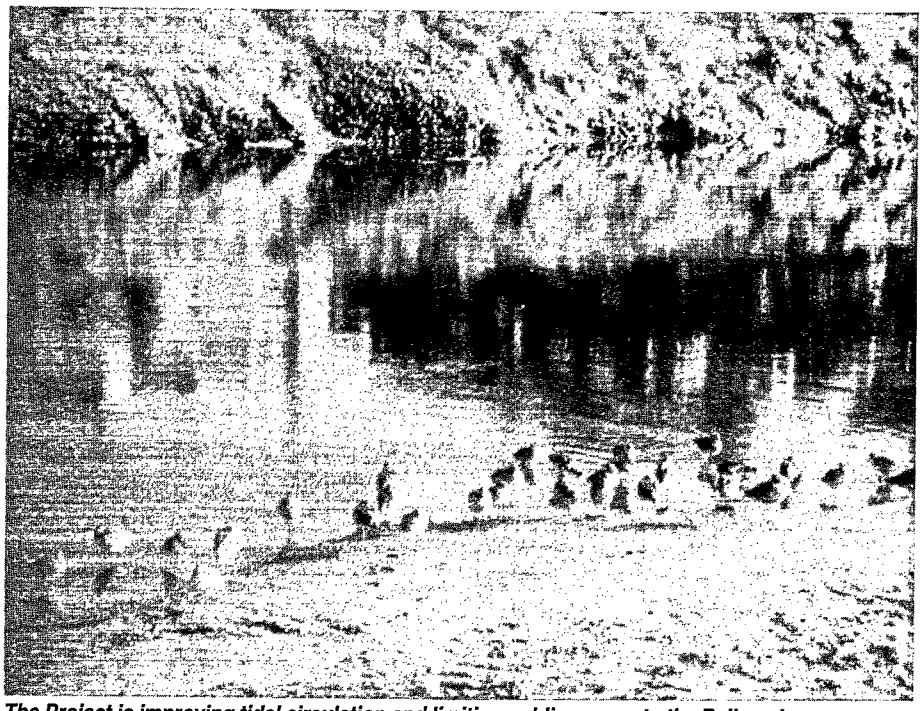
and other sites. In addition, the state's Mussel Watch program has sampled transplanted mussels for organic and inorganic contaminants for well over a decade.

These monitoring programs make up only a portion of the total monitoring activity in Santa Monica Bay. In all, more than $3 million is spent annually on bay monitoring efforts. However, these activities must be better coordinated to be of maximum value in protecting the bay. To that end, the project held a workshop in September 1990, where scientists and decision makers met to determine the goals and objectives of a comprehensive monitoring and data management system and to develop its technical aspects. The entire bay region, extending far beyond the bay itself, will be represented in the system.

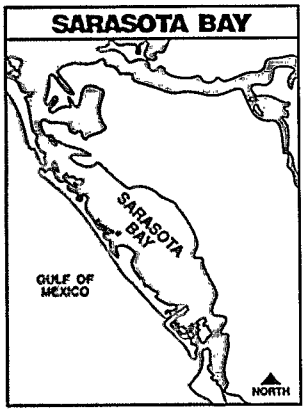
Management Tools

To address its serious storm drain discharge problems, the project recently led negotiations to develop a landmark stormwater discharge permit for Los Angeles County. Issued jointly in June 1990 to the county and cities in the watershed, this NPDES permit requires permittees to control the amount and quality of stormwater runoff into the bay. Unlike most NPDES permits issued to individual municipal and industrial dischargers, this permit focuses on the use of best management practices, rather than numeric effluent limitations. The permit divides the county into five drainage basins. Each will be phased into compliance over three years, beginning with the Santa Monica Bay drainage basin in July 1990. The public will have many opportunities to influence the permit's success: annual workshops will focus public review and comment, and permit provisions require that permittees solicit public input in developing their best management practices and programs.

Whether the issue is storm drain discharges, contaminated seafood, or habitat destruction, community involvement is essential to restoring and protecting the bay in this densely populated watershed. The Santa Monica Bay Restoration Project's Public Advisory Committee is working hard to gather public support for saving the bay. With a special appearance by the Teenage Mutant Ninja Turtles, the project kicked off a storm drain campaign on Earth Day 1990. An excited crowd greeted the Turtles and picked up over 40,000 copies of "Storm Drain Savers," an original eight-page Turtles comic book discussing Santa Monica's storm drain problems. Public enthusiasm continued into September 1990, when thousands of Los Angeles County citizens combed the beaches for marine debris during Coastal Cleanup Day. This activity was repeated in September 1991, with a 50-percent increase in participation. The project is building upon its public participation program by sponsoring multilingual and multiethnic programs concerning fishing and seafood contamination issues and radio station spots in which a local marine biologist discusses the bay's problems with the public. Such activities and events generate public input and contribute to consensus building for the CCMP.



The Project is improving tidal circulation and limiting public access to the Ballona Lagoon Marine Preserve.



Sarasota Bay

Introduction

Sarasota Bay is a narrow, 56-mile-long, subtropical bay on the southwest coast of Florida. Spectacular white sand and related bay environs make this a favorite spot for tourists and seasonal and retired residents. Canal front residential development valued in the billions of dollars and visitor expenditures that totaled $1.5 billion in 1987 indicate that a healthy Sarasota Bay is an important economic asset. Favorite activities in the bay include boating, skiing, diving, and surfing. Sailing, especially regatta events, attracts a national field of competitors. The bay also has significant ecological value. For instance, it provides a breeding ground for loggerhead turtles and dolphins and a corridor for seasonal manatee migrations. The estuary is also a nursery ground for commercial and recreational fisheries.

Chief Threats to Sarasota Bay

Sarasota Bay is relatively clean in comparison with industrialized estuaries in the United States; however, the system has been heavily altered by development and overuse and is considered vulnerable, given a projected population increase of 25 percent over the next five years. The bay is typical of Florida estuaries because its problems stem more from development and overuse than from industrialized pollution. In Sarasota Bay, stormwater, inadequately treated wastewater, dredging, unmanaged access and use, and habitat loss are the primary concerns.

Rainfall that washes over roads, parking lots, and other impervious surfaces collects pollutants and eventually flows into the bay. Stormwater entering the bay increases turbidity, decreases salinity, and causes eutrophication—increased algal growth due to an excess of nutrients. These algal blooms reduce water clarity and the amount of dissolved oxygen in the water, harming fish, submerged aquatic grasses, and other marine life.

Wastewater discharge also contributes to eutrophication and creates additional problems. Pathogen contamination from septic systems and inadequately treated wastewater has led to shellfish bed closures in most areas of the bay.

In the past, Sarasota Bay was routinely dredged to create navigation channels and enhance private development. The bay's shoreline length has increased by 64 percent as a result, leaving less than 22 percent of that shoreline in its natural state. Carving channels where shallow sea grass beds once were has destroyed important habitats and created large areas where bottom sediments are devoid of aquatic life. Dredge spoil islands have also blocked natural water circulation in the bay and changed salinity patterns, disrupting aquatic communities.

In addition to dredging, boat propellers in shallow water harm sea grass beds. Scarred grass beds often cannot support sea grass and other marine life and take several years to recover. This problem is particularly relevant to Sarasota Bay, since 65 percent of the bay area is less than three feet deep.

The Sarasota Bay National Estuary Program

Convened in July 1989, the Sarasota Bay National Estuary Program completed a State of the Bay report in January 1990. The Management Conference plans to complete a Framework for Action in 1992, synthesizing information resulting from the technical, early action, public outreach, and education projects now in progress. The Framework for Action also will present a preliminary strategy for bay restoration, management, and implementation funding. The final CCMP is due in June 1994.

In 1990, the Management Conference initiated and managed new technical, early action, and public participation projects. Public outreach and educational activities were expanded as well, including development of a Citizen Advisory Committee Action Plan, a mass media strategy, and instructional materials for use in local school systems. Projects for 1991 included continuing the basinwide characterization of trends in water quality, habitat, and living resources, and presenting these findings to the Citizens and Technical Advisory Committees before presenting findings to the public in 1992.

Priority Problems

The following list of concerns was presented in the State of the Bay report, a document reviewed by over 150 scientists and citizens from the bay area as well as by all committees in the Management Conference:

- decline in water quality
- stormwater and wastewater
- habitat loss
- decline in finfish and shellfish populations
- inadequate and inconsistent public access and overuse of resources

Scientific Research

Based on information included in the State of the Bay report, the Technical Advisory Committee, which includes members from NOAA's National Marine Fisheries Service and the Florida Sea Grant Program, decided what scientific work was still needed to manage the bay properly. Research planned and in progress ranges from laboratory tests to interviews with anglers.

Sarasota Bay

Six projects were completed, including projects that map and catalog the quality and quantity of freshwater and intertidal wetlands in the bay area; assess finfish diversity, shellfish

Students planting marsh grass.

contamination, and alterations to bay bottom habitats; and analyze historical water quality data and sediment contamination.

Other technical work that began in 1990–1991 and will be completed in 1992 includes a model of pollutant loadings, a baywide circulation model, an assessment of how and where people use the bay, and an assessment of potential impacts from a rise in sea level. Scientific research and technical expertise for conducting these studies is available through New College, Mote Marine Laboratory, the Universities of Florida and South Florida, government agencies, and private consulting firms.

Monitoring

In 1990, the Sarasota Bay National Estuary Program initiated a quarterly comprehensive monitoring program that included 102 sampling sites baywide. The program, supported by local governments with coordination and oversight provided by Mote Marine Laboratory, also includes a baywide sediment scan and an analysis of historical water quality data. Emphasizing nutrients, light, and light-related parameters, this long-term program will help determine where water quality is a problem in the bay and will become a tool for measuring progress over the next several decades.

Management Tools

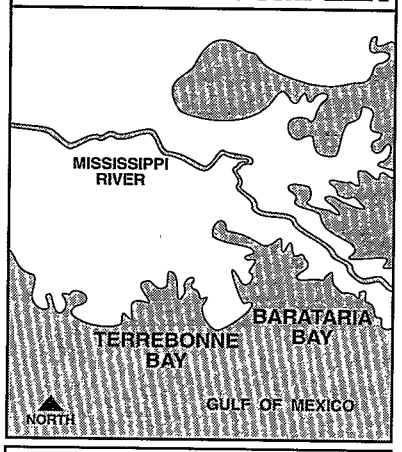
The Sarasota Bay National Estuary Program is examining a variety of initiatives to improve bay management, including upgraded wastewater treatment facilities, enhanced stormwater management programs using Stormwater Environmental Utility resources, baywide habitat restoration, and public education and community support. Public education may be the most important component, because many homeowners around the bay unknowingly pollute it, as indicated by the response to a recent public opinion survey and by the reaction to the "Bay Repair Kit." The kit, released by the program this year, is a nationally recognized homeowner's guide to protecting the bay.

The Sarasota Bay program is successfully conducting six early action demonstration projects to test innovative approaches on a small scale and develop cost estimates for baywide application. The projects focus on preserving, restoring, and protecting ecologically significant bay areas; protecting sea grass beds through marking and through public awareness; modifying bulkheads and seawalls to create more natural shorelines; and improving stormwater drainage systems through structural changes and best management practices. Not only have the projects proven valuable in demonstrating early actions and developing implementation strategies, but they have also fostered strong public recognition and support for Sarasota Bay program goals.

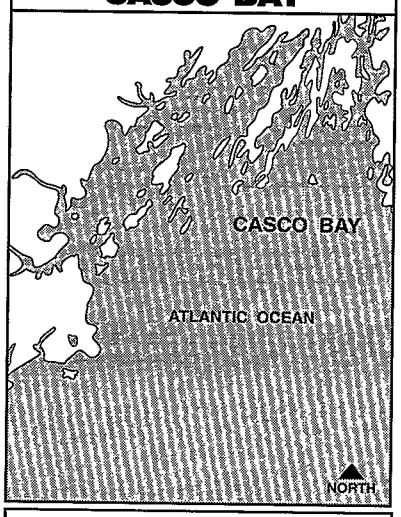
The Management Conference is expected to consider preliminary recommendations from each of the ongoing technical, early action demonstration, and public education and outreach projects through the Framework for Action report review process, due in August 1992. The recommendations will be reviewed by the Citizen and Technical Advisory Committees prior to approval by the program's Management and Policy Committees. Subsequent to the release of the Framework for Action report by the Management Conference, the findings will be presented in a series of public meetings to take place in 1993 and 1994. It is anticipated that the recommendations will broaden and strengthen as this process is completed, leading to the release of the final CCMP in June 1994.

Tier 3

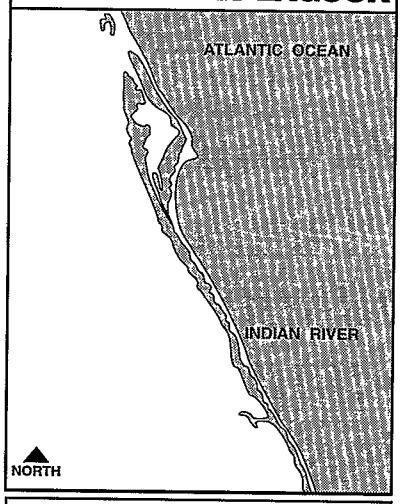
BARATARIA-TERREBONNE ESTUARINE COMPLEX



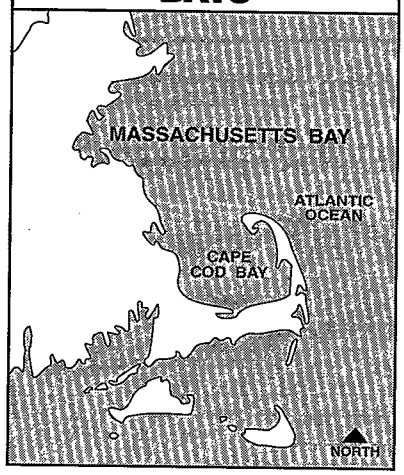
CASCO BAY



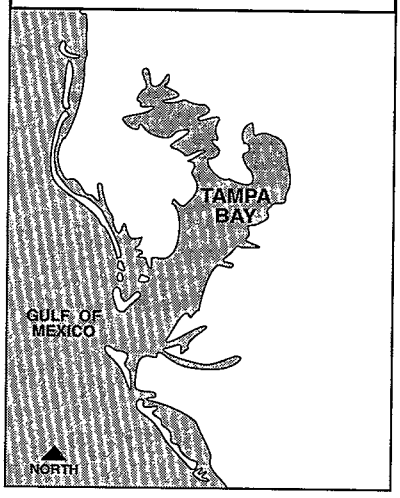
INDIAN RIVER LAGOON

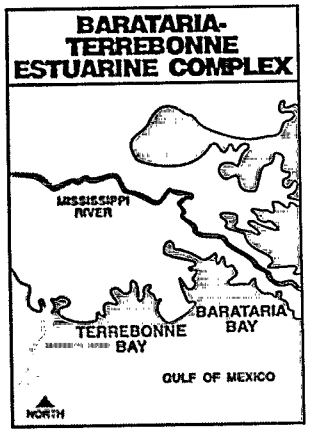


MASSACHUSETTS BAYS



TAMPA BAY





Barataria-Terrebonne Estuarine Complex

Introduction

The Barataria-Terrebonne Estuarine Complex of Louisiana is an area of unparalleled national significance. With a total water and wetland area of 3,600 square miles, this estuarine system contains more coastal wetlands than any other in the United States and has an open water area twice that of Long Island Sound. The complex consists of estuarine wetlands and bodies of water filling basins between the two active distributary systems of the Mississippi River, the lower Mississippi River proper and the Atchafalaya River. Described as a "Sportsman's Paradise," the area is heavily used by boaters, fishermen, and hunters. Of great economic importance, the Barataria-Terrebonne Estuarine Complex supports at least 19 percent of the estuarine-dependent fishery resources of the United States. Commercial fishing in Louisiana employs well over 35,000 people, while subsistence fishing helps support many other coastal residents. The complex is also home to a great variety of endangered wildlife and is a source of several valuable mineral resources, including oil and natural gas.

Chief Threats to the Barataria-Terrebonne Estuarine Complex

Like other estuaries, Barataria-Terrebonne has been used as a waste repository for point and nonpoint sources of pollutants, including domestic and industrial discharges and agricultural drainage. It has also suffered the effects of shoreline development and dredge-and-fill activities. However, some significant environmental degradation has resulted from activities unknown or unusual in other estuarine systems: large-scale hydrologic and sediment modification caused by an interplay of natural processes and human activities such as canal construction, flood control, and oil and gas activities.

Hydrologic modifications have been identified by the Management Conference as the "lynch pin" problem confronting the Barataria-Terrebonne Estuarine Complex. Reductions in the natural flow of sediments and fresh water to the estuarine complex have altered its balance of salt and fresh waters, the rate of natural sediment deposition, and the passage of runoff waters through wetlands. As a result, habitat modifications and losses and changes in the area's living resources have occurred. Through its focus on hydrological modifications, the Management Conference will address most of the major problems confronting the Barataria-Terrebonne Estuarine Complex.

The Barataria-Terrebonne National Estuary Program

The Barataria-Terrebonne National Estuary Program was convened in April 1990. Its Policy Committee is chaired by the Louisiana Department of Environmental Quality; EPA Region VI provides the Vice-Chairman. The Management Committee is chaired by the Louisiana Department of Natural Resources; again, EPA Region VI fills the Vice-Chairman position. Committees include representatives from EPA, NOAA, Army Corps of Engineers, Soil Conservation Service, Fish and Wildlife Service, U.S. Geological Survey, and the Coast Guard. The key to committee structure, however, is the

strong participation of state, local, and interest group representatives.

The CCMP will be completed in 1996. The plan could be incorporated into state and local coastal zone management programs and will likely build on the considerable work already done under the Coastal Zone Management Act by the Barataria Basin Technical Working Group.

Priority Problems

The primary environmental quality problems in the Barataria-Terrebonne Estuarine Complex are the physical deterioration of habitats; diffuse sources of pathogens, nutrients, and toxicants; and activities related to oil and gas production. Pending further refinement, the Barataria-Terrebonne National Estuary Program will focus on seven major problems:

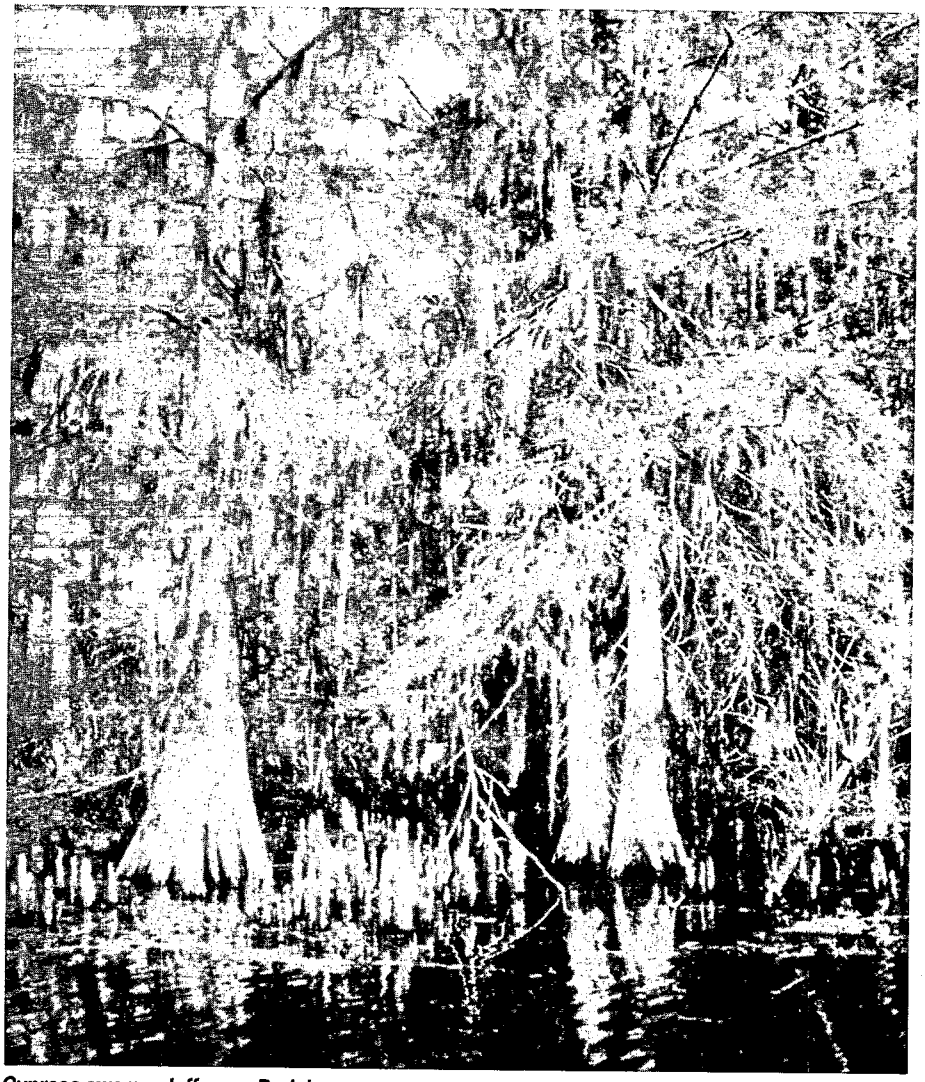
- hydrological modification
- reduced sediment flows
- habitat loss and modification
- changes in living resources
- eutrophication
- pathogen contamination
- toxic substances

Hydrologic modification is considered the "lynch pin" problem because it is linked to all the other problems.

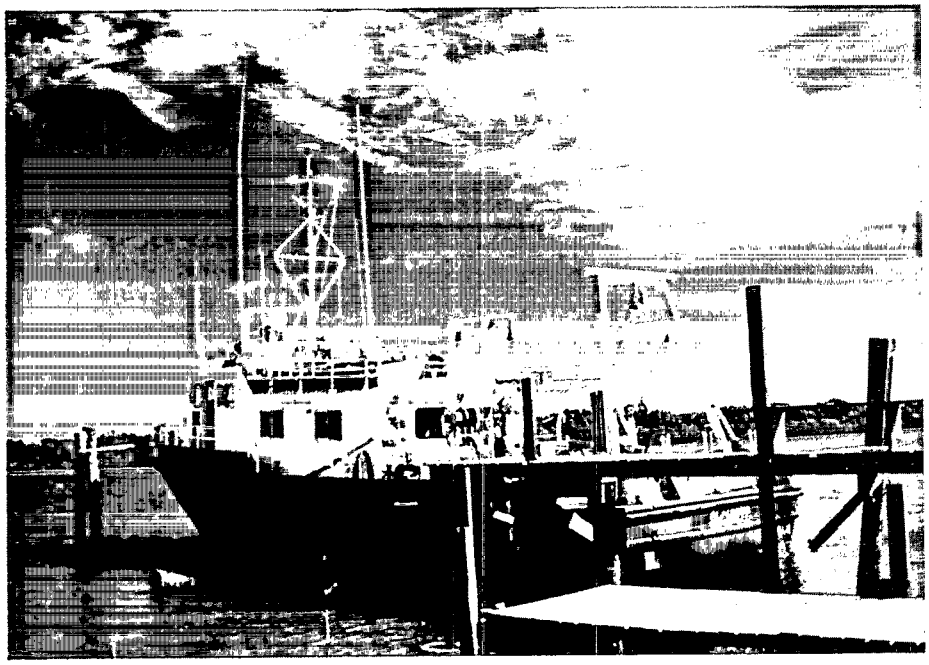
Scientific Research

Federal and state agencies are currently undertaking several studies of the Barataria-Terrebonne Estuarine Complex. For instance, the U.S. Geological Survey and the Fish and Wildlife Service are conducting a five-year cooperative research program on the causes of coastal wetland loss, emphasizing sedimentation and wetland plant ecology. These agencies also have recently completed a study on the geology and environmental processes of barrier islands fringing the complex.

Universities have historically contributed much technical information on water quality and habitat degradation in this estuarine system. The Center for Wetland Resources, the School of Geosciences, and the Institute for Environmental Studies at Louisiana State University, as well as Nicholls State University, have all researched local ecology, eutrophication, geological history, environmental contamination, and fishery resources and will continue to do so in the future. Research has also been sponsored by the Louisiana Sea Grant Program at Louisiana State University. Louisiana Universities Marine Center, the consolidated marine laboratory of the Louisiana Universities Marine Consortium, provides excellent facilities, including



Cypress swamp, Jefferson Parish.



LUMCON research boat, Timbalier Island.

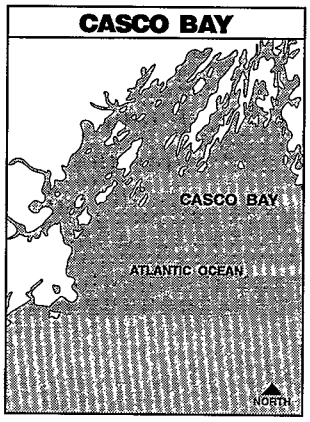
two research vessels in Cocodrie and a field station at Port Fourchon.

In the future, one major research focus will be on the relative importance of salinity increases and reduced sedimentation on coastal wetland losses within the Barataria-Terrebonne Basins.

Management Tools

The Barataria-Terrebonne National Estuary Program expects to build upon several state estuarine management efforts, including those of the Barataria Basin Technical Working Group, the State Coastal Restoration Authority, the Wetland Conservation and Restoration Task Force, and the Federal/State Task Force empowered in 1990 by the Coastal Wetlands Planning, Protection, and Restoration Act, P.L. 101-646 (the "Breaux Bill").

A primary management challenge of the Barataria-Terrebonne National Estuary Program is to integrate the various goals and objectives of these ongoing state management activities, as well as those of federal activities. The program will focus on specific manageable regions and will promote the inclusion of water quality and living resource considerations in wetland restoration plans. Overall, the Management Conference will strive to improve basin hydrology and manage salinity, reduce natural habitat loss and improve sediment management, improve water quality, maximize fish and wildlife populations, protect human and cultural resources, and inform and educate the public concerning the resources and environmental problems of the estuarine environment.



Casco Bay

Introduction

Casco Bay lies within the Gulf of Maine, bounded by Cape Elizabeth on the west and Small Point on the east. Currently the most heavily developed bay in northern New England, Casco Bay attracts both business and tourism with its quality of life. Indeed, much of Maine's economy is dependent on the Casco Bay region. In 1988 alone, estimated tourist sales in the area totaled $236 million. Strategically important for commerce since colonial times because of its deep water and protection from open ocean, Casco Bay is still Maine's most important cargo port and fishing center. The Portland Fish Exchange—the only fish auction north of Boston—is located here. The bay's rich habitat provides 20 percent of all lobster caught in Maine and supports an abundance of other living resources, including endangered and threatened species.

Chief Threats to Casco Bay

Until 1983, people believed that Casco Bay was pristine. That year, studies showed that sediments in Casco Bay were laden with various pollutants including heavy metals, PCBs, and PAHs. In NOAA's 1988 *Long Term Status and Trends Program* report, Casco Bay ranked among the most polluted sites in several categories. While more data must be collected to determine the actual extent of contamination, there is general agreement that economic growth in the area has placed new pressures on the bay's environment. Currently 11 percent of the shellfish areas are closed because of pollution, contaminants are harming eagles and waterfowl, and routine violations of pollution standards threaten safe swimming in certain areas.

Despite these threats, Casco Bay's problems are less extreme than those of other NEP estuaries. The bay offers an opportunity to emphasize protection as well as restoration.

The Casco Bay Estuary Project

The Governor of Maine's 1989 Agenda for Action recommended eight immediate steps to improve the bay and eight subsequent initiatives to be completed after 1989. The Casco Bay Estuary Project, established within the National Estuary Program in April 1990, will build upon on this Agenda for Action. Goals of the Casco Bay Management Conference include preventing further degradation and improving existing conditions in the bay. The Conference will work toward these goals with a process that emphasizes action and the involvement of all interested parties. The project is made up of a Management Committee, a Citizens Advisory Committee, a Local Government Advisory Committee, and a Technical Advisory Committee. Federal, state, and local government agencies are represented on the Management Committee and throughout the conference structure. The CCMP will be completed in September 1995.

Priority Problems

The Management Conference has identified three issues that will be addressed in the project's inaugural year. First, more information is needed to assign priorities to specific concerns and problems. This effort will include gathering existing information and collecting new data. Second, a broad

spectrum of people and interests must be involved in the project. This involvement is necessary for developing credible and effective programs. Third, the Management Conference aims to focus on issues and activities at the local level. The Conference realizes that the success of future actions depends on local efforts. In addition to identifying the above needs, the Management Conference has received feedback on the following list of specific environmental concerns:

- toxic waste
- balancing economic development with environmental protection
- lack of enforcement
- nutrients
- bacteria
- combined sewer overflows

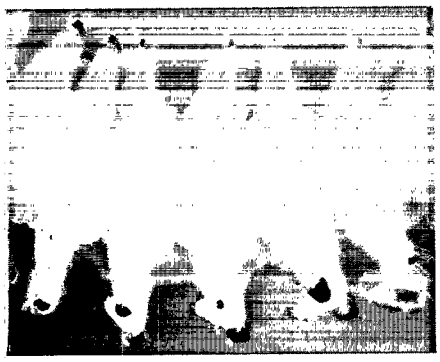
Scientific Research

Work in the first year will help focus future research and management efforts. To this end, the project will gather and analyze existing information about the bay. New research will include measuring the distribution of contaminants in sediments and beginning an extensive effort to identify critical habitats for mapping on the state Geographic Information System.

In advance of a formal information analysis, scientists have been able to identify research needs: studies of flushing capability, nutrient loading capacity, extent of pollutants, appropriate biological monitoring protocols, fate and transport of contaminants in the environment and food chain, and safe levels of pollutants in sediments and tissues.

Lee Doggett

Healthy worm.



Lee Doggett

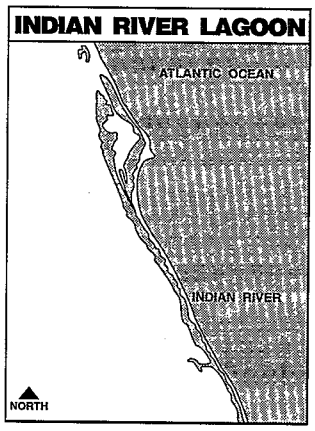
Worm with oil-like globules on feet.

Monitoring

Effective monitoring has often been lacking in the past and will be a priority for the Casco Bay Management Conference. Monitoring will include physical, biological, and social trends (such as population and land use), as well as chemical testing. An important component of the Casco Bay monitoring program will be data collected by citizen volunteers to provide quality-controlled, credible information for use in evaluating Casco Bay water quality.

Management Tools

Many activities which affect the health of coastal resources are controlled locally, such as zoning, site review, stormwater control, health code enforcement, building performance standards, and infrastructure planning. The Casco Bay Estuary Project plans to develop management tools for use at the local level that will strengthen the ability of communities to protect water quality and habitats. Funding mechanisms for these activities will be crucial to success. It is also important that management and funding approaches take into account the differences among the wide variety of communities involved, from urban areas to small rural towns.



Indian River Lagoon

Introduction

Florida's Indian River Lagoon system stretches from Ponce de Leon Inlet near Daytona Beach to Jupiter Inlet, a distance of 155 miles. It includes Mosquito Lagoon, Banana River Lagoon, St. Lucie Estuary, and Indian River Lagoon, an area with a drainage basin of approximately 2,300 square miles and a surface water area of approximately 353 square miles. The Indian River Lagoon is in a biogeographical transition zone, between the temperate Carolinian province and the subtropical province, resulting in a complex ecosystem that has the highest species diversity of any estuary in North America. The Indian River Lagoon supports a number of rare and endangered species, including the loggerhead turtle and the West Indian manatee.

The mild climate and diversity of recreational opportunities have attracted many visitors and residents to this coastal area. Currently the lagoon area is one of the fastest-growing population centers in the nation. The resources of the lagoon are an important part of the region's economy, with direct economic benefits from commercial fisheries, sport fishing, and other recreational pursuits.

Chief Threats to Indian River Lagoon

Though presently a source of community pride and economic well-being, Indian River Lagoon may not be as healthy as it appears. Stormwater runoff through manmade drainage systems, wastewater discharges, and mosquito control impoundments pose great threats to Indian River Lagoon. These disturbances cause sediment and nutrient loading, pathogen and toxic contamination, and destruction of habitat. Such impacts ultimately affect the area's ecology and economy.

In certain areas, high nutrient levels have resulted in increased algal growth, often reducing the levels of dissolved oxygen to levels below that required to support a healthy fish population. Total fish landings and their dockside value have steadily decreased since 1982. Construction of mosquito control impoundments has resulted in an 85-percent loss of mangrove swamp and a 30-percent loss of seagrass meadow. Continued habitat destruction could lead to extinction of endangered species and to reduced species diversity. Measurable levels of toxic metals have been found in some commercially important species, even though toxins do not yet pose a health risk.

The Indian River Lagoon National Estuary Program

Convened in April 1990, the Indian River Lagoon National Estuary Program now has a functional organizational framework. A nine-member Policy Committee consisting of representatives from EPA, the Florida Department of Environmental Regulation, the St. Johns River Water Management District, the South Florida Water Management District, and five counties within the lagoon basin provide direction for the Management Conference. A Characterization Report will be submitted in 1994, and the CCMP will be complete in 1996.

The program's Management Conference will conduct a program inventory to identify and describe various state, local, and regional

programs in operation. This report will scrutinize the effectiveness of existing management programs and identify duplicated efforts, gaps, weaknesses, and inconsistencies. In general, the Management Conference will plan for long-term improvements and will initiate early action activities to address defined management problems.

One early action activity will restore the connection between the Indian River Lagoon and 75 acres of coastal marsh presently impounded for mosquito control purposes. Reincorporating this marsh into the lagoon ecosystem is expected to improve water quality and wildlife habitat. This marsh reconnection project will serve as a demonstration project with possible application throughout the lagoon system.

The Management Conference also recognizes the importance of an informed, involved, and educated public and is in the process of developing a public involvement and education plan. One of the first steps in this effort was a workshop aimed at familiarizing educators with the lagoon. Two workshop sessions attended by a total of 60 teachers were held during July of 1990.

Priority Problems

The Indian River Lagoon National Estuary Program Management Conference, with the help of public input, has identified and assigned priorities to the environmental problems facing the lagoon. The adopted list is based on a list prepared through the Surface Water Improvement and Management (SWIM) program, which was itself based on lists prepared by several previous groups. The Management Conference wanted to refine and build on the existing list of priority environmental problems rather than to duplicate these efforts. The following priority environmental problems list will be reevaluated by the Management Conference as part of the lagoon characterization process:

- ☐ increased nutrient loadings
- ☐ lagoon circulation
- ☐ increased suspended matter loadings and sedimentation
- ☐ loss of seagrass beds and increased stress on remaining beds
- ☐ loss of emergent wetlands and their isolation from the lagoon
- ☐ increased input of toxic substances
- ☐ increased levels of pathogens

Scientific Research

Much of the information on Indian River Lagoon is scattered among several agencies and institutions. The Data and Information Management System (DIMS) created by the Indian River Lagoon National Estuary Program will become a clearinghouse for information. DIMS will have two components—an information center for lagoon-related publications and a system for integrating numerical data from many sources. The Management Conference is also investigating the possibility of using DIMS to aid in coordinating the various environmental learning centers located throughout the lagoon.

The Management Conference also plans to study seagrass and other submerged aquatic vegetation (SAV) throughout the lagoon. Seagrass and SAV are prime habitat for many important species and good indicators of the overall health of the lagoon. Through this project, which will build on existing information, the extent of seagrass growth and of SAV coverage in the lagoon will be determined, and factors causing the loss of seagrass

The West Indian manatee is an endangered species.

and of SAV will be identified and analyzed. Recommendations to correct causes of vegetation loss, to restore seagrass and SAV, and to plan for further study will be developed also.

Other research projects include an inventory and assessment of agricultural runoff within the lagoon basin and a review of water quality and circulation models for possible application to the lagoon. Further research projects on nonpoint source pollution of the lagoon, fisheries, and restoration methods are anticipated in upcoming years.

Monitoring

To study water quality in the Indian River Lagoon and certain other bodies of water within the State of Florida, the state legislature passed the Surface Water Improvement and Management (SWIM) Act. Through SWIM, a lagoon-wide water quality monitoring program has been implemented that involves several agencies and local governments. The Indian River Lagoon National Estuary Program will work closely with the SWIM program and build on this foundation. The addition of a volunteer monitoring network, an effort to assist in developing water quality data for the lagoon system, is receiving favorable consideration.

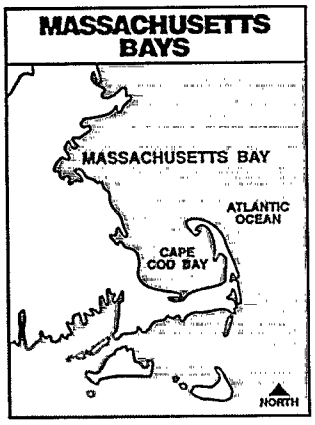
The Management Conference will also establish a sampling network to monitor toxic substances in the lagoon. It is anticipated that this program will analyze water column, sediment, and tissue samples from locations throughout the lagoon to determine the extent of toxic contamination of the lagoon and to establish baseline conditions for future monitoring projects.

Children are learning to appreciate the lagoon.

Management Tools

To implement the CCMP, the Indian River Lagoon National Estuary Program plans to integrate and coordinate management plans for the lagoon with several existing management programs. These management plans include SWIM and the comprehensive growth management plans of the various cities, counties, and regional planning councils within the lagoon, as well as management plans for the various state and federal facilities, refuges, parks, and preserves located within the lagoon.

There are excellent opportunities to incorporate CCMP strategies, standards, and recommendations into the SWIM program and the local and regional comprehensive growth management plans. The SWIM plan for the Indian River Lagoon was updated in 1991 and is scheduled to be updated again in 1994; and the comprehensive growth management plans for local governments, which must include conservation and coastal elements addressing protection of resources such as the Indian River Lagoon, are due to be updated and amended between 1994 and 1996. The Indian River Lagoon National Estuary Program Management Conference intends to take full advantage of these and any other available opportunities to implement the CCMP.



Massachusetts Bays

Introduction

The Massachusetts Bays study area includes Massachusetts and Cape Cod Bays, Ipswich Bay (to the New Hampshire border), and the system's major freshwater source, the Merrimack River. A multitude of historic sights in a beautiful natural setting attract tourists to this area from around the world. In 1985, 22.6 million visitors spent $6.2 billion in the region, for a total economic gain of $10.9 billion. In addition to boosting tourism, the Atlantic Ocean and its resources provide job opportunities for most local residents. In 1987, Massachusetts ranked third nationwide in fishery value ($278.9 million); Gloucester is the leading port for volume of fish landed. In terms of cargo, the Port of Boston, one of the oldest and most historic international trade centers in the United States, is the regional deep-water port for New England. Boston handles more than 25 million tons of cargo annually, worth more than $7 billion. The bays, however, are ecologically as well as economically vital. State and national parks, protected salt marshes, and tidal flats provide habitat for many species of estuarine and marine animals and plants. In particular, Cape Cod Bay and Stellwagen Bank are favorite spots for the right whale, one of the world's most endangered whale species.

Chief Threats to the Massachusetts Bays

Sewage inputs, nonpoint (diffuse) source pollution, and improper development are Massachusetts Bays' major sources of degradation. Since the days of the Boston Tea Party, the bays have borne the brunt of waste disposal in the area. Many of the 42 bordering communities use the bays as receptacles for wastewater and sewage sludge. In 1985, the United States sued the Commonwealth of Massachusetts because sewage treatment plant discharges into Boston Harbor were in violation of the Clean Water Act. Other sewage outfalls near Salem and Scituate contribute pollutants as well. Bacteria from treatment plant discharges, along with septic tank leaks and storm drain runoff, contaminate shellfish beds. While the number of closed shellfishing areas in southeastern Massachusetts remained relatively stable between 1970 and 1980, in the next four years the total number of closed acres jumped from 19,891 to 25,398.

Excess nutrients flowing into the bays from the surrounding land also present problems. This runoff, comprised mainly of improperly applied lawn and farm fertilizers, clogs waters with algal bloom and leads to decreases in the amount of dissolved oxygen available to marine life.

Destruction of habitat is a serious consequence of extensive water contamination and increasing land development, such as the construction at Boston's Logan Airport. The 48,105 acres of salt marsh remaining in Massachusetts are less than half the amount found by the first colonists. Such habitat destruction threatens both endangered species and valuable resources.

The Massachusetts Bays Program

In 1988, the Massachusetts Bays Program (MBP) was established and funded by the Boston Harbor-Massachusetts Bays Environmental Trust Fund (created as a result of the

lawsuit mentioned above). This original MBP, modeled after the NEP structure, was managed by the Massachusetts Coastal Zone Management Office (MCZM). The program was accepted into the NEP in April 1990.

All committees of the Management Conference have been formed, with participants from federal (EPA, NOAA, Army Corps of Engineers, Fish and Wildlife Service, Geological Survey, and the Department of Agriculture's Soil Conservation Service), state, and local agencies or organizations. MCZM, primarily funded by NOAA, has provided infrastructure and personnel support including a Program Coordinator, a writer for the CCMP, and office space for data management activities. Biennial drafts of the CCMP will be submitted to EPA, with a final CCMP due in September 1995.

Priority Problems

The original MBP sponsored a goals-setting workshop in October 1988. Participants defined the following problems, which are assigned priorities and explained in the 1991 CCMP:

- ☐ toxics
- ☐ bioaccumulation of toxics
- ☐ pathogen contamination
- ☐ water quality
- ☐ habitat loss and modification
- ☐ sea level rise

Scientific Research

To make the most of limited resources, the original MBP worked with the Massachusetts Water Resources Authority (MWRA) Harbor Studies Department to sponsor several studies. These investigations examined the sources, transport, and fates of pollutants entering Massachusetts and Cape Cod Bays. The Massachusetts Institute of Technology (MIT) Sea Grant Program and the U.S. Geological Survey (USGS) have also funded several relevant projects.

While most research in the past has focused on site-specific problems, current MBP research is comprehensive and wide-ranging. Studies on physical, biological, and chemical oceanography, characterization of contaminant sources, transport and retention of contaminants, and bioaccumulation and biotransformation are being funded by MBP, MWRA, MIT Sea Grant, and USGS. The Boston Harbor-Massachusetts Bays Environmental Trust Fund has also provided $400,000 to conduct three projects in areas directly influenced by MWRA sewage outfalls in Boston Harbor.

Preliminary results from MBP-sponsored studies indicate that circulation within the bays is substantially connected with the Gulf of Maine and that the Merrimack River and perhaps other rivers to the north, which are major sources of fresh water to the bays, are also significant sources of pollutant loadings. Another important finding is that atmospheric deposition may contribute as much contamination as do sewage outfalls or the Merrimack River.

Future research will continue efforts to understand the sources, transport, fate, and effects of contaminants entering Massachusetts Bays. To this end, MBP funded three projects on sources of contaminants, examining the effects of atmospheric deposition, organic pollutants from the Merrimack, and land use. In coordination with USGS, MBP will continue physical oceanography work to understand transport and circulation in the bays and will conduct studies to assess the impact of contaminants or

Michael Quan, 1989

A view of Boston Harbor.

Michael Quan, 1989

Schoolchildren and adults help keep the harbor clean.

human alterations on living resources. MBP research efforts, based on the 1991 CCMP, may include investigations of a predictive model for circulation in the bays, processes controlling nitrogen transport and availability, processes controlling bioaccumulation in marine organisms, and the impact of contaminants or human alterations on living resources.

Monitoring

Long-term monitoring is planned by MBP. This monitoring will measure changes in key dynamics and resources in the ecosystem, record changes in pollutant loadings, provide information on the ecosystem to resource managers and the public, and measure the success of MBP management actions.

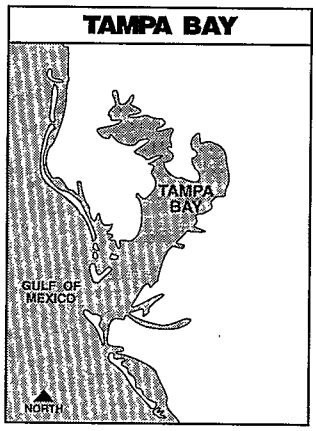
A monitoring plan will be developed in early 1994 for submission with the final CCMP. All monitoring will be coordinated with municipal, regional, state, and federal agencies and with research institutions. Monitoring results will also be developed for use by the Gulf of Maine Initiative.

Management Tools

Public participation was a major priority of the original MBP and continues to be emphasized today. The ongoing objective is to expand public outreach so that local planners, elected and appointed officials, opinion leaders, environmental activists, and the general public are all involved. Their participation will ensure the political support necessary for the success of the Massachusetts Bays Management Conference objectives.

The original MBP included a Citizens Advisory Committee (CAC), as does the current Massachusetts Bays Management Conference. The first outreach activities included distributing fact sheets and brochures; giving a press conference; conducting regional meetings; issuing Bays Action Grants; and creating a database of committee members, contractors, and related organizations. The CAC also held several public meetings with the environmental community and interested citizens. The Management Conference will continue and expand on these activities through the current CAC. The committee will consult with and inform the public regarding Management Conference objectives, action plans, and CCMP drafts.

The program's approach to CCMP development is itself an important management tool. The MBP Management Conference has conceived of the CCMP as an evolving agenda for management activities, to be issued and updated biennially. The first CCMP, in 1991, was based on existing information and a review of management actions taken or proposed by earlier planning documents or other estuary studies. In particular, the first CCMP was geared toward identifying management actions that can be undertaken in the Massachusetts Bays immediately. Taken together, the biennial CCMPs will be an integral part of the management process—both directing and reflecting progress made at various stages.



Tampa Bay

Introduction

The largest open water estuary in Florida, Tampa Bay lies on the west central coast of the state's peninsula. The bay's 398 square miles support a variety of aquatic life and human uses. Many species of fish and wildlife thrive in its mangrove forests, salt marshes, and seagrass beds. Residents and tourists alike enjoy the bay's excellent fishing, boating, and beaches. Businesses have depended upon the ports of St. Petersburg, Manatee, and Tampa (the latter now the seventh-busiest in the nation) for vital transportation and for income opportunities. Municipalities and industry discharge treated wastewater and other effluents into the bay, and electrical power facilities rely on the bay as a source of cooling water. Finally, beautiful views along the 904 miles of Tampa Bay shoreline greatly enhance residential and commercial real estate values. Together, these beneficial uses add approximately $3 billion annually to the regional economy.

Chief Threats to Tampa Bay

Tampa Bay is not grossly polluted, but water quality is declining in Old Tampa Bay (the northwestern segment), despite being good to excellent in much of lower and middle Tampa Bay. In poorly flushed Hillsborough Bay (the northeastern segment) nitrogen overloading from treated sewage effluent and untreated stormwater runoff may lead to algal blooms and low dissolved oxygen levels if left unabated. Improved municipal and industrial water management practices since the 1960s and early 1970s have reduced the adverse effects of nutrient loading from water treatment facilities and from phosphate mining and processing around the bay. However, a major phosphoric acid spill in 1988 emphasized that serious threats to the bay still exist.

Dredge-and-fill operations, power plant thermal discharges, turbid water conditions, and propeller damage have reduced Tampa Bay's seagrass bed area to 19 percent of its 1876 coverage. Wetlands, too, have been affected by the pressures of urbanization and are being altered throughout the watershed. These habitat losses have been accompanied by steady declines in finfish and shellfish landings since peak catches in the 1950s and 1960s. Vital habitat, water quality, and tidal flushing are also threatened by the prospect of increasing marina construction and operation that comes with rising interest in recreational boating. Urbanization has also brought proposals for highway and bridge construction to ease automobile travel over and around the bay; construction and operational impacts from these projects threaten both water quality and natural systems.

The Tampa Bay National Estuary Program

A part of the National Estuary Program since April 1990, the Tampa Bay National Estuary Program receives its direction from a nine-member Policy Committee consisting of EPA Region IV, the Florida Department of Environmental Regulation, the Southwest Florida Water Management District, and six local governments in the bay area. An existing basinwide management plan developed through the water management district's Surface Water Improvement and Management (SWIM) program has

already accomplished much of the initial characterization and consensus-building work. Because of the substantial existing information base, the Tampa Bay National Estuary Program (TBNEP) expects to complete its draft CCMP in four years rather than the usual five.

Priority Problems

Pending refinement through further studies, workshops, and public meetings, the program will focus on seven categories of priority problems in the bay:

- water quality deterioration/eutrophication
- loss of habitat, including seagrasses and emergent vegetation
- lack of community awareness
- increased user conflicts between various recreational activities, industrial and navigational needs, and urban development
- lack of agency coordination and response
- circulation and flushing
- hazardous/toxic contamination

Scientific Research

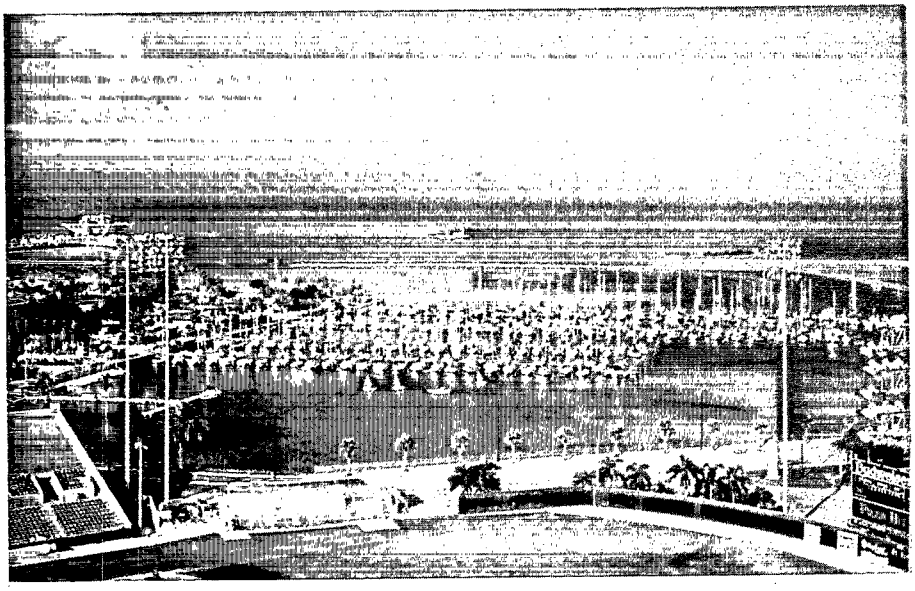
Through SWIM, the Southwest Florida Water Management District has prepared a computerized collection of all available data sources for Tampa Bay. Its approximately 1,350 references include technical literature, interpretive reports, mathematical models, computerized information systems, permit and compliance information, and other relevant compilations.

Florida's Department of Environmental Regulation and Department of Natural Resources currently sponsor a variety of applied research projects. These projects emphasize improved methods of stormwater treatment and control, sediment analysis, and coastal resource assessment.

A recent NOAA report documented the status and trends in concentrations of selected toxicants in sediments and biota of Tampa Bay. The National Status and Trends (NS&T) report concluded that oysters from those sites in Tampa Bay have had relatively high concentrations of mirex, chlordane, mercury, and zinc as compared to the oysters from the other 70 NS&T Program sites along the Gulf Coast. The potential for toxic effects among resident oysters is probably relatively low as a result of accumulation of PAHs, DDT, chlordane, dieldrin, copper, and lead in oyster tissues and moderate as a result of contamination by PCBs, mercury, and zinc. Overall, the study found what appears to be a moderate potential for adverse effects of sediment-associated toxic substances in the bay, though no observations of toxicant-associated effects in resident fish have been reported. Alterations in benthic communities have been observed; however, the alterations have been attributed more to losses of habitats than to exposure to toxicants. Another NOAA study is measuring the bay's current structure and developing a predictive model of circulation. Both studies will help to determine the cause-effect relationships crucial to estuary characterization.

These government-funded studies are complemented by the strong research capabilities of the area's academic institutions, including the University of South Florida, the University of Tampa, Mote Marine Laboratory, and the Florida Institute of Technology.

Scientists and policy makers from many of these government and academic organizations, as well as from the private sector, shared their ideas in February 1991 at Tampa BASIS 2, a three-day Bay Area Scientific Information Symposium. At



A marina on Tampa Bay.

this second BASIS meeting, papers and discussion focused on watershed practices. BASIS 2 also updated themes from the first BASIS meeting in 1982.

At workshops during the summer of 1991, a framework for characterization was agreed upon by members of the Technical Advisory and Citizens Advisory Committees of the Tampa Bay NEP. Workshop attendees determined the key bay resources and processes and developed guidelines for depicting them and their interrelationships. The depictions are to help educate decision makers and the public and to describe the characterization process components. Directions for immediate and future bay assessments were also determined through these workshops. Priority assessments will address estuarine seagrasses, low-salinity habitats, and benthic habitats, and a nitrogen "budget" will be refined, expanded, and used to assess hypotheses linking excess nitrogen inputs to impacts on water quality and living resources. TBNEP is the first estuary project to develop a characterization framework using consensus-building workshops.

Framework for Characterization Workshop.

Monitoring

TBNEP realizes the importance of integrating data from existing monitoring programs in the bay with that from future Tampa Bay monitoring projects. Accordingly, the TBNEP is designing a Basinwide Monitoring Program. This design will identify the baseline monitoring programs necessary to provide continuing baywide characterization and general indicators of bay "health" and will develop basic data reporting formats and minimal collection protocols for each data collection effort. The NEP has provided a draft Monitoring Guidance Document that will be used extensively during the Tampa Bay Basinwide Monitoring Program design. This design project will be closely linked to concurrent work in developing a data management strategy.

Management Tools

When it reaches its CCMP implementation phase, the Tampa Bay National Estuary Program will closely coordinate with other ongoing bay management efforts at the state and local levels. The key connections will be to the Tampa Bay SWIM plan and local government comprehensive plans. The SWIM plan for the bay was updated in 1991 and will be updated again by August of 1994.

Local governments in Tampa Bay will have particular influence over CCMP development and implementation. Officials from six major Tampa Bay cities and counties sit on the Policy Committee, the Management Conference's ultimate decision-making body. Municipalities in the region, already playing important roles in SWIM projects, will also help to carry out CCMP initiatives through their state-mandated local government comprehensive plans. Covering all municipal services, these plans include strategies for managing environmental resources within a given jurisdiction. Comprehensive plans for municipalities in the Tampa Bay watershed are due for amendment in 1994 and 1995, presenting another excellent opportunity to coordinate with CCMP implementation.

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