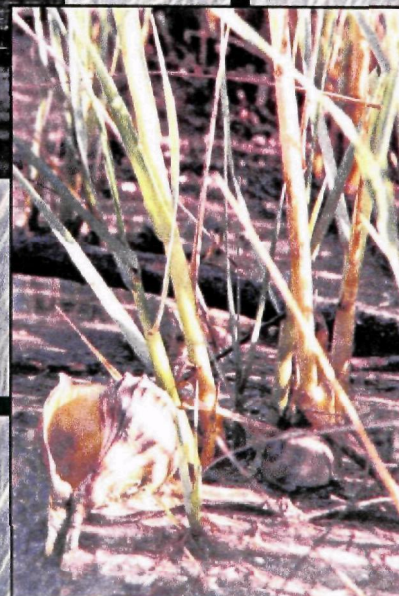
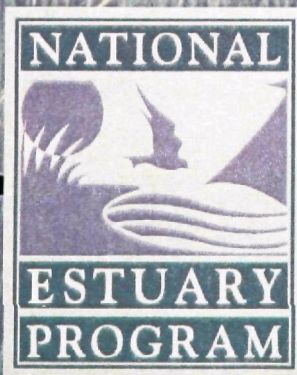




United States
Environmental Protection
Agency

Successful Coastal Management Solutions





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Environmental Protection
Agency

National Estuary Program
February 2003

Successful Coastal Management Solutions



The information in this document was obtained through interviews and correspondence with the National Estuary Programs, websites, and other materials between 1999 and 2002. For more recent information and contacts please access the U.S. Environmental Protection Agency's National Estuary Program website at: <http://www.epa.gov/owow/estuaries> or websites of individual programs (listed in the Contacts section of this document).

Except where noted, all photos are from the
U.S. Environmental Protection Agency's National Estuary Program.

EXECUTIVE SUMMARY

The National Estuary Program (NEP) was established under Section 320 of the Clean Water Act in 1987 to “identify nationally significant estuaries threatened by pollution, development, or overuse; promote comprehensive planning for and conservation and management of, nationally significant estuaries; encourage the preparation of management plans for estuaries of national significance; and enhance the coordination of estuarine research.” Most of the 28 estuaries currently participating in Tiers I-V of the NEP were selected in response to chronic environmental problems stemming from increasing population and development. The programs use a watershed management approach to address the chronic environmental problems.

The watershed management approach is a strategy for effectively protecting and restoring aquatic ecosystems and protecting human health. This type of management strategy recognizes the integrated and interconnected nature of the ecosystem. It has as its premise that many water quality and ecosystem problems are best solved at the watershed level, rather than at the individual water-body or discharger level. The NEP process and watershed approach are adaptable to a variety of environmental management situations because, unlike traditional regulatory approaches to environmental protection, they target a broad range of issues and engage local communities in the process.

Although each of the 28 estuaries in the National Estuary Program is unique, many face common environmental problems and challenges. The seven key environmental issues most commonly faced by the NEPs are:

- **Habitat** loss and degradation
- **Pathogen** contamination
- Alteration of **Freshwater Inflow**
- **Nutrient** overloading
- Declines in **Fish and Wildlife** populations
- **Introduced Species**
- **Toxic** contamination

Some or all of these seven issues are experienced by almost all of the coastal watersheds in the United States. The impacts of these problems are serious and generally quite visible. Pathogen contamination leads to the closing of large numbers of shellfish beds and beaches across the nation. Nutrient overloading contributes to lower dissolved oxygen levels—a primary cause of fish kills, harmful algal blooms, and loss of seagrasses. Introduced non-native plants and animals disrupt native species through predation and competition. Changes in land use and the introduction of pollutants and toxic chemicals result in habitat loss, declines in water quality, and degradation of the health of entire ecosystems.

To achieve its goal of protecting and improving water quality and enhancing living resources, one of the primary activities that the NEP performs is the transfer of scientific and management information, experience, and expertise among NEP program participants and other watershed management efforts. To facilitate the transfer of technology and sharing of lessons learned, the Coastal Management Branch of the U.S. Environmental Protection Agency (EPA) has sponsored the development of this document to illustrate the diversity of management solutions that have been adopted in response to specific environmental goals within the context of the political, regulatory, and economic frameworks of each NEP. It is hoped that this document will facilitate the transfer of technical information and encourage the adoption of this type of integrated approach for both coastal and inland watershed planning initiatives.

This document contains an introductory section, with information on important phases of the NEP process: characterization/assessment, priority planning, and monitoring/research. Key management approaches are highlighted in the following sections, which are organized by the seven key environmental issues that can be

easily referenced by NEP program participants and other resource managers. A separate section on financing follows the individual environmental issue sections. A glossary, an index to the document, and a list of contacts for all the NEPs are also included at the end.

CONTENTS

PAGE

EXECUTIVE SUMMARY	<i>i</i>
INTRODUCTION	I-1
Key Issues	I-3
Habitat	I-3
Pathogens	I-4
Freshwater Inflow	I-4
Nutrients	I-4
Fish and Wildlife	I-4
Introduced Species	I-5
Toxics	I-5
Characterization/Assessment	I-6
Habitat	I-6
Pathogens	I-6
Freshwater Inflow	I-6
Nutrients	I-7
Fish and Wildlife	I-7
Introduced Species	I-7
Toxics	I-7
Priority Planning	I-8
Monitoring/Research	I-9
HABITAT	H-1
Degradation and Loss of Habitat	H-1
Management Actions	H-2
Habitat Restoration	H-2
Habitat Creation	H-8
Public Education and Outreach	H-9
PATHOGENS	P-1
Pathogen Contamination	P-1
Management Actions	P-2
Legislative Changes	P-2
Combined Sewer Overflow (CSO) Abatement Programs	P-3
Identification of Nonpoint Sources	P-4
Control of Discharges from Marine Vessels	P-7
Public Education and Outreach	P-8
FRESHWATER INFLOW	F-1
Freshwater Inflow	F-1
Management Actions	F-1
Management Plans	F-2
Reclamation Actions	F-4
Public Education and Outreach	F-4

NUTRIENTS	N-1
Nutrient Enrichment	N-1
Management Actions	N-2
Legislative Changes	N-2
Development of Management Plan	N-3
Identification of Nonpoint Sources	N-4
Public Education and Outreach	N-6
FISH AND WILDLIFE	FW-1
Fish and Wildlife Species	FW-1
Management Actions	FW-2
Habitat Restoration and Creation	FW-2
Public Education and Outreach	FW-3
INTRODUCED SPECIES	IS-1
Introduced Species	IS-1
Management Actions	IS-1
Regulation	IS-2
Prevention	IS-2
Management	IS-3
Public Education and Outreach	IS-3
TOXICS	T-1
Toxic Contamination	T-1
Management Actions	T-2
Prevention	T-2
Public Education and Outreach	T-4
FINANCING	FN-1
Financing	FN-1
Federal Grants	FN-1
State and Local Support	FN-2
Donations	FN-3
Penalty Funds	FN-4
REFERENCES	R-1
GLOSSARY	G-1
CONTACTS	C-1
INDEX	INDEX-1

LIST OF FIGURES

Figure 1: Watersheds of the National Estuary Program	I-1
Figure 2: “No Discharge Zone” in Rhode Island	P-8
Figure 3: Effects of Excessive Nitrogen.....	N-3



INTRODUCTION

Established under Section 320 of the Clean Water Act in 1987, the National Estuary Program (NEP) identifies nationally significant estuaries threatened by pollution, development, or overuse, and promotes the preparation of comprehensive management plans to ensure their ecological integrity. Section 320 outlines an approach to estuarine protection and management that emphasizes the importance of collaboration among multiple users and stakeholders. This approach supports the notion that, through collaborative planning, disputes about uses of environmental resources can be resolved. It also endorses the value of education and research as essential components of long-term efforts to restore and manage estuaries.

To date, 28 estuaries (see **Figure 1**) have been designated as estuaries of national significance and are classified in tiers, based on the year that they were accepted into the program. Most of the NEPs were formed in response to chronic environmental problems stemming from increasing population and development or years of industrial or municipal discharges. The NEPs range greatly in terms of geographic scope (from 50 to 34,889 km²) and jurisdictional boundaries.

After an estuary has been designated as a NEP, the U.S. Environmental Protection Agency (EPA) convenes a Management Conference to develop a Comprehensive Conservation and Management Plan (CCMP). The Management

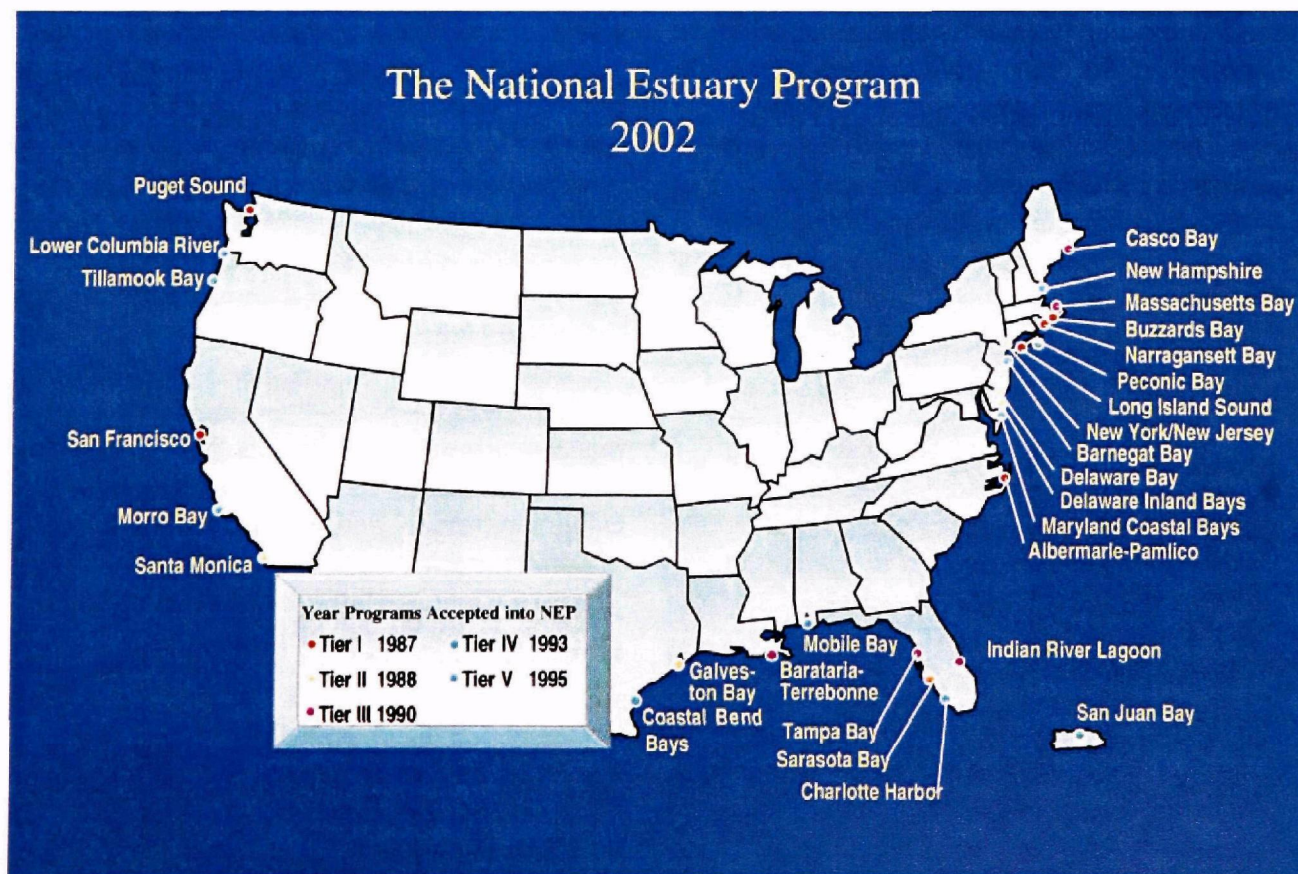


Figure 1: Watersheds of the National Estuary Program

Conference is charged with balancing conflicting uses in the estuary while restoring or maintaining its natural resources. The Management Conference consists of representatives from the EPA, other appropriate federal agencies, state governments, appropriate interstate or regional agencies, local governments, affected businesses and industries, public and private institutions, non-governmental organizations, and the general public. This collaborative planning process enables multiple stakeholders and members of local, state, and federal government agencies to participate in the decision-making process. Substantive public participation and consensus building are vital to the NEP planning process, and many aspects of the NEP approach can be adapted to a variety of community-based environmental protection programs.

Most NEPs focus their efforts on all, or a significant portion, of the estuarine watershed. This watershed approach encompasses both coastal and inland residents, in recognition of the integrated and interconnected nature of the ecosystem. The watershed approach also considers the sociological and ecological characteristics of the system together, ensuring that decisions take into account the integrated nature of the ecosystem and addressing problems instead of mere symptoms. When planning initiatives incorporate the entire watershed or basin, cumulative

impacts can be better addressed and political boundaries can be more easily crossed.

The goals of the NEP are the protection and improvement of water quality and the enhancement of living resources, with due regard for the economic viability of the local community. To achieve these goals, one of the primary activities that the NEP performs is the transfer of scientific and management information, experience, and expertise among NEP program participants and other related watershed management efforts. This technical transfer of information and lessons learned includes a wide range of activities: characterizing environmental problems; establishing working partnerships among federal, state, and local governments; increasing public awareness of pollution problems and ensuring public participation in consensus building; promoting basin-wide planning to control pollution and to manage living resources; and overseeing the development and implementation of pollution abatement and control programs. Recognizing the important role of the NEP in transferring technology and lessons learned among program participants and non-NEP resource managers, the Coastal Management Branch of EPA fosters innovative methods to facilitate this exchange of information. As part of that mission, this document serves to record and transfer the lessons, methodologies, experience, and progress of the NEPs across the United States.

The Watershed Protection Approach is a strategy for effectively protecting and restoring aquatic ecosystems and protecting human health. This strategy has as its premise that many water quality and ecosystem problems are best solved at the watershed level rather than at the individual water-body or discharger level. Major features of the Watershed Protection Approach include targeting priority problems, promoting a high level of stakeholder involvement, formulating integrated solutions that make use of the expertise and authority of multiple agencies, and measuring success through monitoring and other forms of data gathering.

In addition to telephone interviews with a representative from each of the NEPs, the development of these modules included the collection, review, and synthesis of the following information:

- Characterization reports
- CCMPs
- Status and trends reports
- Nomination documents
- State of the Estuary reports
- Framework for characterization reports
- Monitoring reports
- Biennial Reviews

The objective of this document is to illustrate the diversity of NEP management approaches that are implemented in seven key issue areas: (1) habitat; (2) pathogens; (3) freshwater inflow; (4) nutrients; (5) fish and wildlife; (6) introduced species; and (7) toxics. The organization of this document facilitates easy referencing for specific environmental concerns by NEP program participants and other resource managers.

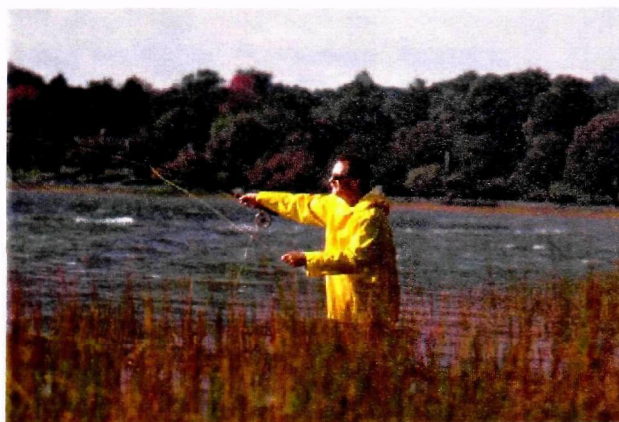
This **Introduction** section provides overview information on the seven key issues and important phases of the NEP process:

- **Key Issues** – describes the seven environmental problems and challenges common to the 28 NEPs.
- **Characterization/Assessment** – describes the approaches used to determine the extent of the problem, and identifies data gaps and research needs.
- **Priority Planning** – outlines approaches used to develop action plans, form partnerships, and gain consensus.
- **Monitoring/Research** – describes methods used to measure the effectiveness of management actions, including the development of indicators, long-term monitoring strategies, technologies, and ongoing research.

The following seven **Environmental Issue** sections are organized by environmental issue and provide background information and management approaches specific to each issue:

- **Overview of the Issue** – provides a general description and relates the national significance of the issue, including sources and impacts.
- **Management Actions** – highlights management actions being implemented by the NEPs.

A separate section on **Financing** discusses sources of funding for implementing manage-



ment actions and creative financing strategies. A section of **Contacts** lists the current NEP staff to contact for additional information regarding specific technical issues and a section of **References** includes documents used in preparing the modules. An **Index** to the document is also provided at the end.

The NEP process is adaptable to a variety of environmental management situations because, unlike traditional regulatory approaches to environmental protection, it targets a broad range of issues. A **Glossary** provides definitions of key terms and engages local communities in the process. The program focuses not just on improving water quality in an estuary, but on maintaining the integrity of the whole system — its chemical, physical, and biological properties, as well as its economic, recreational, and aesthetic values. It is hoped that this document will facilitate the transfer of this type of integrated approach for both coastal and inland watershed planning initiatives.

KEY ISSUES

Habitat

High quality habitat is critical to the continued health and biodiversity of marine and estuarine systems. However, coastal habitats, which provide essential food, shelter, migratory corridors, and breeding and nursery areas for a broad array of coastal and marine plants and animals, are often the same areas that attract human development. In addition, these habitats per-

form other important functions, which benefit humans, such as water quality improvement, flood protection, and water storage. Ecosystems can be degraded through loss of habitat; a change or degradation in structure, function, composition, or biodiversity of habitats; and increased flood damage during storms.

Human population density is steadily increasing in coastal areas, resulting in the gradual conversion of habitat to urban landscapes. Threats to habitat include conversion of open land and forest to other uses, dredging and filling, damming, and bulkheading of the water's edge. Activities such as these generally increase the level of sediment, nutrients, and chemicals in runoff and can increase flood damage during storms.

Pathogens

Based on state reports, pathogens are the most common pollutant affecting estuaries. Pathogens are disease-causing organisms, including certain viruses, bacteria, and fungi. Pathogens found in marine waters can pose a health threat to swimmers, surfers, and divers. Fish and filter-feeding organisms, such as shellfish, concentrate pathogens in their tissues, creating public health risks for consumers of contaminated fish. Many shellfishing areas and bathing beaches are closed due to the presence of high concentrations of pathogens.

Sources of pathogens include urban and agricultural runoff, boat and marina waste, faulty or leaky septic systems, sewage treatment plant discharges, combined sewer overflows (systems wherein sewer lines are linked to stormwater drains and discharge untreated sewage during periods of heavy rainfall), recreational vehicles or campers, illegal sewer connections, and waste from pets and wildlife.

Freshwater Inflow

In many areas of the country, freshwater is an increasingly limited resource. Human management of freshwater has altered the timing and

volume of flow to some bays and estuaries, which can have significant effects on water quality and the health and distribution of living resources. Too much or too little freshwater can adversely affect fish spawning, shellfish survivability, bird nesting, shellfish seed propagation, or other seasonal activities of fish and wildlife. In addition, salinity levels are moderated by freshwater flowing into bays and estuaries. Freshwater inflows to coastal areas provide nutrients and sediments that are, in moderate amounts, important for overall productivity but which can have adverse impacts at high levels.

Nutrients

Small amounts of nutrients, such as nitrogen and phosphorus, are essential for healthy marine and freshwater environments. Under certain circumstances, however, these nutrients may become too abundant, leading to algal blooms, low dissolved oxygen, and fish kills. Recent outbreaks of the toxic dinoflagellate *Pfiesteria*, for example, have been attributed to excess concentrations of nutrients in the Gulf of Mexico and parts of the east coast. These outbreaks or "blooms" resulted in fish kills and also, because of their toxic component, human health problems.

The relationships between nutrient enrichment and environmental problems are complex. Algal blooms, stimulated by an excess of nutrients, block sunlight from penetrating the water column, reducing the growth of submerged vegetation, which in turn, results in habitat loss and decreased concentrations of dissolved oxygen.

Nutrients that enter aquatic ecosystems come from both point and nonpoint sources, including sewage treatment plants, combined sewer overflows, storm sewer overflows, urban and agricultural runoff, faulty septic systems, animal wastes, and atmospheric deposition.

Fish and Wildlife

The decline of various fish and wildlife species has been a concern for over a century. Fragment-

tation or loss of habitats, pollution and decreased water quality, over-exploitation of resources, and introduced species have resulted in declines in fish and wildlife populations. The distribution and abundance of fish and wildlife depend on factors such as light, water turbidity, nutrient availability, temperature, salinity, and habitat and food availability, as well as natural and human-induced events that disturb or change environmental conditions.

Decreases in sport and commercial fish and shellfish populations, changes in fur-bearing and waterfowl populations, and decreased habitat for neotropical migratory birds and other species have occurred as a result of habitat loss and degradation. Pollutants such as herbicides, pesticides, and other chemicals pose a threat to living resources by contaminating the food chain—eliminating food sources and introducing physiological and reproductive impacts. Sport or commercial fishermen, trappers, hunters, or



collectors have over-exploited the resources by taking too many young and/or breeding adults of a species, thereby reducing its ability to maintain population levels. Agricultural and logging activities, trawling and fishery bycatch, boat disturbances, entanglement from marine debris, and changes in freshwater inflow have also contributed to declines in fish and wildlife populations.

Introduced Species

Unexpected ecological, economic, and social impacts to the estuarine environment often result from the intentional or accidental introduction of non-native species. Introduced species, through predation and successful competition, have contributed to the eradication or decline of many native populations and have fundamentally altered the food web in many ecosystems. Overgrazing of wetland vegetation and a resultant degradation and loss of marsh habitat have resulted from over-population of some introduced species. Other impacts of introduced species include: alteration of water tables; modification of nutrient cycles or soil fertility; increased erosion; interference with navigation, agricultural irrigation, sport and commercial fishing, recreational boating, and beach use; and possible introduction of pathogens. Sources of introduced species include ship ballast water, mariculture operations, and the aquarium trade.

Toxics

Harmful to both wildlife and humans, substances, such as heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and pesticides, are of concern whenever they are found in the coastal environment. These toxic contaminants enter waterways through storm drains; industrial discharges; runoff from lawns, streets, and farmlands; sewage treatment plants; and atmospheric deposition. Many historically contaminated sediments contain toxic substances, which can be re-suspended into the water column by storms, dredging, and boating activities. Bottom dwelling organisms are directly exposed to these

chemicals, which may lead to bioaccumulation at higher levels of the food chain, possibly resulting in fish and shellfish closures and consumption advisories to protect public health.

CHARACTERIZATION/ ASSESSMENT

With respect to the NEP, Section 320 of the Clean Water Act requires an objective assessment of the state of the estuary. This assessment, referred to as technical characterization, is a scientific evaluation of the conditions of the resources and uses of the estuary, the priority problems being experienced by those resources and uses, and the causes of the priority problems that exist. The fundamental goal of the technical characterization is to identify the problems facing the estuary and present this information in a way that supports the selection of actions for inclusion in the management plan.

To determine if an environmental issue is a problem at a NEP site, the existing conditions within the estuary must first be characterized and assessed. This process is generally conducted through the comparison of historical data with present-day conditions, determined by evaluating more recent data or by direct on-site observations.

Habitat

Habitat data are normally available as aerial photographs, digitized maps, land-use maps, documentation of submerged aquatic vegetation, or descriptions on deeds and land surveys. Several of the estuary programs found that historical data were available from universities and various government agencies, such as the National Wetland Inventory, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and U.S. Geological Survey. Other estuary programs found that historical data were not readily available and that the program needed to assess habitat loss through indirect approaches. Water quality data and fluctuations in wildlife populations have been used to assess estuarine health and, therefore, infer habitat availability.

Once habitat data have been collected, a comparison and assessment is made of whether existing habitats have been reduced in size or degraded to the extent that the habitats do not meet the goals of the NEP. Habitat degradation and loss is generally considered an issue at a NEP site if there has been a significant decrease or change over the years.

Pathogens

Measuring the concentration of pathogens from various locations around the estuary helps to determine whether contamination has increased or decreased over the years. Pathogen monitoring is normally conducted on a regular basis by state agencies in support of federal regulations. The collected data are compared to state and federal guidelines for pathogen concentrations, based on the defined use of the site. Each body of water has an assigned use designation, depending on whether the area is used for drinking water, recreation (i.e., swimming), and/or fish and shellfish harvesting. The levels of pathogen contamination that can be tolerated vary with the designated use of the site. Whenever the pathogen concentration exceeds the allowed levels, the area is considered "impaired" and must be closed until the levels drop below the permitted guidelines. If a body of water is designated "impaired" on a regular basis, pathogen contamination is probably an issue.



Freshwater Inflow

Changes in freshwater inflow are monitored over an extended period of time to determine

whether current freshwater inflow has degraded or altered the quality of the surrounding habitat, or if the amount of the freshwater inflow is adequate to meet the goals of the NEP. This process is generally conducted through the comparison of historical data with present-day conditions by agencies, such as the U.S. Geological Survey and state resource agencies.

Nutrients

If the concentrations of nutrients within the estuary have increased significantly over the years and symptomatic problems, such as algal blooms or low dissolved oxygen, are detected, then nutrient enrichment is probably an issue for that estuary.

Water quality data are normally available from universities and state agencies and, in some instances, data are available from volunteer monitoring groups. Several of the estuary programs have also found that historical data were available from various government agencies, such as the EPA, U.S. Fish and Wildlife Service, U.S. Geological Service, and U.S. National Park Service. Once nutrient data have been collected, a comparison and assessment is made to determine whether nutrients have increased.

Fish and Wildlife

The populations of fish and wildlife in the estuary must be characterized and assessed to determine if the diversity or populations of fish and wildlife within the estuary have greatly decreased over the years. If the numbers of native fish and wildlife species have significantly declined, then fish and wildlife is most likely an issue for that particular NEP.

The characterization/assessment process is generally conducted through the comparison of historical fish and wildlife population data with recent information or data from direct on-site observations. Fish and wildlife data are normally available as reports from various federal and state agencies, including U.S. Fish and

Wildlife Service stock status reports. These data document the amount of available habitat for each species being evaluated, assess the quality of the habitat, and determine if species introduced into the estuarine ecosystem have invaded another species' natural habitat. Data on fish and wildlife habitat, water quality, and nonindigenous species also assist in determining the population status of fish and wildlife resources.

Introduced Species

The determination of whether introduced species are a concern for a NEP site can normally be made during an assessment of habitat degradation or an assessment of fish and wildlife populations. Introduced species that have become a problem normally invade a habitat such that the native species populations are adversely affected. During standard assessments of habitat degradation or fish and wildlife populations, the presence of introduced species can usually be detected. The difficult part of assessing the presence of an introduced species is in determining whether the plant or animal is truly introduced, rather than a native species that has grown out of control due to changes in the ecosystem. There are examples of plants and animals, which have been labeled as "introduced species," that have actually been resident in an ecosystem for many years.

Toxics

To determine if toxic contamination is a problem at a NEP site, the amount and type of contamination must first be characterized and assessed. The first step in this process is to measure the concentrations of suspected toxic compounds in water, sediment, and tissue samples collected from various locations throughout the estuary. The concentrations of toxic chemicals found in the samples are compared to federal and state guidelines for allowable concentrations of individual compounds. If the concentrations found in the samples are higher than the permitted concentrations, then toxic contamination is most likely an issue for the estuary.

PRIORITY PLANNING APPROACHES

Technical Expertise

- Government agencies involved in the management of the estuary program basically determine the issues and priorities that they will address based on the goals and responsibilities of their agency. The only non-government involvement would then be determined by the funds raised directly by the estuary program.
- Based on available research, technical advisors make recommendations on issues, public opinion is considered, and regulation structures are designed to address the gaps. The priority in which the issues are addressed is determined by the time frame by which the regulations are enacted and when the funds are made available to the responsible parties.
- Technical advisors determine the technical issues and the priority in which they will be addressed. The Citizens Advisory Committee works only on public education and outreach issues.
- Technical advisors develop the technical issues, then the public votes on the priority in which they will be addressed.
- Technical advisors and representatives of the general public meet to decide on the technical issues and on the priority in which they will be addressed.
- The general public presents its opinion on the issues and the technical advisors or members of the management committee determine the priority in which they will be addressed.
- Various groups living in and around the area (land trusts and other watershed groups) submit proposals for management actions. The management group determines if funds are available and if the project is appropriate to the goals of the program.

Public Opinion

PRIORITY PLANNING

If the results of the characterization/assessment suggest that an environmental issue may be a problem, the NEP will develop appropriate actions to help correct the problem. Whatever actions the NEP determines to be appropriate are prioritized on the basis of various factors, which are discussed below.

For most estuaries, issues must be prioritized because funds to address them are usually limited. Priorities are often determined at the beginning of the program through a priority planning process, which differs among NEPs, depending on their partnerships and available funding. The San Francisco Estuary Project, for example, divides the various program areas among NEP staff and small working committees to develop priority actions. The small working committees normally include technical advisors and program stakeholders. Once the priority actions are determined, the issues are brought to the management committee for final prioritization. Then, about every three years (since 1993), the San Francisco Estuary Project invites the public to a one-day meeting to evaluate the plan currently being implemented and to review the results obtained over the last three years. In support of this public meeting, the San Francisco Estuary Project distributes performance information — including the Bay-Delta Environmental Report Card (San Francisco Estuary Project 1999) — to educate the public on the progress made as a result of program activities. After a review of the results, the public is invited to help direct future program actions by commenting on priority items, which could remain the same, be re-prioritized or, in some cases, be removed.

The Long Island Sound Study ranks potential restoration sites primarily by their potential ecological value, but other factors, such as availability of funds, presence of local partners, availability of basic knowledge about the site, and status of site planning and design, are also considered. The New York - New Jersey Harbor

Estuary Program organized specific work groups and various agencies, along with its Citizen's Advisory Committee, to determine management actions for various priority issues. To ensure broad citizen involvement, public meetings were held to solicit input from various users. Then, each issue was reviewed separately by the management committee members to establish their priority.

The Delaware Center for the Inland Bays approached priority planning by conducting a consensus session, where 54 critical areas within the estuary were ranked according to importance by a diverse group, which included farmers, educators, elected officials, and citizens. Everyone was given the opportunity to select five to 10 issues as high-priority items. The issues in this group were then narrowed down to the final priorities.

A unique approach to priority planning is illustrated by the Lower Columbia River Estuary Program, which used a formal comparative risk assessment approach. Through newspaper surveys and public meetings, the public was targeted as one group. Then, through a series of focused workshops, various groups of stakeholders were targeted as a second group. Technical experts comprised a third group. Risk rankings from the three groups were then compared and problem-area priorities were developed. It is important to note that the problems of habitat loss and modification were ranked as the greatest threat to the Columbia River Estuary by all three groups.

In general, however, priority planning is usually accomplished through a combined effort of technical expertise and public opinion. The approaches, which illustrate the varying combinations of technical and public involvement that can be considered in priority planning, are shown in the text box. Once the issues have been prioritized, the specific NEP is responsible for directing available funds and resources to the highest priority action items. This is normally

accomplished through management actions that define a particular project, through the agency or groups performing the work, and by estimates of the cost to complete the project.

MONITORING/RESEARCH

Once management actions have been funded and implemented, the results of their implementation need to be determined. This is normally accomplished by monitoring the ecosystem to document any changes that may result from one or more management actions.

Monitoring/research that documents the changes in habitat is not clearly defined by most NEPs. The San Francisco Estuary Project, however, is particularly well organized for monitoring habitats. This NEP monitors changes in habitat by tracking the numerous projects being conducted within the system. The program documents the location, number of acres, type of habitat, and type of change (i.e., creation, restoration, loss, and enhancement). This information is then reported in the Bay - Delta Environmental Report Card every three years (San Francisco Estuary Project 1999).



Routine monitoring for pathogen contamination in estuaries that contain shellfish habitat is required by federal law. Monitoring is generally conducted after every rain event to determine if shellfish have been contaminated with fecal coliforms above the levels determined acceptable for shellfish consumption. Routine moni-

toring for pathogens is generally required at sewage treatment facilities and at some combined sewer overflows. Data from this type of monitoring can be used by the estuary program to develop baseline concentrations, which can later be used to monitor pathogen concentrations as management actions are implemented.

The Casco Bay Estuary Project intends to implement a plan-wide tracking system that will include monitoring of significant habitat and development of a map of protected wetlands.

An excellent example of monitoring is the Regional Monitoring Program conducted for the San Francisco Estuary Project by one of its implementation entities — the San Francisco Estuary Institute. The institute is the lead organization for carrying out the San Francisco Estuary Project Management Plan's research and monitoring actions for the San Francisco Estuary. The Institute has developed a Re-

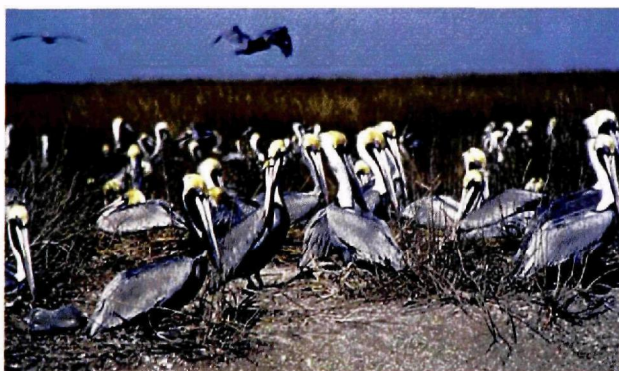
gional Monitoring Program for Trace Substances, which includes 68 agencies and organizations that work in partnership to address toxic contaminant issues. This program collects samples at 24 stations three times a year for: (1) water quality and chemistry; (2) aquatic bioassays; (3) sediment quality and chemistry; (4) sediment bioassays; and (5) transplanted, bagged bivalve bioaccumulation, survival, and condition studies. The Program is funded by local industry and government at a cost of \$3 million per year, and provides a forum for dischargers and regulators to discuss solutions to toxic contamination problems. The Program supports several interagency public/private coordinating committees that focus on specific areas of toxic contamination, including: (1) pesticide toxicity in urban and agricultural runoff; (2) contaminants in San Francisco Bay fish; (3) air deposition of mercury, copper, and nickel; and (4) improving regulatory decisions on the basis of monitoring results.



HABITAT

DEGRADATION AND LOSS OF HABITAT

In the last decade, the ability and desire to restore degraded and lost habitats have progressed significantly. Much of this progress has been due to advancement in the scientific knowledge available to restore habitat, and through an increase in public awareness of the need to restore and maintain various kinds of habitat. In response to a variety of impacts and threats, habitat restoration is being undertaken by citizens, private organizations, universities, and governmental agencies (NOAA 1998a). At the national level, there are 14 federal programs working to restore habitats, while at least 11 federal laws authorize and fund restoration activities (NOAA 1998a). One of these programs is the U.S. Environmental Protection Agency's (EPA) National Estuary Program (NEP).



One concern common to many of the 28 NEPs is degradation and loss of habitat. With human population density increasing near the coast, estuarine habitat is gradually being converted to urban landscapes or is being altered in ways to satisfy the population demands. Open spaces and large tracts of forested land are being subdivided and developed, while wetlands, marshes, and riparian areas are being drained to

allow for public access, development, or activities that support human habitation. As habitat diversity decreases, the concomitant loss of wetlands, riparian, marsh, open, and forested areas has a significant effect on the health of the entire ecosystem.

According to a survey of NEP directors, conducted in the fall of 1999, the following 24 of the 28 NEPs consider habitat degradation and loss a high-priority action item:

Albemarle-Pamlico (NC)
 Barataria-Terrebonne (LA)
 Buzzards Bay (MA)
 Casco Bay (ME)
 Charlotte Harbor (FL)
 Coastal Bend Bays and Estuaries (TX)
 Delaware Estuary (DE, NJ, PA)
 Delaware Inland Bays (DE)
 Galveston Bay (TX)
 Indian River Lagoon (FL)
 Long Island Sound (NY, CT)
 Lower Columbia River (OR)
 Mobile Bay (AL)
 Morro Bay (CA)
 Narragansett Bay (RI, MA)
 New York – New Jersey Harbor (NY, NJ)
 Peconic Estuary (NY)
 Puget Sound (WA)
 San Francisco Estuary (CA)
 San Juan Bay (PR)
 Santa Monica Bay (CA)
 Sarasota Bay (FL)
 Tampa Bay (FL)
 Tillamook Bay (OR)

This section highlights management approaches and public education and outreach activities implemented by the NEPs to address the issue of habitat degradation and loss.

MANAGEMENT ACTIONS

After the issues have been prioritized, the NEP develops a number of management actions to address each issue. The following are examples of management actions to address habitat loss that have been successfully implemented by NEPs across the country. The management actions presented here have been categorized and grouped under the headings of habitat restoration and habitat creation.

Habitat Restoration

The restoration activities described in the following management actions focus mostly on wetlands. Wetlands are described as “those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas” (40CFR 230.3). The wetlands described below have been altered either directly or indirectly by man through impairment of some physical property. The result has been a reduction in the diversity of wetland-associated species. The goal of wetland restoration projects is to use natural material to restore wetlands or alter physical processes to allow the wetland to recover naturally.

CRITICAL NATURAL RESOURCE AREAS **Peconic Estuary Program**

The Peconic Estuary Program (PEP) has applied the concept of “critical natural resource areas” as a management strategy for the variety of species and natural communities that exist within the PEP study area. Critical Natural Resource Areas (CNRAs) are geographically specific locations that currently have significant

biodiversity and may require an extra level of protection (regulation and/or management) to preserve their unique characteristics. Many of these areas are presently threatened by development or

uses that could degrade their quality. The CNRA designations have already been used in developing the Critical Lands Protection Strategy, a watershed-wide approach to systematically evaluating and identifying lands in need of protection, and evaluating the funding needed and available for that protection.

CRITICAL NATURAL RESOURCE AREAS
Peconic Estuary Program
Web: <http://www.epa.gov/owow/estuaries/pb.htm>
Problem: Threatened critical natural areas requiring additional protection.
Solution: Implement “Critical Natural Resource Areas” strategy to identify lands in need of protection and evaluate funding available.

FISH FRIENDLY TIDE GATE REPLACEMENT **Tillamook Estuaries Partnership**

Tide gates were originally installed to drain pasturelands after heavy rains or high tides as part of the levee system along the five rivers that enter Tillamook Bay.

While the old tide gates effectively prevented salt water from encroaching on dairy pastures, the exchange of salt and freshwater behind the

gates in the minor waterways running through the pastures was poor. These low-lying channels potentially provide high quality off-channel habitat for juvenile salmonids and much of this habitat was blocked to fish passage by the nature of how the old tide gates operated. The Tillamook County Performance Partnership, through partnership with private landowners, sought to design a “fish friendly” tide gate to restore and protect native salmonid habitat, improve water quality, protect valuable farmland from the negative effects of flooding, and improve overall floodwater dispersal across the landscape. Seventeen of the old tide gates have been replaced since 1998, eight of which are

FISH FRIENDLY TIDE GATE REPLACEMENT
Tillamook Estuaries Partnership
Web: <http://www.co.tillamook.or.us/gov/estuary/tbne/nephome.html>
Problem: Blockage of fish passage to critical habitat by existing tide gates.
Solution: Design a “fish friendly” tide gate to restore and protect native salmonid habitat, improve water quality, and protect valuable farmland.

“fish friendly.” The new tide gates, along with better pasture drainage, provide a win-win situation for landowners and for fish. In addition, dissolved oxygen and temperature, priority water quality concerns of the Tillamook Estuaries Partnership have been improved through more complete exchange of farmland drainage with river and estuary flows.

CHRISTMAS TREE MARSH RESTORATION PROGRAM

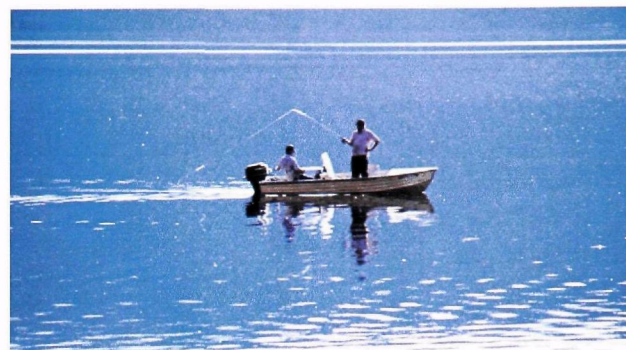
Barataria-Terrebonne National Estuary Program

Over the last seven years, several Louisiana parishes have participated in the state's Christmas Tree Marsh Restoration Program. This program makes use of post-holiday Christmas trees to protect eroding shorelines and restore the natural hydrology of the marshes. Since 1991, more than 450,000 trees have been recycled to fill in abandoned canals, construct shoreline, and serve as sediment fences.

**CHRISTMAS TREE MARSH
RESTORATION PROGRAM**
*Barataria-Terrebonne
National Estuary Program*
Web: <http://www.btneep.org>
Problem: Wetlands loss due to sediment removal by wave action and sediment removal for oil exploration canal construction.
Solution: Rebuild wetlands using post-holiday Christmas trees to protect shorelines and fill canals by trapping and holding suspended sediments.

Jefferson Parish has been one of the most active participants in the Christmas Tree Marsh Restoration Program. Part of this success is due to volunteers — mostly high school students — that bundle together the trees. These bundles are then airlifted into the marsh by the Louisiana Army National Guard, who also volunteers time, resources, and aircraft. Additional volunteers, who donate their time, boats, and fuel, arrange the bundles in fences. For one specific project, Jefferson Parish installed 35 Christmas tree brush fences to combat shoreline erosion near the Town of Jean Lafitte. These structures protect against wave damage and trap sediments that eventually build up new wetlands.

In January 1997, Senator John Breaux hosted a ceremony recognizing the support of the Clinton



Administration in the Louisiana Coastal Restoration Program. As part of the special dedication ceremony, 80 Christmas trees from the White House lawn were transported to Jefferson Parish to benefit the Christmas Tree Marsh Restoration Program. The donation of White House Christmas trees to the Jefferson Parish program garnered much local and national news coverage. From 1995 to 1998, eight Louisiana parishes participated in the program, benefiting more than 12 acres of marshes at a construction cost of approximately \$273,000 (\$23,000/acre) (Barataria-Terrebonne National Estuary Program 1998).

BARRIER ISLANDS

Barataria-Terrebonne National Estuary Program

Louisiana's barrier islands are deteriorating because of hurricanes, global sea-level rise, subsidence, inadequate sediment supply, and human disturbances.

These islands are essential habitats for neotropical migrant birds, and serve to protect inland wetlands and coastal communities from hurricane storm surges. The State of Louisiana and a federal task force, formed under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA), are reconstructing these important islands. Federal agencies comprising the CWPPRA task force include the U.S. Army Corps of Engineers, EPA, Department of Commerce, Department of the Interior, and Department of Agriculture.

BARRIER ISLANDS
*Barataria-Terrebonne
National Estuary Program*
Web: <http://www.btneep.org>
Problem: Barrier island deterioration by various natural and human disturbances.
Solution: Rebuild or repair barrier islands using dredged material.

The islands are being restored primarily through the use of hydraulic dredges to replace the sand on the islands. The restored islands are then stabilized with plantings of various non-woody species. The Barataria-Terrebonne National Estuary Program partnership is currently working on projects that will encourage the use of woody plant species to increase the habitat value of the restored islands.

Between 1995 and 1999, enough sediment was pumped onto the Barataria-Terrebonne barrier islands to restore more than 2,200 acres, at a cost of more than \$47 million (\$21,000/acre). In addition, vegetative plantings and, for some shoreline applications, rocks were used to stabilize the barrier island restoration projects (Barataria-Terrebonne National Estuary Program 1998; NOAA 1999).

LAKE NAOMI WETLAND RESTORATION PROJECT *Delaware Estuary Program*

The Lake Naomi Wetland Restoration Project was performed as part of the habitat restoration for the Delaware Estuary Program. The project, conducted in the middle Delaware sub-basin, created 7.5 acres of wetlands, which provide food and habitat for winter birds. The restoration was conducted by the Pennsylvania Department of Environmental Protection (DEP), in conjunction with the Lake Naomi Club, the U.S. Fish and Wildlife Service (USFWS), and Ducks Unlimited. The project converted an abandoned sand and gravel mine to a wetland mosaic, which provides habitat for several species of wildlife. The site is 80 percent standing water, with islands for nesting habitat and rest areas. The remaining 20 percent was vegetated with winterberry, which transitions the site from the shallow waters to adjacent upland, dominated by hemlocks. Forty percent of the standing water will be 4-18 inches deep; creating habitat that will support

**LAKE NAOMI WETLAND
RESTORATION PROJECT**
Delaware Estuary Program
Web: <http://www.delep.org>
Problem: Loss of wetlands habitat from the Lake Naomi area.
Solution: Create a wetland mosaic from an abandoned sand and gravel mine.

button bush, wild celery, and duck potatoes, all of which serve as additional food sources. The mosaic of open water and vegetated shallows should attract a variety of waterfowl, songbirds, and other animal species, including black bear and snowshoe hare. The entire restoration project cost \$7,000. The Lake Naomi Club provided the land, Ducks Unlimited provided the construction materials, USFWS provided technical assistance, and the Pennsylvania DEP Wetland Restoration Project paid for the equipment and construction (Delaware Estuary Program 1996).

ENHANCEMENT OF FISH HABITAT AND WATER QUALITY WITH ROCK BARBS *Tillamook Estuaries Partnership*

In Tillamook Bay, both sedimentation and loss of salmonid habitat can be traced, in part, to excessive stream bank erosion, lack of stream type diversity, and limited riparian vegetation. The Biotechnical Barb Structure and Gravel Bar Stabilization Project was designed to be a low-cost, easily implemented, fish friendly method of stream restoration, which lessens erosion and sedimentation while improving fish habitat. By strategically pointing rock structures known as barbs into the stream channel and following up with tree planting, this effort fosters channel structure diversity and increased riparian vegetation. In 1996 the Tillamook County Soil and Water Conservation District began by constructing seven barbs in the Kilchis River. After the first two years, which included several significant winter flood events, the barbs produced noticeable benefits. The barbs have continued to achieve their stated goals of stabilizing stream banks, improving stream channel structure, and adding salmonid habitat. Riparian plantings have withstood high water levels due to the

**ENHANCEMENT OF FISH
HABITAT AND WATER
QUALITY WITH ROCK BARBS**
*Tillamook Estuaries
Partnership*
Web: <http://www.co.tillamook.or.us/gov/estuary/tbnep/nephome.html>
Problem: Loss of salmonid habitat due to stream bank erosion, lack of stream type diversity, and limited riparian vegetation.
Solution: Implement a low-cost, fish friendly method of stream restoration, which lessens erosion and sedimentation while improving fish habitat.

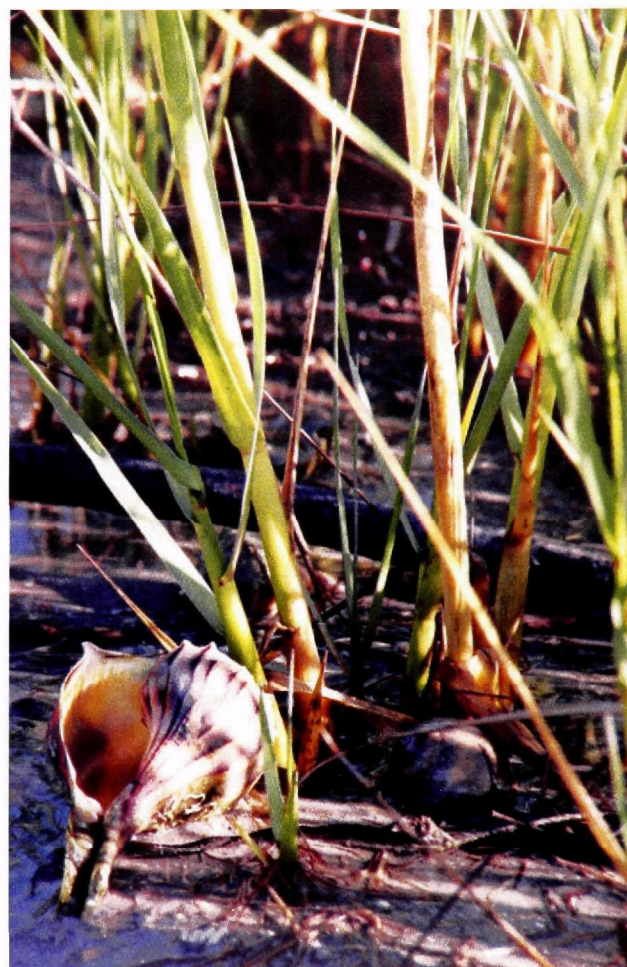
barb's flow diversion and are expected to flourish in newly stabilized banks. Adult Chinook salmon were seen using the newly created scour pools for refuge while smolts used the slack water behind the barbs for cover.

**DICKINSON BAY OYSTER REEF/
WETLAND RESTORATION
DEMONSTRATION PROJECT**
Galveston Bay Estuary Program

One goal of the Galveston Bay Estuary Program is to restore, create, or protect the diverse habitats throughout its system. Included in these habitats are oyster reefs and wetlands. The Dickinson Bay Oyster Reef/Wetland Restoration Demonstration Project was created to develop innovative ways to stabilize shorelines and, at the same time, to create oyster and fish habitat.

**DICKINSON BAY OYSTER REEF/
WETLAND RESTORATION
DEMONSTRATION PROJECT**
Galveston Bay Estuary Program
Web: <http://gbep.tamug.tamu.edu>
Problem: Loss of shoreline and oyster and fish habitat.
Solution: Create reef berms using oyster shells, revetment mat, and rip-rap and create emergent marsh using *Spartina alterniflora*.

This project involves 1,400 feet of reef berms along the south shore of Dickinson Bay. The reef berms were created using oyster shells held in place by submerged wooden fences, revetment mat, and riprap. Deposition of oyster spat on the oyster shell substrate will be monitored to determine the colonization rates on the reef. Shoreward of the oyster berms, a newly created marsh was planted with *Spartina alterniflora*. The survival and distribution of *Spartina*, as well as the rate of shoreline erosion, will be monitored to evaluate the success of the wetland restoration. The Natural Resources Conservation Service is responsible for the \$250,000 project, the results of which will be compared to more conventional shoreline stabilization methods to evaluate its success (Galveston Bay Estuary Program 1999a; 1999c).



**MARSH RESTORATION AT
SAYBROOK POINT, CONNECTICUT**
Long Island Sound Study

In 1994, the Connecticut Department of Environmental Protection Wetlands Restoration Unit began reviving the Saybrook Marsh on the grounds of Fort Saybrook Monument Park in Old Saybrook. Over time, the marsh area had been cut off from its source of brackish water and *Phragmites* had spread over the area. Using special heavy construction equipment designed for wetland restoration, the Wetlands Restoration Unit reconnected the marsh to its brackish-water source, cleared existing channels of debris, constructed several shallow ponds, and removed

**MARSH RESTORATION AT
SAYBROOK POINT,
CONNECTICUT**
Long Island Sound Study
Web: <http://www.epa.gov/region01/eco/lis/>
Problem: Marsh degradation, due to loss of brackish water source, clearing of channels, and construction of shallow ponds along with the removal of invasive *Phragmites*.
Solution: Reconnect the marsh to a brackish water source.

the invasive *Phragmites*. Although *Phragmites* is expected to return in the near future, as the area gradually becomes more saline, indigenous vegetation, such as *Spartina*, should eventually return as well (Long Island Sound Study 1999a).

COQUINA BAYWALK AT LEFFIS KEY
*Sarasota Bay National
 Estuary Program*

The Sarasota Bay National Estuary Program — with assistance from Manatee County, the Florida Department of Environmental Protection, and the EPA — has created 30 acres of native habitat near Coquina Beach in Manatee County. The area had previously been a small mangrove island before being covered by dredged material in the 1950s. The objectives of the project were to (1) restore a dredged material disposal site as a model for other projects; (2) increase mangrove, wetland, and shallow-water habitat; (3) improve bay circulation; and (4) increase spawning and juvenile fish habitats.

The project included removal of exotic species, excavation of intertidal pools and tidal inlets, and construction of boardwalks for public access. Volunteers planted more than 50,000 native saltmarsh, intertidal, and upland plants and trees after the exotic species had been

**COQUINA BAYWALK AT
 LEFFIS KEY**

*Sarasota Bay National
 Estuary Program*

Web: <http://www.sarasotabay.org>

Problem: Loss of small mangrove island due to dredged material disposal.

Solution: Restore native habitat, including mangrove wetlands, through removal of exotic species, and excavation of intertidal pools and tidal inlets.

removed and excavation was complete. Interpretive signs were also prepared to educate visitors to the native species. This project received an Environmental Excellence Award from the Florida Marine Research Institute and was featured in *Good Housekeeping* magazine. The overall project cost \$350,000, which was funded through a wide range of sources (Scheda Ecological Associates 1998; EPA 1997).

**WETLANDS HEALTH
 ASSESSMENT PROGRAM**
Massachusetts Bays Program

The Massachusetts Bays Program, in collaboration with Coastal Zone Management and the University of Massachusetts at Amherst, has spearheaded a unique approach to assess wetland quality and ecological health to better protect the overall condition of critical areas. Considered a cornerstone of the Massachusetts Bays Program work plan, the Wetlands

Health Assessment Program is teaching citizens how to determine wetland health by evaluating the condition of a variety of biological, chemical, and ecological indicators, such as tidal influence, vegetation, aquatic macro-invertebrates, avifauna, water chemistry, and land use. Using these tools, volunteers are assessing the effectiveness of modifications to wetland sites that have recently been restored through improved tidal flow. Concurrent with the citizen monitoring program, scientists are collecting data to validate citizen efforts, and are developing an easy-to-use manual for the future. The long term goals of the program are to use citizen help to monitor wetland health, to promote ecological stewardship, and to advocate a comprehensive biological approach to wetland protection (Massachusetts Bays Program 1999).

**WETLANDS HEALTH
 ASSESSMENT PROGRAM**

Massachusetts Bays Program

Web: <http://www.state.ma.us/massbays/>

Problem: Protection and conservation of newly restored wetlands habitat require monitoring and assessing their health.

Solution: Utilize citizen help in monitoring wetland health and promote ecological stewardship as an approach to habitat protection.



SAN FRANCISCO BAY JOINT VENTURE WETLANDS RESTORATION PROJECT

San Francisco Estuary Project

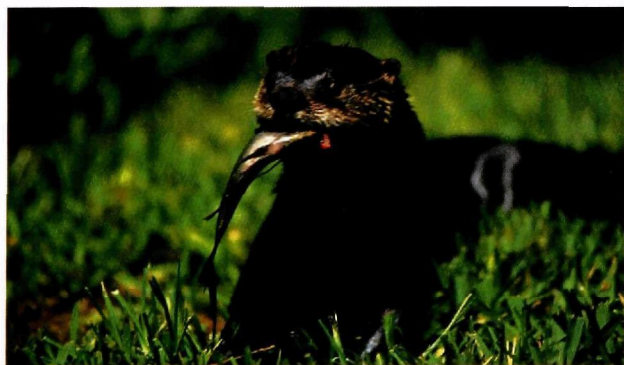
The San Francisco Bay Joint Venture Wetlands Restoration Project, established in 1995, is a partnership among 28 government agencies, environmental organizations, hunting and fishing groups, business interests, and landowners. The goal of the Venture is to acquire, restore, and protect wetlands throughout San Francisco Bay. The focus is on completing on-the-ground projects by leveraging existing public and private resources, developing new funding sources, and creating public-private partnerships. Since its establishment, the Venture has acquired 3,175 acres of wetlands and has restored 871 acres. It has assisted with at least 30 public-private wetland projects and has approximately 90 additional acquisitions or restorations (San Francisco Estuary Project 1996).

SAN FRANCISCO BAY JOINT VENTURE WETLANDS RESTORATION PROJECT San Francisco Estuary Project

Web: <http://www.abag.ca.gov/bayarea/sfep/sfep.html>

Problem: Habitat loss due to various human disturbances.

Solution: Acquire and preserve various types of habitat by a NEP-directed partnership.



HABITAT RESTORATION WORK GROUP Peconic Estuary Program

The Peconic Estuary Program has convened a Habitat Restoration Work Group to address the enhancement of existing resources and the restoration of habitats that have been lost or degraded. The purpose of this group is to identify and prioritize the significant natural habitats of the system, develop overall habitat restoration goals, identify locations where these

habitats can be restored, and develop, in conjunction with public and private landowners, specific restoration projects.

Priority restoration needs, based on degree of loss and threats, include restoration of eelgrass beds and terrestrial habitats, such as coastal grasslands and forests. The estimated cost for implementing the 18 highest priority restoration projects identified by the Group—the ten-year goal of the Peconic Estuary Program—is \$4 million. The cost of implementing the 72 projects evaluated to date is \$42 million.

HABITAT RESTORATION WORK GROUP

Peconic Estuary Program

Web: <http://www.epa.gov/owow/estuaries/pb.htm>

Problem: Enhancement of existing resources and restoration of degraded habitats.

Solution: Identify and prioritize habitats, develop goals, and develop, in conjunction with landowners, specific restoration projects.

REGIONAL HABITAT RESTORATION AND PROTECTION MASTERPLAN

Tampa Bay Estuary Program

The Tampa Bay Estuary Program's Masterplan includes restoration and protection goals based on the needs of key wildlife guilds that share common habitat and feeding preferences. This Masterplan includes a strategy to "restore the historic balance" of the key emergent

REGIONAL HABITAT RESTORATION AND PROTEC- TION MASTERPLAN Tampa Bay Estuary Program

Web: <http://www.tbep.org/>

Problem: Loss of coastal habitats in varying proportions that are critical for specific wildlife guilds.

Solution: Develop and implement Masterplan to restore the historic balance of key emergent wetland plant communities and protect habitat through land acquisition and conservation easements.

wetland plant communities that recognizes that some coastal habitats have been lost in greater proportion than others, and that those habitats may be critical for specific guilds of bay-dependent species. An overall minimum goal is to restore roughly 100 acres of low-salinity tidal marsh habitat every five years, while maintaining and enhancing salt marshes and mangroves at existing levels. The long-term aim is to recover more than 1,600 acres of these habitats over time, either through habitat restoration or enhancement of existing areas that have been severely degraded.

Habitat protection, through public land acquisition and conservation easements on private property, is the other focal point of the Habitat Masterplan, with identifies 28 specific sites as priorities for protection. The majority of these sites have been incorporated into the 1996 Save Our Rivers/Preservation 2000 acquisition priorities of the Southwest Florida Water Management District, greatly improving the changes that these important coastal lands will be acquired and protected.

ECOSYSTEM FEASIBILITY STUDY **Barnegat Bay Estuary Program**

The Barnegat Bay Estuary Program, in conjunction with the New Jersey Department of Environmental Protection and the U.S. Army Corps of Engineers, are involved in various ecosystem restoration construction projects throughout the watershed, which will help preserve and improve habitats for numerous species of plants and animals. These projects include the restoration of fish passageways past dams and high quality habitat in dredged areas which are demonstrating low viability as habitat, as well as the restoration of freshwater wetlands, salt marsh, abandoned lagoons, submerged aquatic vegetation, and waterfowl habitat.

ECOSYSTEM FEASIBILITY STUDY

Barnegat Bay Estuary Program

Web: <http://www.bbep.org>

Problem: Degraded or lost habitat.

Solution: Preserve or improve habitat for plants and animals.



ReefBall Development Group, Ltd.

Habitat Creation

Habitat creation involves the use of manmade or natural material to develop a substrate that serves as a habitat for habitat-specific species. Prior to creating habitat, an evaluation should be conducted to determine if this is the appropriate action. Once it is determined that habitat creation

is the appropriate action, then a multi-step process — including site survey to final design to installation — is implemented.

PUNTA GORDA WATERFRONT **JUVENILE FISHERIES HABITAT**

Charlotte Harbor National **Estuary Program**

The Charlotte Harbor National Estuary Program is partially funding a project to create artificial fish habitat throughout the harbor and off-shore reefs. The project involves constructing and installing “reef balls” of various sizes to act as safe shelter for juvenile fish. Reef balls are hollow,

PUNTA GORDA **WATERFRONT JUVENILE** **FISHERIES HABITAT** **Charlotte Harbor National** **Estuary Program**

Web: <http://charlotteharbornep.com>

Problem: Loss of shelter and feeding habitat for juvenile fish.

Solution: Construct and install throughout the estuary concrete igloo-shaped hollow structures to create artificial juvenile fish habitat.

igloo-shaped concrete structures with holes that allow juvenile fish to move in and out of the structure. In addition to providing safe shelter for the fish, reef balls also provide a suitable surface for the attachment of other estuarine life, which may serve as food for fish or other marine organisms. In May 1999, the Charlotte Harbor Reef Association, volunteers from the Reef Balls Foundation, and the Marine Contracting Group placed 105 reef balls on the south end of Charlotte Harbor Reef. The group also has plans to place 105 reef balls at the north end of the reef, and 252 reef balls under various piers and private docks throughout the area. The Charlotte Harbor NEP funded one-third of the \$6,000 cost of the project (Charlotte Harbor National Estuary Program 1999).

CLEAR CREEK BENEFICIAL USES **OF DREDGED MATERIAL** **DEMONSTRATION PROJECT** **Galveston Bay Estuary Program**

Over the years, the Clear Creek area has lost many acres of wetlands to subsidence or erosion. The Galveston Bay Estuary Program worked with several government agencies and private companies to develop 14 acres of smooth cordgrass wetlands along Clear Creek. This

project used material dredged from the channel of Clear Creek to build a berm around a 14-acre area that had previously been wetlands, but which had since experienced subsidence. The containment area was then filled with the dredged material and planted with smooth cordgrass to create the wetland. With a total cost of \$195,000, this project successfully demonstrated that dredged material could be used to create wetlands. The project was so successful that it was selected to receive one of six 1999 Coastal America Partnership Awards presented by the U.S. Department of Agriculture and EPA (Galveston Estuary Program 1999b).

**CLEAR CREEK BENEFICIAL
USES OF DREDGED
MATERIAL DEMONSTRATION
PROJECT**

*Galveston Bay
Estuary Program*

Web: [http://
gbep.tamug.tamu.edu](http://gbep.tamug.tamu.edu)
Problem: Loss of wetland
due to subsidence.
Solution: Use dredged
material to build a smooth
cordgrass wetland.



SARASOTA BAY WALK AT CITY ISLAND
Sarasota Bay National Estuary Program

In 1990, the City of Sarasota, with assistance from the Florida Department of Environmental Protection and the EPA, created 4.5 acres of productive intertidal habitat on City Island in Sarasota. The primary objective of the project was to create more than one mile of natural, intertidal shoreline; intertidal pools planted with native plants; and a nature trail with interpretive signs. To meet these objectives, debris and non-native plant species were removed from the site, six inter-

**SARASOTA BAY WALK
AT CITY ISLAND**
*Sarasota Bay
National Estuary Program*

Web: [http://
www.sarasotabay.org](http://www.sarasotabay.org)
Problem: Loss of intertidal
habitat due to human distur-
bances and urbanization.
Solution: Create intertidal
shoreline, intertidal pools
planted with native vegetation,
and a nature trail with interpre-
tive signs over a 4.5-acre area.

tidal pools were excavated, natural land elevations were restored, 25,000 native plants were transplanted to the site, and a public boardwalk was constructed. The project took about three years and \$200,000 to complete, and now has more than 20,000 visitors each year. In addition, many species native to Sarasota Bay (e.g., scallops, conch, striped mullet, and sea trout) have returned to the site and the native plants are thriving. Monitoring suggests that the area is equal in productivity to natural coastal wetlands (Scheda Ecological Associates 1998; EPA 1995).

PUBLIC EDUCATION AND OUTREACH

HIGH SCHOOL WETLAND NURSERY PROGRAM

Tampa Bay Estuary Program

The Tampa Bay Estuary Program's wetland nursery program involves middle and high school students in constructing and maintaining a nursery on their school grounds to grow *Spartina* and mangroves for use in publicly financed habitat restoration projects. Students build and operate the nursery, incorporate the experience into their science and math curriculum, and harvest the plants at the appropriate time. Usually, students participate in habitat restoration projects utilizing the plants they have grown. Costs for the program include funds for a nursery setup, power supply, and maintenance.

**HIGH SCHOOL WETLAND
NURSERY PROGRAM**
*Tampa Bay Estuary
Program*

Web: <http://www.tbep.org/>
Problem: Need to foster
stewardship and commit-
ment to bay protection
among students.
Solution: Construct and
maintain nursery on school
grounds to grow *Spartina*
and mangroves for use in
habitat restoration projects.

What started as a pilot project at one school is now a permanent program currently involving fifteen area schools, both public and private. Hundreds of students have helped to raise the wetland plants and transplant them to approved restoration sites, fostering a sense of stewardship and commitment to bay protection among these young people. The project has also saved

public agencies more than \$60,000 over the last six years by providing wetland plants for projects free of charge.

**MASSACHUSETTS BAYS EDUCATION
ALLIANCE TEACHER TRAINING**
Massachusetts Bays Program

The Massachusetts Bays Education Alliance (MBEA) was formed in 1993 as a subcommittee of the Massachusetts Bays Program to bring together ongoing efforts in marine education. This strong, united community of educators is teaching the many values of Massachusetts bays, shores, and water-

**MASSACHUSETTS BAYS
EDUCATION ALLIANCE
TEACHER TRAINING**
Massachusetts Bays Program

Web: <http://www.state.ma.us/massbays/>

Problem: Need to coordinate and increase ongoing efforts in marine and coastal education programs.

Solution: Develop training and network for teaching community focused on the value of the coastal environment to ensure its responsible use and protection.

sheds to help ensure their responsible use and appropriate protection.

Two types of training are offered by MBEA to further its mission: Watershed Education Training and Watershed Stewardship Training. Watershed Education brings together teams of educators, grades 4-9, to attend the workshop series and share the way they adapt the curriculum materials in their classrooms.

Watershed Stewardship builds upon prior education training to introduce concepts and activities from the Massachusetts Bays Watershed Stewardship Guide, which is a companion to the management plan. This workshop is offered to upper elementary to high school teachers. Both types of training emphasize problem-solving, hands-on activity, and stewardship actions.



PATHOGENS

PATHOGEN CONTAMINATION

Pathogens are microorganisms that cause disease. Human pathogens in estuarine environments consist of both pollution-related bacteria and viruses, such as hepatitis and Norwalk viruses, and naturally occurring marine organisms, *Vibrio vulnificus*, for example. The primary routes of human exposure are through the consumption of raw molluscan shellfish, and recreational or occupational contact with surface waters. Diseases associated with these pathogens include gastroenteritis, hepatitis, typhoid fever, cholera, and poliomyelitis; *Vibrio*



vulnificus exposure has caused death in immuno-compromised individuals. Pollution-related pathogens can enter estuarine waters through malfunctioning septic systems, stormwater overflows from sewage treatment plants, runoff from farms and animal populations, and overboard discharge of sewage from vessels. Once released into the water, pathogens disperse, contaminating not only the water column and bottom sediments, but also fish and shellfish. With the intent of protecting the

public from exposure to pathogenic microorganisms, both shellfish-growing areas and bathing areas are monitored for contamination.

In the winter of 1924, sewage-contaminated oysters caused a widespread outbreak of typhoid fever, resulting in 1,500 cases of the disease and 150 deaths (NOAA 1998b). This outbreak led to the development of the National Shellfish Sanitation Program (NSSP) to protect the public from illnesses associated with the consumption of molluscan shellfish. The NSSP, currently administered by the Interstate Shellfish Sanitation Conference, requires the classification of shellfish-growing areas, based on actual and potential pollution sources. The NSSP also protects public health through policies and procedures for interstate commerce in molluscan shellfish.

Shellfish-growing waters are monitored for an indicator of sewage pollution (i.e., fecal coliform bacteria) and a sanitary survey, a qualitative written evaluation, is conducted for all areas potentially affecting the growing waters. Growing area classifications — approved, conditionally approved, restricted, conditionally restricted, and prohibited — are based on fecal coliform monitoring results and the sanitary survey. Fecal coliform concentrations in growing waters, determined by the Most Probable Number (MPN) procedure, must be equal to or less than 14 colonies per 100 mL (with some allowances for higher concentrations) to attain an approved classification. To then ensure public health, growing-water classifications are enforced through patrols, inspections, and harvest tagging.

There is a direct correlation between the concentration of sewage pollution indicators — fecal coliform, *Enterococcus*, and *E. coli* — in water and the occurrence of illness in swimmers (Cabelli 1983). At the same time, naturally occurring *Vibrio vulnificus* has been responsible for wound infections in swimmers and fishermen. In general, state-level recreational water monitoring programs are not as developed as shellfish-growing water programs. There has been significant discussion on the appropriate indicator for recreational water monitoring. Most states use either fecal coliform or *Enterococcus* monitoring data, or a combination of both, to establish bathing restrictions or prohibitions in estuarine and marine waters.

As the population near the Nation's coast increases, the risk of pathogen-related illnesses will also increase for consumers of shellfish and those who use the water for recreation or their livelihood. Several federal programs, such as the U.S. Environmental Protection Agency's (EPA) National Estuary Program (NEP), have determined that pathogen contamination is a priority problem that must be addressed and corrected.

According to a survey of NEP directors, conducted in the fall of 1999, the following 13 of the 28 NEPs list pathogens as a high-priority action item:

Albemarle-Pamlico (NC)
 Buzzards Bay (MA)
 Casco Bay (ME)
 Long Island Sound (NY, CT)
 Massachusetts Bays (MA)
 Morro Bay (CA)
 New Hampshire (NH)
 New York-New Jersey Harbor (NY, NJ)
 Peconic Estuary (NY)
 Santa Monica Bay (CA)
 San Juan Bay (PR)
 Tampa Bay (FL)
 Tillamook Bay (WA)

This section highlights key management approaches and public education and outreach activities implemented by the NEPs to address the issue of pathogen contamination.

MANAGEMENT ACTIONS

After the issues have been prioritized, the NEP develops a number of management actions to address each issue. Although all issues and actions developed by the NEPs are important, many management actions for pathogen contamination are generally incorporated and enforced quickly by local and state government agencies because of the potential impact on human health. Management actions that NEPs across the country have implemented to reduce or eliminate pathogen contamination include legislative changes, abatement programs for combined sewer overflows, identification of nonpoint source discharges, and control of discharges from marine vessels. Each of these management actions and related examples from specific NEPs are discussed in the following sections.

Legislative Changes

Pathogen contamination normally results from the discharge of human or animal wastes through failing septic systems or runoff. In most cases, legislative action is required to correct these problems. Once proper legislation is in place, municipalities and state agencies have the authority to correct the problems responsible for pathogen contamination. Several NEPs have assisted states in developing legislation, which gives state agencies the authority to demand correction measures.

NEW HAMPSHIRE LEGISLATIVE CHANGES

New Hampshire Estuaries Project

Pathogen contamination is the highest priority issue for the New Hampshire Estuaries Project because contamination results in the closure of most shellfish beds along the state's coast. When the New Hampshire Estuaries Project began, pathogen contamination of shellfish was monitored and overseen by the New Hampshire

Department of Human Health (DHH). Under the supervision of DHH, monitoring for pathogens in the estuary was conducted by the New Hampshire Department of Environmental Safety (DES), the New Hampshire Fish and Game Department (F&G), the University of New Hampshire Jackson Estuarine Laboratory (UNHJEL), and the Great Bay Coast Watch — a local volunteer monitoring group.

**NEW HAMPSHIRE
LEGISLATIVE CHANGES**
*New Hampshire
Estuaries Project*
Web: <http://www.epa.gov/owow/estuaries/nhe.htm>
Problem: Shellfish bed closures due to pathogen contamination.
Solution: New legislation changing the state agency responsible for shellfish sanitation.

Some of the data collected were used for classification of shellfish-growing waters while other data were collected for baseline monitoring or to answer specific questions regarding contaminant loading or sources. To help improve shellfish sanitation management, the New Hampshire Estuaries Project established a Shellfish Project Team, comprised of representatives from the New Hampshire DHH, DES, F&G, and Office of State Planning; UNHJEL; volunteer monitoring groups; and recreational shellfishers. The Shellfish Project Team proposed several solutions for improving shellfish management and developing a sustainable vehicle for estuary wide water-quality monitoring in New Hampshire. One of these solutions was to transfer legislative authority for classification of shellfish-growing waters from the New Hampshire DHH to DES. The state government incorporated this action and legislation was enacted.

RHODE ISLAND LEGISLATIVE CHANGES *Narragansett Bay Estuary Program*

The Narragansett Bay Estuary Program has helped to enact legislation that addresses mitigation of pathogen contamination through the control of on-site sewage disposal systems. This new state legislation (1) requires all septic system designers/installers to be licensed in the State of Rhode Island, (2) changed septic system design requirements to soils-based rather than water-table-based criteria, and (3) revised regulations for on-site sewage disposal systems.

In the meantime, the Narragansett Bay Estuary Program is implementing a non-regulatory approach, which provides technical assistance and grants to communities to study the wastewater management district association (Narragansett Bay Estuary Program 1999).

**RHODE ISLAND
LEGISLATIVE CHANGES**
*Narragansett Bay Estuary
Program*
Web: <http://www.nbep.org>
Problem: Inadequate legislation for on-site sewage disposal.
Solution: Revision of legislation for on-site sewage disposal that requires licensing of designers/installers and change in design criteria.

Combined Sewer Overflow (CSO) Abatement Programs

In most cases, the NEPs have reported that combined sewer overflows (CSOs), including storm sewer overflows, represent the largest source of pathogens into estuaries. Several NEPs have listed CSO abatement as the most important action for mitigating pathogen contamination. The NEPs have worked with EPA and state agencies to develop CSO upgrades and inspection programs to prevent illegal dumping of raw sewage into the environment.

CSO ABATEMENT PROJECTS *Long Island Sound Study*

In its management plan, the Long Island Sound Study listed several million-dollar CSO abatement projects being conducted in New York and Connecticut locations. The New York and Connecticut CSO projects will not be completed until 2006 (Long Island Sound Study 1994).

**CSO ABATEMENT
PROJECTS**
Long Island Sound Study
Web: <http://www.epa.gov/region01/eco/lis/>
Problem: CSO contamination throughout the New York and Connecticut area.
Solution: CSO abatement projects costing several million dollars and implementation over several years.

CASCO BAY INITIATIVE *Casco Bay Estuary Project*

Fifty-nine active CSOs discharge pathogens, toxic chemicals, nutrients, and sediments into the Casco Bay estuary. The CSOs are located in the cities of Portland, South Portland, and Westbrook. In 1991, EPA and the Maine De-

partment of Environmental Protection (DEP) began an aggressive campaign — called the Casco Bay Initiative — that imposed on communities an ambitious schedule to develop and implement CSO abatement programs. The Casco Bay Initiative required each city to develop and submit a plan to the Maine DEP for approval. Once approved, the cities were required to submit yearly progress reports to the DEP Division of Engineering and Technical Assistance. The progress reports included information, such as CSO volumes and events from the previous year, and annual progress made on CSO abatement projects. Although the initiative was successful in getting the plans written and approved, they were not always implemented. Several years after the City of Portland's CSO abatement plan was approved, work on CSO abatement had still not been initiated. Finally, the Maine DEP, the EPA, and the City of Portland, with assistance from the Casco Bay Estuary Project, formed a partnership to develop a revised five-year schedule for CSO abatement. The partnership was successful in developing a plan that the City of Portland would agree to fund. According to the Casco Bay Estuary Project, the key to the success of the partnership was an excellent working relationship among EPA, DEP, Friends of Casco Bay, board members, and the Mayor of Portland (Casco Bay Estuary Project 1998).

CASCO BAY INITIATIVE
Casco Bay Estuary Project
Web: <http://www.cascobay.usm.maine.edu>
Problem: 59 CSOs dumping pathogens and toxics into Casco Bay.
Solution: Partnership between EPA, ME DEP, and cities responsible for the CSOs to design and implement abatement projects.



Identification of Nonpoint Sources

Many NEP management plans list nonpoint sources of pollution as contributing much of the pathogen contamination in an estuary. Nonpoint sources vary in size and scope, but are classified together because there is not one specific point of entry that can be controlled and monitored. Included in the nonpoint-source category are malfunctioning septic systems, farm runoff, and urban runoff. Through investigative work, a few nonpoint sources can be identified and controlled.

In cases where nonpoint source discharges cannot be specifically identified, the NEP must develop a program that relies on public involvement to help reduce or eliminate the problem. The primary implementation tools used by NEPs for unidentified nonpoint source controls include best management practice changes in building codes, consent agreements, and education (Long Island Sound Study 1994). The main drawback with these tools is that they rely on voluntary public involvement with no guarantee of effectiveness.

If a source of contamination can be identified, the NEPs work with state agencies to enforce actions to abate the contamination. Several NEPs have been successful in identifying specific urban areas and farm runoff as sources of pathogens. In these cases, the NEPs have succeeded in convincing state agencies to implement stormwater permits that require the discharged stormwater runoff to be treated before it enters the estuary. Successful abatement of pathogen contamination has been accomplished in several ways, including construction of wetlands to filter runoff and to remove sediment (Buzzards Bay Project 1999). Some NEPs have successfully accessed Clean Water Act Section 319 funds to control erosion and to implement sediment-retention practices on farmland.

Sometimes, after an extensive investigation, pathogen contamination can be linked to a specific malfunctioning septic system or a series

of systems. When a malfunctioning system is located, the state requires the landowner to upgrade or replace the failing system. If replacement is necessary and a municipal sewer collection system is available, hookup to the municipal system may be required. Examples of programs that were initiated to address a nonpoint source pathogen contamination problem are listed below.

SANTA MONICA BAY EPIDEMIOLOGICAL STUDY

Santa Monica Bay Restoration Project

Urban runoff and stormwater flow are the most significant uncontrolled sources of pollution to Santa Monica Bay. Although water quality at 90 percent of Santa Monica Bay beaches is safe for swimming during the summer months, bay waters are still periodically contaminated by sewage spills and urban runoff. High concentrations of bacteria in urban runoff are the primary cause of health risks to the bay's swimmers and surfers. The most notable action taken to protect public health is the epidemiological study conducted by the Santa Monica Bay Restoration Project in 1995. This landmark health-effects study conclusively demonstrated a link between illness (e.g., fever, vomiting, ear infections, gastrointestinal illness, and other health problems) and swimming in the ocean near some piers and dry weather storm drain flows.

Results of the study led to improvements in beach warning signs, improved monitoring, and financing for capital projects to divert dry weather flows that might otherwise impact popular beach sites. The County of Los Angeles Department of Health Services (DHS) revised its 1987 beach warning and closure policy based on the results of the 1995 epide-

SANTA MONICA BAY EPIDEMIOLOGICAL STUDY *Santa Monica Bay Restoration Project*

Web: <http://www.smbay.org>

Problem: Urban runoff and dry weather flows from storm drains are contaminated with pathogens and pose health risks to swimmers and surfers.

Solution: Conduct of a health-effects study that conclusively demonstrated a link between health risks and pathogen-contaminated water. Study results led to improved posted warnings, monitoring, and funding for mitigation projects.

miological study. The DHS now directs lifeguards to close a beach for a minimum of 48 hours after a known discharge of untreated or partially treated sewage. Warning signs must be posted permanently at all continually flowing storm drains, storm drains flowing intermittently during dry weather, and discharge points from Malibu Lagoon. Warning signs must also be posted at any site where sampling indicates that bacterial counts are above the health risk thresholds. People are also advised to stay out of the water for at least 72 hours following a storm event (Santa Monica Bay Restoration Project 1998).



SHELLFISH BED RESTORATION PROGRAM *Massachusetts Bays Program*

Approximately 40 percent of the shellfish beds in Massachusetts and Cape Cod Bays are either closed or variously restricted due to contamination. Nonpoint source pollution, especially stormwater runoff, has been identified as the most important source of contamination to the shellfish beds. In accordance with an action plan specified in its management plan, the Massachusetts Bays Program has coordinated an effort to restore and protect 13 shellfish beds in these bays. Using a coordinated "institu-

SHELLFISH BED RESTORATION PROGRAM *Massachusetts Bays Program*

Web: <http://www.state.ma.us/massbays/>

Problem: Shellfish bed impacted by nonpoint-source pollution, specifically stormwater runoff and discharge from storm drains.

Solution: Targeting a single specific category of pollution, discharge from storm drains, and the use of innovative remediation technologies are proving to be successful in restoring contaminated shellfish beds.

tional" approach, the project participants believed that remediation and restoration of the shellfish beds would be more successful if a single, specific category of pollution sources was targeted. The Shellfish Bed Restoration Program presented opportunities for some program participants to demonstrate the effectiveness of innovative technologies, which specifically target remediation of contaminants in storm water. One such technology, which employs a sedimentation basin, a series of filter screens, and a constructed wetland to mitigate pollution associated with stormwater runoff, has been used at two shellfish bed sites targeted for restoration. Although many of the mitigation projects are still in initial stages, preliminary results from several sites indicate encouraging early successes in restoration and opening of shellfish beds Massachusetts Bays Program (1997).



VOLUNTARY INSPECTION AND INFORMATION ASSISTANCE PROGRAM FOR HOMEOWNERS

Galveston Bay Estuary Program

In response to pathogen contamination, suspected to be originating from failing septic systems, the Galveston Bay Estuary Program initiated the Voluntary Inspection and Information Assistance Program to Reduce Bacterial Pollution Caused by Malfunctioning Septic Systems. This program conducted door-to-door voluntary inspections of on-site septic systems at homes along the Galveston Bay shoreline to determine potential malfunctions. Of the 102 septic systems surveyed in the Dickinson Bayou Watershed, 46 were found to be failing. As a

result of this voluntary survey, some of the residents were given technical assistance and information regarding septic system problems; several homeowners have voluntarily corrected the problem. Additional technical assistance, in the form of an assessment plan outlining the technical and economic options for homeowners with failing septic systems, is being supplied to the Pine Oak subdivision. This assessment will evaluate the cost differences between a municipal system and enhancement or replacement of malfunctioning systems. On the Bolivar Peninsula, the Texas General Land Office removed 12 houses because of malfunctioning septic tanks (Galveston Bay Estuary Program 1999a).

VOLUNTARY INSPECTION AND INFORMATION ASSISTANCE PROGRAM Galveston Bay Estuary Program

Web: <http://gbep.tamug.tamu.edu>

Problem: Pathogen contamination from suspected on-site septic systems.

Solution: Voluntary inspection and information assistance program to educate the homeowners about their failing septic systems.

CONSTRUCTED WETLANDS SYSTEM Buzzards Bay Project

The Buzzards Bay Project assisted in developing a constructed wetlands system to abate pathogen contamination from a moderately settled area. This area was contaminating the western section of Sippican Harbor, called Spragues Cove, a valuable shellfish harvesting site and the Town of Marion's only bathing area. The Massachusetts Division of Marine Fisheries (DMF) and the Town of Marion's public health department consistently closed the area due to high concentrations of fecal coliforms. Upon investigation by DMF, it was determined that stormwater was the major source of contamination.

The Town of Marion submitted a proposal to the Buzzards Bay Project to reduce bacteria and

CONSTRUCTED WETLANDS SYSTEM Buzzards Bay Project

Web: <http://www.buzzardsbay.org>

Problem: Pathogen contamination from a moderately settled urban area that closed bathing areas and shellfish beds.

Solution: Constructed wetlands to filter stormwater runoff.

other pollutants entering the bay from Spragues Cove Creek. The town's proposal was funded and resulted in a three-acre constructed wetland adjacent to Silvershell Beach. The constructed wetland was designed to collect and treat storm-water runoff and associated nonpoint-source pollutants from 64 acres of Marion's lower village. Within the first year of construction, sampling indicated an overall reduction of fecal coliform bacteria in the cove. As additional plants become established in the wetlands, it is expected that fecal coliform counts will continue to decrease (Buzzards Bay Project 1999).

PARTNERSHIP BUILDING FOR SEWER EXTENSION

Tillamook Estuaries Partnership

Failing septic systems are a significant contributor to elevated bacterial concentrations throughout the Tillamook Bay basin. Expanding the sewer network offers the best solution to widespread septic failures, and the City of Tillamook is taking steps to extend lines to the city's "hot spots." There are many obstacles to overcome, including existing city policy, limited city staff, landowner resistance, existing sewer infiltration and inflow, and existing sewer plant capacity. The Tillamook Estuaries Partnership is working with the city to overcome these obstacles by providing technical and organizational skills and resources in the form of strategizing with city and community leaders, working with potential project funders, writing loan applications, and facilitating meetings.

PARTNERSHIP BUILDING FOR SEWER EXTENSION Tillamook Estuaries Partnership

Web: <http://www.co.tillamook.or.us/gov/estuary/tbnep/nephome.html>

Problem: Elevated bacterial concentrations in Tillamook Bay due to failing septic systems.

Solution: Partnership building to expand sewer network to "hot spot" areas.

SHELLFISH WATERS RESTORATION

Barnegat Bay Estuary Program

The hard clam harvest in Barnegat Bay has experienced a steady decline over the past 50 years due in large part to nonpoint sources of pollution. The Barnegat Bay Estuary Program has been working with the New Jersey Depart-

ment of Environmental Protection to conduct a coordinated and comprehensive approach to pollution source identification. This Sanitary Survey, in conjunction with an intensive, land-based survey, includes a watershed assessment and land use analysis to determine potential point and nonpoint sources of pollution. This information is being used to implement a comprehensive shellfish water quality planning and management strategy to control sources of bacterial contamination, including the implementation of Best Management Practices (BMPs). As a result, as of March 2001, more than 5,000 acres of shellfish waters were opened for unrestricted harvesting for the first time in 30 years.

SHELLFISH WATERS RESTORATION

Barnegat Bay Estuary Program

Web: <http://www.bbep.org>

Problem: Closure of polluted hard clam waters.

Solution: Identify pollution sources and implement BMPs.

Control of Discharges from Marine Vessels

Although vessel-discharged sewage is normally only a minor source of pathogens, when dumped in an inappropriate area, it can cause closures of shellfish beds and health warnings at beaches and bathing areas. In response to the dumping of vessel sewage, the federal government enacted Section 312 of the Clean Water Act, which mandates the use of marine sanitation devices on vessels and provides procedures for establishing "No Discharge Zones" by EPA or the state, for sewage from vessels, both commercial and recreational. The Clean Vessel Act is a grant program administered by the U.S. Fish and Wildlife Service for construction, renovation, operation, and maintenance of pumpout stations for vessel sewage. Several NEPs have assisted state agencies with planning the locations of pumpout facilities and designating additional areas as "No Discharge Zones."

MARINA PUMPOUT SITING PLAN

Narragansett Bay Estuary Program

The Narragansett Bay Estuary Program developed and assisted in implementing a bay-wide pumpout facility plan, called the Narragansett

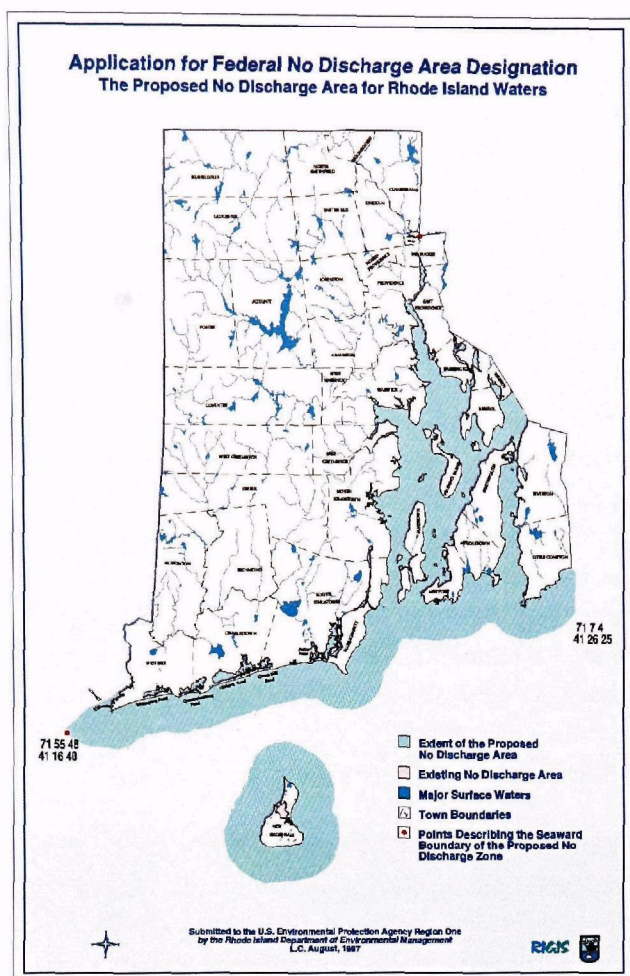


Figure 2: "No Discharge Zone" in Rhode Island
(Rhode Island Department of Environmental Management 1999)

Bay Estuary Program Marina Pumpout Siting Plan. This plan provides for access to pumpout facilities throughout Narragansett Bay and Rhode Island. Once implemented, the plan successfully located pumpout facilities along the entire Rhode Island coast so that Rhode Island officials could designate the entire coast of Rhode Island as a "No Discharge Zone" (see Figure 2). The Narragansett Bay Estuary Program also instituted a boater education program on the proper disposal of waste. The educational materials included information on the operation and maintenance of marine sanitation devices, and the identification of "No

MARINA PUMPOUT SITING PLAN
Narragansett Bay Estuary Program
Web: <http://www.nbep.org>
Problem: Dumping of sewage from vessels into area waters.
Solution: Installation of vessel pumpout stations at marinas and designation of a "No Discharge Zone."

Discharge Zones" and local pumpout stations (Narragansett Bay Estuary Program 1999).

SHELLFISH CHALLENGE INITIATIVE

Barataria-Terrebonne National Estuary Program

From April 1997 to June 1998, the EPA Gulf of Mexico Program, the National Oceanic and Atmospheric Administration's Strategic Environmental Assessments Division, and the Barataria-Terrebonne NEP co-sponsored the Barataria-Terrebonne Shellfish Challenge Initiative, the goal of which was "to increase shellfish beds in the Barataria-

SHELLFISH CHALLENGE INITIATIVE
Barataria-Terrebonne National Estuary Program
Web: <http://www.btnep.org>
Problem: Need to increase shellfish beds available for safe harvest by 10 percent.
Solution: Implement shellfish bed restoration projects, including new pumpout stations at marinas and connecting individual sewage systems to existing WWTP

Terrebonne estuary available for safe harvest by ten percent." The partners strategically analyzed the type and severity of fecal coliform bacteria pollution problems and resource management issues causing shellfish harvest limitations. Using this preliminary analysis, a series of four stakeholders workshops for regional shellfish experts, water quality officials, scientists, and local stakeholders were held, where 61 candidate oyster growing water restoration projects in the Barataria-Terrebonne estuary were identified, described, and mapped using GIS. Through an additional consensus-based workshop using feasibility and funding opportunity criteria, this list was refined to four priority projects for immediate implementation, three of which contribute to the implementation of the Management Plan. The priority projects included installing new pumpout/dump stations at marinas throughout the estuary and connecting poorly operating individual wastewater treatment systems to an existing wastewater treatment plant at selected sites. More than \$250,000 has been leveraged by Barataria-Terrebonne NEP to implement the Shellfish Challenge Initiative.

PUBLIC EDUCATION AND OUTREACH

VOLUNTEER WATER QUALITY MONITORING

Morro Bay National Estuary Program

The Friends of the Estuary/Morro Bay National Estuary Program's Volunteer Monitoring Program has successfully recruited and trained volunteers to help collect water quality samples to provide much needed scientific data. The Volunteer Monitoring Program has developed as a partnership between many agencies, organizations, and citizens. The Bay Foundation and the Central Coast Regional Water Quality Control Board, through the NEP, provide support for volunteer coordination, program management, and laboratory funds for monitoring activities. The Friends of the Estuary provided funds for water quality equipment and volunteer recognition. Partnerships are continually forming to expand the watershed-wide Volunteer Monitoring Program. Hundreds of volunteers of all ages have gotten their feet wet in the creeks and bay.

VOLUNTEER WATER QUALITY MONITORING
Morro Bay
National Estuary Program
Web: <http://www.mbnep.org/>
Problem: Need to conduct regular water quality monitoring.
Solution: Recruit and train volunteers to collect water quality samples and promote stewardship of Morro Bay.

On-going monitoring activities include: *Benthic Invaders*, volunteers who each spring venture into the creeks using kicknets to gather benthic macroinvertebrates from the stream bottom gravels; *Bac Attackers*, volunteers who routinely gather samples for E.coli, total coliform, and nitrates on a bi-weekly basis at the freshwater seeps at the edge of the bay; *Stream Profiles*, volunteers who conduct habitat assessments and stream channel profiles once a year; *SLO Floaters*, volunteers who every other week measure creek flows in the tributaries that flow into Morro Bay; the *Dawn Patrol*, volunteers who ride in kayaks, at dawn once a month, to measure dissolved oxygen; *Bay Nitrate Monitoring*, volunteers who ride in boats, canoes and kayaks to collect nitrate and salinity samples; the *Drain Rangers*, "on-call" volunteers who collect storm water runoff samples from culverts and drains during the winter season.

Through training in proper sample collection techniques, instrument operation, and quality control, volunteers collect sound scientific data. The information gathered through the program is being incorporated into the Morro Bay NEP's management plan. The involvement of volunteers in the monitoring program has successfully promoted stewardship and increased awareness of need to protect the resources of Morro Bay.

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FRESHWATER INFLOW

FRESHWATER INFLOW

The availability of freshwater has been an issue in the United States for a long time. When the population of the United States initially increased, settlers moved west across the plains in search of fertile areas with a good supply of freshwater. The availability of freshwater was so important to the settlers that the U.S. government included water rights on deeds for property. Today, the right to access freshwater is still an issue and most original water rights deeded to landowners are still in effect.

As the population continues to grow, the domestic demand for freshwater must compete with those of agriculture and industry. With this ever-increasing demand for water, state and local governments search for the least expensive delivery mechanisms.

One way that freshwater can be obtained is through stream or river diversions. In this case, water is diverted from the original flow path into a low-lying area or structure to form a holding basin. Once contained, the water can be removed, purified, and delivered to the final user. Because many communities were originally located along rivers, it is not unusual for one river to be diverted in several locations to supply water to different communities.

A consequence of freshwater diversion that is normally not considered is the change in freshwater flow at the mouth of a river. As water is diverted upstream for various uses, less volume is delivered to the river's mouth. This change in flow results in alterations to the water quality (e.g., salinity) as well as to the quality of the area's habitat. The issue of freshwater inflow is so important that several federal programs, including the U.S. Environmental Protection

Agency's (EPA) National Estuary Program (NEP), consider freshwater inflow a priority problem that must be addressed.

According to a survey of NEP directors, conducted in the fall of 1999, two of the 28 NEPs consider freshwater inflow a high-priority action item:

Albemarle-Pamlico (NC)
San Francisco (CA)

Note: Several other NEPs list freshwater inflow as a concern, but not as a top priority.

This section highlights key management approaches and public education and outreach activities implemented by the NEPs to address the alteration of freshwater inflow.

MANAGEMENT ACTIONS

After the issues have been prioritized, the NEP develops a number of management actions to address each issue. Most estuaries experience a problem with reduced freshwater inflow to the estuary because water is diverted for various reasons. A decrease in freshwater inflow can result in a decrease in the quantity of low-salinity wetlands, changes in tidal-flow patterns, and losses of vital habitats. In these cases, the estuary must develop a plan to increase the flow to acceptable levels. A few estuary programs, such as the Albemarle-Pamlico Sounds NEP, have problems with increased freshwater inflow due to hurricanes, large rain storms, or the draining of areas previously not connected to the estuarine system. In cases where too much freshwater inflow occurs, diversion of streams may be used to mitigate the problem. In either case — too much or too little inflow — a Best

Management Practice (BMP) can be developed for the watershed or area influenced by the stream or river.

The following are examples of management actions that have been successfully implemented by NEPs across the country. These management actions have been categorized under management plans or reclamation actions.

Management Plans

The freshwater inflow management plans described below focus mainly on finding a solution through proper management of the freshwater that is available throughout the entire system. These actions rely on state agencies to work out an amicable solution to providing freshwater to all parties involved.

HOLISTIC APPROACH TO FRESHWATER MANAGEMENT

Coastal Bend Bays and Estuaries Program

In the Corpus

Christi Bay region, management of freshwater inflow is currently an issue at the local and state government levels, and requires an agreed-upon process for decision-making. The current decision-making framework is politically and emotionally charged, and more reactionary than proactive in nature.

***HOLISTIC APPROACH TO
FRESHWATER MANAGEMENT
Coastal Bend Bays and
Estuaries Program***

Web: <http://www.cb bep.org/>

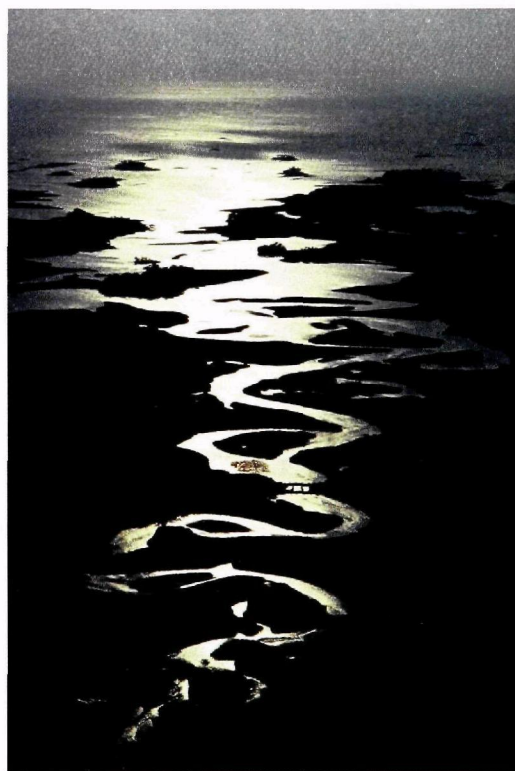
Problem: Current management framework for freshwater is reactionary.

Solution: Develop holistic proactive management approach for freshwater.

The Coastal Bend Bays and Estuaries Program determined that the management of freshwater resources in the system needed to be carried out within the framework of a regional, holistic approach that also included environmental needs. At a minimum, the holistic management approach attempts to address the following:

- Infrastructure for wastewater reuse
- Return flows to the estuary
- Freshwater inflow
- Watershed management

- Affordable water supply
- In-stream needs
- Wetland and other habitat preservation
- Demand management
- Urban runoff management
- Atmospheric loading
- Industrial treatment
- Municipal treatment
- Total estuarine productivity
- Conjunctive use
- Sustainable development
- Water permitting/re-allocation
- Onsite sewage facilities
- Water recreation
- Conservation
- Public education
- Data acquisition
- Meteorological studies
- Bay circulation



FRESHWATER INFLOW MODEL Delaware Estuary Program

The Delaware River Basin Commission is developing models to determine optimum salinity ranges or to establish ecological criteria necessary to: (1) set minimum flows; (2) de-

velop salinity standards; (3) integrate resource planning by water and wastewater authorities, water conservation rate structures/conservation retrofitting programs by water and wastewater utilities, and wastewater reclamation; and (4) provide infrastructure for wastewater reuse. This program will assure adequate freshwater flows into the estuary.

FRESHWATER INFLOW MODEL
Delaware Estuary Program
Web: <http://www.delep.org>
Problem: Decrease in amount of freshwater entering the estuary.
Solution: Develop freshwater inflow model to determine minimum freshwater flows needed to meet the program goals.

BEST MANAGEMENT PRACTICES TO REDUCE THE LOSS OF FRESHWATER INFLOW

Charlotte Harbor National Estuary Program

In the Charlotte Harbor study area, a watershed approach to surface-water management will be used to form a watershed management plan for each drainage basin, including establishing minimum flows and water levels for each water body.

Water management districts are responsible for establishing minimum in-stream flows so that permitted water withdrawals do not adversely impact natural resources. The Florida Department of Environmental Protection and the water management districts regulate groundwater withdrawal for water supply, agriculture, and industrial purposes. Point source discharges, such as those from sewage treatment plants and industrial facilities, are regulated for water quality and monitored for flow rates. Best Management Practices (BMPs) are encouraged to decrease and retain stormwater runoff, and water-use permits are administered to control use.

Lake Okeechobee serves as the central freshwater supply and as a floodwater reservoir. When the lake rises above a pre-determined

**BEST MANAGEMENT
PRACTICES TO REDUCE THE
LOSS OF FRESHWATER INFLOW**
*Charlotte Harbor National
Estuary Program*
Web: <http://www.charlotteharbornep.com>
Problem: Irregular and inconsistent flows of fresh water to the estuary.
Solution: Develop best management practices to regulate the flow.

height, mandatory releases are made to the Caloosahatchee and St. Lucie estuaries. Environmental problems in these estuaries are a direct result of their unnatural connection to the lake and resulting changes within their watersheds. Periodic releases of freshwater, some as high as 10,000 cubic feet per second, can turn these estuaries into freshwater systems. By contrast, agricultural and municipal demands for water during the dry season severely limit the freshwater discharges and result in near-marine (salt water) conditions throughout the estuaries. Compounding the problem, and affecting all estuaries within the South Florida Water Management District, has been the development of an intricate network of secondary canals, which drain surrounding urban and agricultural lands. This artificial modification of the watershed has altered freshwater discharge to the estuaries without regard for the volume, timing, frequency, duration, or water quality necessary to maintain downstream ecological integrity.

The Caloosahatchee Estuary faces three major problems: (1) disruption of the natural magnitude and timing of freshwater discharge, (2) increasing inputs of nutrients and other materials of concern, and (3) loss of critical estuarine habitats and species. The changing salinity and water quality conditions threaten the seagrass beds and other aquatic vegetation in the estuary.

Water flows in the Peace River have generally declined over the last 50 years. Springs and wetland areas have run dry due to increased use



of groundwater and subsequent lowering of the water table or aquifer pressure. Coastal communities are becoming increasingly dependent on surface water sources for water supply. Large projected population increases indicate that water demand will continue to increase while sources of freshwater decrease. The primary purpose of the Caloosahatchee (Charlotte Harbor) Watershed Program, operated by the water management district, is to protect and enhance this critical ecosystem through the development of a plan that addresses restoration and water supply, while maintaining and enhancing the estuary within the context of continued urban, agricultural, and recreational use of water resources.



Reclamation Actions

Freshwater inflow reclamation involves the collection of wastewater from various sources, and purification so that the wastewater is suitable for use by agriculture and industry.

MANATEE RIVER WASTEWATER RECLAMATION PLAN

Sarasota Bay National Estuary Program

A major component of the Sarasota Bay NEP management plan recommends the construction of a multi-jurisdictional regional wastewater reuse system. The overall plan is to reclaim approximately 50 million gallons of wastewater per day for agricultural, urban, and possibly potable use. Most of the wastewater will be returned to the Manatee River watershed in the Tampa Bay area, which has historically received

attention due to the lack of freshwater inflow. A multi-jurisdictional task force has been established, chaired by the Southwest Florida Water Management District, to complete the final design of the wastewater recovery system. Funding is being provided through congressional appropriation, the Water Management District, and local governments.

MANATEE RIVER WASTEWATER RECLAMATION PLAN *Sarasota Bay National Estuary Program*

Web: <http://www.sarasotabay.org>

Problem: Decreased flow of fresh water to the Manatee River.

Solution: Develop a regional wastewater re-use plan to reclaim wastewater.

PUBLIC EDUCATION AND OUTREACH

COMMUNITY EDUCATION TO DECREASE WATER USE

Charlotte Harbor National Estuary Program

The Charlotte Harbor NEP, Florida, recognized very early in its process that alterations in freshwater flows into the estuary had resulted in significant changes in the harbor's environment. After identifying the problem, the NEP is assisting

in the development of water management plans for each drainage basin throughout the entire watershed, including the establishment of minimum flows and water levels for each water body, as well as the implementation of Best Management Practices (BMPs). Public education is also part of the approach. Two programs that target community education in methods to use less water for landscaping and in improving the quality of surface water runoff are the Florida Yards and Neighborhoods Program and Xeriscaping. In addition, both programs use plants that are native to the area and that grow well in local conditions.

COMMUNITY EDUCATION TO DECREASE WATER USE *Charlotte Harbor National Estuary Program*

Web: [http://](http://www.charlotteharbornep.com)

www.charlotteharbornep.com

Problem: Alterations in freshwater flows.

Solution: Educate the community to reduce water use and improve water quality.



NUTRIENTS

NUTRIENT ENRICHMENT

Nutrients, such as nitrogen and phosphorus, are essential for the growth of plants and animals and to support healthy marine and freshwater ecosystems. However, excessive levels of nutrients can lead to algal blooms, low dissolved oxygen, and fish kills. The relationships between high levels of nutrients and environmental problems are complex.

Nutrients stimulate the growth of algae which blocks sunlight from the water column and, which when decomposing, draws oxygen out of the water leading to hypoxic (low dissolved oxygen) or even anoxic (no dissolved oxygen) conditions. These conditions can lead to fish kills and loss of seagrass habitat. The loss of seagrass habitat results in animals that depend on seagrasses for food or shelter either leaving the area or dying. In addition, decaying algae often produce foul smells resulting lower aesthetic values for coastal resources.

The links are being studied between nutrient overloading and harmful algal blooms, such as red and brown tides and toxic *Pfiesteria* outbreaks. *Pfiesteria* outbreaks have occurred in several tributaries to the Chesapeake Bay and in

North Carolina rivers in recent years, resulting in fish kills, fish lesions, and suspected human health impacts.

Other harmful algal blooms have been linked to fish kills, manatee deaths, and declines in scallop populations. Some of these algal blooms emit toxins that can contaminate fish or shellfish, making them unfit for human consumption.

According to a survey of NEP directors, conducted in the fall of 1999, the following 10 of the 28 NEPs consider nutrient enrichment a high-priority action item:

Albemarle-Pamlico (NC)
 Delaware Inland Bays (MD)
 Indian River Lagoon (FL)
 Long Island Sound (NY, CT)
 Maryland Coastal Bays (MD)
 Mobile Bay (AL)
 New York - New Jersey Harbor (NY, NJ)
 Peconic Estuary (NY)
 San Juan Bay (PR)
 Sarasota Bay (FL)



Nutrients that enter aquatic ecosystems come from both point sources, such as sewage treatment plant discharges, and nonpoint sources, such as stormwater runoff of fertilizers from lawns and agricultural lands, combined sewer overflows, faulty or leaking septic systems, animal wastes, atmospheric deposition originating from power plants or vehicles, and groundwater discharges.

This section highlights key management approaches and public education and outreach activities implemented by the NEPs to address the issue of nutrient enrichment.

MANAGEMENT ACTIONS

After the issues have been prioritized, the NEP develops a number of management actions to address each issue. The following are examples of management actions to address nutrient enrichment that have been successfully implemented by NEPs across the country. The management actions presented below include legislative changes, development of a comprehensive management plan, and identification of nonpoint-source discharges.

Legislative Changes

Nutrient overloading normally results from the discharge of human or animal wastes through inadequately treated wastewaters, failing septic systems, or runoff. In most cases, legislative action is required to correct these problems. Once proper legislation is in place, municipalities and state agencies have the authority to correct the problems responsible for nutrient enrichment. Several NEPs have assisted states in developing legislation, which gives state agencies the authority to implement corrective measures. The Sarasota Bay NEP and the Long Island Sound Study are two programs that have helped to pass legislation to mitigate nutrient contamination.

GRIZZLE FIGG LEGISLATION

Sarasota Bay National Estuary Program

The principle pollutant of concern in Sarasota Bay is nitrogen. Since the 1940s and 1950s, about 30 percent of the seagrass beds in Sarasota Bay have been lost, due primarily to excessive nitrogen from wastewater and stormwater runoff.

The Sarasota Bay NEP helped to enact Florida's 1990 Grizzle Figg legislation, aimed at controlling

GRIZZLE FIGG LEGISLATION
Sarasota Bay National Estuary Program
Web: <http://www.sarasotabay.org>
Problem: Loss of seagrasses due to nutrient enrichment.
Solution: New legislation requiring advanced treatment of discharged wastewater.

the amount of nutrients entering the bay. The Grizzle Figg legislation requires that wastewater, discharged directly to surface waters, meets advanced wastewater treatment standards (i.e., <3 mg/L total nitrogen, <1 mg/L total phosphorus). To meet these requirements, counties upgraded wastewater treatment plants, expanded agricultural reuse programs, and developed deep-well injection and aquifer storage and recovery systems. As a result of this legislation, nitrogen loads to Sarasota Bay have decreased by 28 to 38 percent, and seagrass coverage has increased by seven percent (about 614 acres) since 1988 (Sarasota Bay National Estuary Program 1999).

NITROGEN REDUCTION PROGRAM

Long Island Sound Study

The Long Island Sound Study (LISS) identified low dissolved oxygen (hypoxia) as the most significant water quality problem in Long Island Sound. Studies

showed that excessive nitrogen, discharged by sewage treatment plants, was the primary cause of hypoxia (<2-3 mg/L dissolved oxygen). In the deeper waters of western Long Island

Sound, this condition usually occurs during the summer months and results in a habitat that is unable to support aquatic life. To address this problem, the LISS has been proceeding with a multi-phase nitrogen reduction program, which began with Phase I in 1990. During Phase I, point and nonpoint nitrogen loadings to Long Island Sound were kept at 1990 levels. This action was taken to prevent the hypoxia problem from becoming more severe. During Phase II, adopted in 1994, the LISS committed to reducing nitrogen discharges from peak loadings. To meet the LISS goal, a variety of low-cost nitrogen removal technologies have been incorporated at selected sewage treatment plants. In addition, state agencies are using innovative strategies and the cooperation of local govern-

NITROGEN REDUCTION PROGRAM

Long Island Sound Study

Web: <http://www.epa.gov/region01/eco/lis/>

Problem: Low dissolved oxygen due to excessive nitrogen loading.

Solution: Freeze nitrogen loading from sewage treatment plants and implement low-cost nitrogen removal technologies at selected plants.

ments to implement nitrogen control methods. As a result of these activities, nitrogen loading to the Sound, from both point and nonpoint sources within the watershed, has been reduced from peak loadings by 3,900 tons per year. In February 1998, EPA, and the states of Connecticut and New York adopted the plan entitled *Phase III Actions for Hypoxia Management*, which includes nitrogen reduction targets for 11 management zones that make up the Long Island Sound watershed. This bi-state agreement calls for a 58.5 percent reduction in human-caused nitrogen loads to the Sound over a 15 year period beginning in 1999. To meet this goal, the states of New York and Connecticut

have developed a final Total Maximum Daily Load (TMDL) for nitrogen, which EPA has approved. The estimated nitrogen load from sewage treatment plants in the drainage basin that entered Long Island Sound in 2000 is approximately 158,676 lbs/day, a decrease of nearly 28,000 lbs/day from 1990 levels. Both states are continuing to prioritize funding for nonpoint source pollution control projects benefiting the Sound. (Long Island Sound Study 1994; 1998;1999b).

Development of Management Plan

Some management actions to address nutrient enrichment are accomplished through the development and implementation of a management plan that comprehensively targets all sources of nutrient contaminants.

NUTRIENT-SENSITIVE WATERS MANAGEMENT STRATEGY FOR THE NEUSE RIVER

Albemarle-Pamlico Sounds National Estuary Program

The Neuse River estuary has had a history of nutrient-related water quality problems, as evidenced by excessive algal blooms, low dissolved oxygen, and fish kills. To curb these problems, the State of North Carolina has developed and is beginning to implement a comprehensive Nutrient-Sensitive Waters Management Strategy for the Neuse River.

**NUTRIENT-SENSITIVE
WATERS MANAGEMENT
STRATEGY FOR THE
NEUSE RIVER**
*Albemarle-Pamlico Sounds
National Estuary Program*
Web: <http://h2o.enr.state.nc.us/nep/>
Problem: Nutrient-related water quality problems in the Neuse River estuary.
Solution: Develop and implement a comprehensive management plan for point- and nonpoint-source pollution.

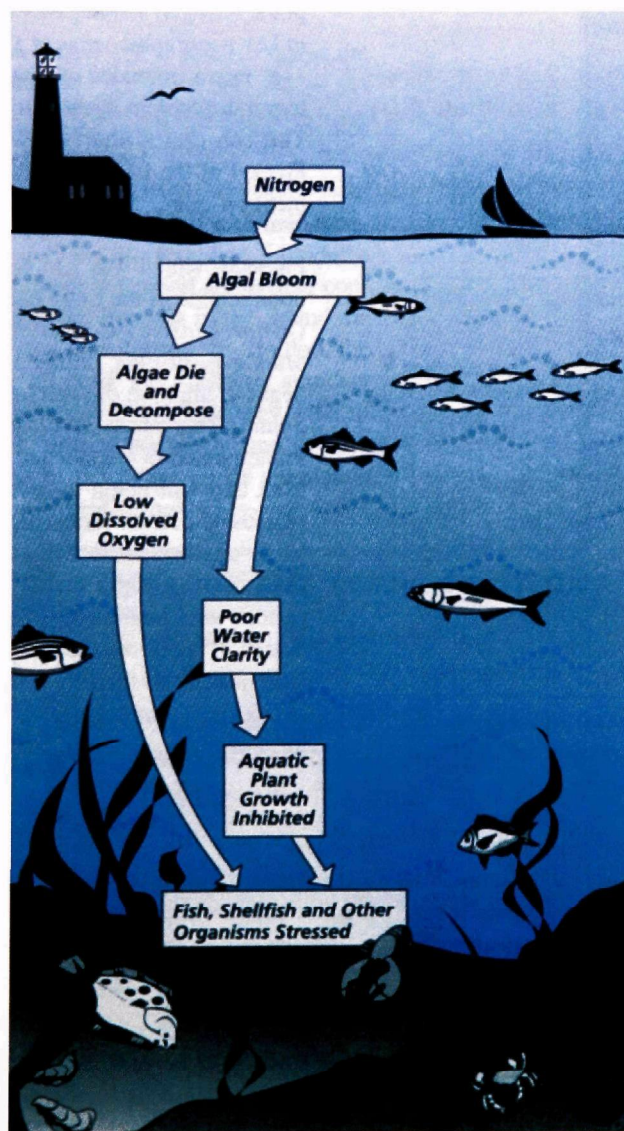


Figure 3: Effects of Excessive Nitrogen
(Source: Long Island Sound Study, 1998)

This strategy is intended to reduce the concentrations of nutrients entering the river. For the first time in state history, the management strategy applies mandatory controls not only on point sources, but also on nonpoint sources of nutrient pollution in the Neuse River basin. For point-source dischargers, a nitrogen limit will be allocated, based on the permitted flow. Management of stormwater and urban runoff has become the responsibility of local govern-

ments of heavily populated and rapidly growing communities. Farmers are being required to implement best management practices to control agricultural runoff, and landowners (of 50 acres or more) must develop and implement nutrient management plans.

***NUTRIENT MANAGEMENT STRATEGY:
PUBLIC – PRIVATE PARTNERSHIP
TO RESTORE SEAGRASSES
Tampa Bay Estuary Program***

To address the long-term management of this disparate mixture of nitrogen sources, the Tampa Bay Nitrogen Management Consortium, consisting of local electric utilities, industries and agricultural interests, as well as local governments and regulatory agency representatives

***NUTRIENT MANAGEMENT
STRATEGY: PUBLIC – PRIVATE
PARTNERSHIP TO RESTORE
SEAGRASSES***

Tampa Bay Estuary Program

Web: <http://www.tbep.org>

Problem: Long-term management of many nitrogen sources.

Solution: Convene consortium to address target load reduction.

participating in the Tampa Bay Estuary Program, has been established to develop a Consortium Action Plan to address the target load reduction needed to “hold the line” at 1992-1994 levels (a total reduction of 17 tons of nitrogen per year each year through the year 2010). To date, implemented and planned projects collated in the Consortium Action Plan are expected to reduce existing nitrogen loads by 140 tons/year by 2000, which meets and exceeds the agreed-upon reduction goal. Seagrass extent, the environmental indicator of “success” for this program, is expanding at the rate of about 350 acres per year, a rate which, if

maintained, will meet the long-term restoration target of restoring seagrass acreage to that observed in 1950 in about 25 years.

NUTRIENT MANAGEMENT

Peconic Estuary Program

Nitrogen is the primary nutrient of concern in the Peconic Estuary system. The Peconic Estuary Program (PEP) has implemented a point source nitrogen freeze and SPDES permits have been modified to reflect this change.

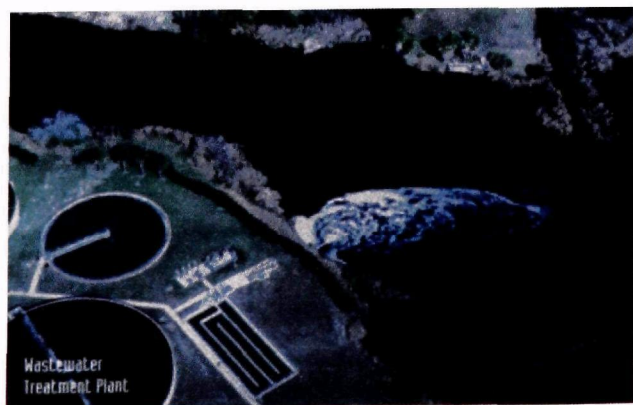
As a result of the comprehensive work done by the PEP, major sewage treatment plants in the area are being upgraded using New York State Clean Water/Clean Air Bond Act monies. The PEP has also made significant progress towards the development and implementation of a nitrogen Total Maximum Daily Load (TMDL) for the entire estuary, using extensive monitoring and state-of-the-art characterization and assessment tools, including a three-dimensional hydrodynamic and water quality model with a predictive sediment submodel. Nonpoint source management plans are underway including expanding the and land use planning. County and town sources have already committed millions of dollars for open space acquisitions.

***NUTRIENT MANAGEMENT
Peconic Estuary Program***

Web: <http://www.epa.gov/owow/estuaries/pb.htm>

Problem: Nitrogen levels in the Peconic Estuary.

Solution: Implement a point source nitrogen freeze, upgrade WWTPs, implement TMDL, and implement nonpoint source management plan.



Identification of Nonpoint Sources

Many NEP management plans list nonpoint sources of pollution as contributing much of the nitrogen overloading that has occurred in estuaries. Nonpoint sources vary in size and scope, but are classified together because there is not one specific point of entry that can be controlled and monitored. Included in the nonpoint-source category are malfunctioning septic systems, agricultural runoff, and urban runoff. Through investigative work, some nonpoint sources can be identified and controlled.

In cases where nonpoint-source discharges cannot be specifically identified, the NEP must develop a program that relies on public involvement to help reduce or eliminate the problem. The primary implementation tools used by NEPs for unidentified nonpoint-source controls include best management practices and public education. The main drawback with these tools is that they rely on voluntary public involvement with no guarantee of effectiveness or success.

If a source of contamination can be identified, the NEPs work with state agencies to enforce actions to abate the contamination. Several NEPs have been successful in identifying specific urban areas and farm runoff as sources of nutrients. In these cases, the NEPs have succeeded in convincing state agencies to implement and enforce stormwater permits that require the discharged stormwater runoff to be treated before it enters the estuary.



POLLUTANT LOAD REDUCTION GOALS *Indian River Lagoon National Estuary Program*

The Indian River Lagoon NEP has been working to develop pollutant load reduction goals for nitrogen, phosphorus, dissolved organic matter, and suspended matter loadings to the Indian River Lagoon. These goals are directed to address nonpoint source nutrient contamination,

POLLUTANT LOAD REDUCTION GOALS
Indian River Lagoon National Estuary Program
Web: <http://www.epa.gov/owow/oceans/lagoon/>
Problem: Nonpoint-source nutrient loads affecting the health of seagrass beds.
Solution: Develop and implement stricter stormwater codes.

which is harmful to the seagrass beds in the Indian River Lagoon. The goals are based on data received from a process-based three-dimensional Pollutant Load Reduction Model being developed for the Indian River Lagoon by the St. Johns River Water Management District, Department of Water Resources. Development of the model is expected to cost approximately \$2.5 million when completed. It will provide a predictive capability for the process of optimally setting and allocating pollution load reduction goals that satisfy management criteria and economic constraints (SJRWMD 1996). Based on the pollutant load reduction goals, local governments are expected to implement more stringent standards for stormwater treatment and management within the Indian River Lagoon.

ATMOSPHERIC NITROGEN DEPOSITION STUDY *Long Island Sound Study*

The primary source of atmospheric nitrogen is the combustion of fossil fuels. Studies have shown that atmospheric nitrogen is deposited to a water body directly or indirectly (from upland and adjacent water bodies) through rainfall and the settling of particles. The Long Island Sound Study (LISS) prepared an estimate of the direct and indirect deposition of nitrogen from atmospheric sources. The study found that atmospheric deposition made up 14.3 percent of the total anthropogenic load to Long Island Sound, making it the second most important cause of hypoxic conditions in the sound. Deriving estimates from computer modeling, LISS calculated that the implementation of the Clean Air Act would reduce the Long Island Sound nitrogen loads by five percent. By controlling nitrogen oxide (NO_x) emissions, an improvement in dissolved oxygen concentrations, as

ATMOSPHERIC NITROGEN DEPOSITION STUDY
Long Island Sound Study
Web: <http://www.epa.gov/region01/eco/lis/>
Problem: Excessive loading of nitrogen that results in low dissolved oxygen.
Solution: Determine the loading of nitrogen from atmospheric sources and enact air pollution control programs to reduce the atmospheric load.

well as ground-level ozone pollution, is predicted (Long Island Sound Study 1997).

AGRICULTURAL ENVIRONMENTAL MANAGEMENT STRATEGY *Peconic Estuary Program*

The Peconic Estuary Program's Agricultural Nitrogen Management Committee has developed, with the region's agricultural community, a strategy to lower nutrient and pesticide inputs into the environment. A 20-30 percent reduction in agricultural fertilizer inputs is targeted over a five-year period, and may be measured by voluntary reporting, surveys, fertilizer sales data, and groundwater monitoring. The Agricultural Nitrogen Management Committee already has produced agricultural use GIS maps for the towns in the Peconic study area and has determined the nitrogen loading rates and estimates of potential reductions for specific crops.

**AGRICULTURAL
ENVIRONMENTAL
MANAGEMENT STRATEGY**
Peconic Estuary Program
Web: <http://www.epa.gov/owow/estuaries/pb.htm>
Problem: Agricultural nitrogen loadings.
Solution: Implement strategy to lower agricultural nitrogen loadings.

The Agricultural Nitrogen Management Committee is currently developing Long Island component to the New York State Agricultural Environmental Management (AEM) Program wherein whole farm management plans are undertaken with farm operators to reduce environmental impacts. Until now, the AEM Program has focused on the livestock farmers in upstate New York, with an emphasis on phosphorus reduction and little emphasis on nitrogen reduction (Long Island's primary issue). In a high cost area like Long Island, AEM must be enhanced with incentives to be viewed as a viable working option to reduce nitrogen and pesticides. The tax credits, cost sharing, and the program itself should be enticing enough so that 90 percent of the farmers working the remaining agricultural acres within the watershed are participating by 2005.

An ambitious AEM Initiative has already been piloted in the Peconic Estuary. Using the AEM

approach, a comprehensive inventory and analysis was conducted for most farms within one subwatershed to assess the potential impact the farms may have had on that part of the Peconic Estuary and shallow aquifer. Plans were developed for high priority farms and best management practices were implemented. A total of 13 farms within the watershed implemented the high priority Best Management Practices (BMPs).

Other tasks for the Peconic Estuary Program's Agricultural Nitrogen Management Committee include: investigating the creation of a farm insurance plan; providing funding for increased local AEM development implementation; investigating and implementing innovative/alternative finance mechanisms for education and outreach and other tasks; and gathering and analyzing economic data on a regular basis and continuing to promote and integrate economic analyses and support mechanisms into the AEM initiatives.

PUBLIC EDUCATION AND OUTREACH

NONPOINT EDUCATION FOR MUNICIPAL OFFICIALS *Long Island Sound Study*

The Long Island Sound Study supported University of Connecticut's Cooperative Extension-sponsored Nonpoint Education for Municipal Officials (NEMO) project that continues to conduct a series of presentations on nonpoint source pollution prevention and the link between land use and water quality to municipal officials.

This project helps to fulfill a Long Island Sound management plan action item to access opportunities to train and educate the environmental decision-making community.

**NONPOINT EDUCATION
FOR MUNICIPAL OFFICIALS**
Long Island Sound Study
Web: <http://www.epa.gov/region01/eco/lis/>
Problem: Need to access opportunities to train and educate the environmental decision-making community.
Solution: Conduct presentation on nonpoint source pollution prevention and the link between land use and water quality to municipal officials.

Methodologies were presented to local officials in Westchester and Fairfield counties on the effects of impervious surfaces, innovative land development techniques, conserving open space, and geographic information systems. NEMO conducted 33 workshops with more than 900 persons in attendance during 1999. Municipal representatives included town selectmen/women, planning and zoning boards, health departments, conservation and environment commissions, highways and parks and recreation departments. Since its inception in September 1997, the NEMO project has provided more than 50 workshops in New York and Connecticut Long Island Sound watershed communities.

FERTILIZER REDUCTION EDUCATION *Peconic Estuary Program*

In the eastern part of the Peconic Estuary, a “water quality preservation” policy is being developed to include Best Management Practices (BMPs), land use controls, and site-specific mitigation in key sub-watersheds to keep nitrogen from reaching levels that could become harmful. Education and outreach programs are vital to the success of these efforts. These programs focus on teaching homeowners and farmers to reduce the amount of fertilizer applied to their yards and farmland.

**FERTILIZER REDUCTION
EDUCATION**
Peconic Estuary Program
Web: <http://www.epa.gov/owow/estuaries/pb.htm>
Problem: Adverse impacts from nitrogen.
Solution: Educate homeowners and farmers to reduce fertilizer use.

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FISH & WILDLIFE

FISH AND WILDLIFE SPECIES

Concern about the decline of various fish and wildlife species populations has been recognized in the United States for more than a century. The federal government initially took interest in this concern during the 1870s when Congress formed a commission to examine the disappearance of important food fish species. In 1900, the first legislation (the Lacey Act) was passed to protect game and to prohibit interstate shipping of illegally taken game (U.S. Fish and Wildlife Service 1999). Federal intervention and regulation to protect fish and wildlife resources were needed because the decline in populations was directly related to impacts associated with human activities. Over-harvesting of wildlife resources for commercial and recreational purposes, as well as the impacts of development and pollution, have contributed to the overall decline in wildlife populations and even the extinction of some species. The latter led to enactment of the Endangered Species Act in 1973 to expand and strengthen laws that protect endangered and threatened species of plants and animals. In addition, the increase in introductions of non-indigenous species is directly contributing to the decline and potential extinction of indigenous species populations.

Recognizing the importance of fish and wildlife resources to the Nation, the federal government established the U.S. Fish and Wildlife Service (USFWS) to assist in their protection. Although the USFWS maintains control over all federal fish and wildlife issues, other federal agencies, including the U.S. Coast Guard and the U.S. Environmental Protection Agency (EPA), assist the USFWS in protecting fish and wildlife through various programs of their own. One of these programs is EPA's National Estuary Program (NEP).

Currently, throughout the coastal United States, there are 28 estuaries in the NEP, all with similar concerns. One concern common to many of the estuary programs is loss of native fish and wildlife species. Fish and wildlife species are declining because of loss of habitat and food, introduction of non-indigenous species, and persistent pesticides and chemicals that have altered normal reproduction cycles and have caused various genetic mutations.

With the human population density increasing near the coast, fish and wildlife habitat is gradually being converted to urban landscapes or is being altered to the detriment of fish and wildlife resources at an alarming rate. Open spaces and large tracts of forested land are being subdivided and developed, while wetlands, marshes, and riparian areas are being drained or altered to allow public access, development, or activities that support human habitation. As habitat diversity decreases, the concomitant loss

According to a survey of NEP directors, conducted in the fall of 1999, the following 9 of the 28 NEPs consider the decline and loss of fish and wildlife species a high-priority action item:

Albemarle-Pamlico (NC)
Charlotte Harbor (FL)
Indian River Lagoon (FL)
Long Island Sound (NY, CT)
Peconic Estuary (NY)
Puget Sound (WA)
San Francisco Estuary (CA)
Santa Monica Bay (CA)
Tillamook Bay (OR)

of native fish and wildlife species has a significant effect on the health of the entire ecosystem.

This section highlights key management approaches and public education and outreach activities implemented by the NEPs to address the issue of fish and wildlife loss.

MANAGEMENT ACTIONS

After the issues have been prioritized, the NEP develops a number of management actions to address each issue. The following are examples of management actions to address fish and wildlife issues that have been successfully implemented by NEPs across the country. The management actions presented here have been categorized and grouped under the headings of habitat restoration and creation.

Habitat Restoration and Creation

STONEY RUN-FOX POINT RESTORATION AND OSPREY RECOVERY PROJECT

Delaware Estuary Program

The Delaware Estuary Program has teamed with the Delaware Division of Parks and Recreation to install four osprey platforms along Stoney Run, a tributary of the Delaware Estuary, and at Fox Point State Park. Volunteers cleaned up the sites by removing trash and exotic plants. After construction is completed, the sites will be monitored for avian activity and maintained to keep the platforms useable. This project cost approximately \$6,000.

STONEY RUN-FOX POINT RESTORATION AND OSPREY RECOVERY PROJECT
Delaware Estuary Program
 Web: <http://www.delep.org>
 Problem: Loss of osprey nesting areas.
 Solution: Construct osprey platforms and monitor bird activity.



QUAKER NECK DAM REMOVAL PROJECT

Albemarle-Pamlico Sounds National Estuary Program

In 1997, work began on a project to remove the Quaker Neck Dam, located near Goldsboro, North Carolina. The dam was scheduled for removal so that 1,054 miles of anadromous fish-spawning habitat could be restored along the Neuse River and its tributaries. This project was significant because it was the first dam ever removed specifically to benefit the environment, and the project received White House recognition and worldwide media coverage.

QUAKER NECK DAM REMOVAL
*Albemarle-Pamlico Sounds
National Estuary Program*
 Web: <http://h2o.enr.state.nc.us/nep/>
 Problem: Loss of commercial and recreational fish-spawning areas due to dam.
 Solution: Removal of dam to allow fish to return to the area.

The Quaker Neck Dam was constructed in 1952 to provide cooling water to a coal-fired electricity generating plant. Studies by the USFWS determined that the dam had a significant effect on the anadromous fish population by preventing fish migration up the river. Additional studies by the U.S. Army Corps of Engineers showed that the installation of a weir dam, within the plant's intake canal, would make the present Quaker Neck Dam obsolete. Thus, with the help of several federal and state agencies, work was initiated to remove the 260-foot-long and seven-foot-high dam.

The removal of the Quaker Neck Dam is expected to enable several major commercial and recreational fish species — American shad, hickory shad, shortnose sturgeon, and striped bass — to spawn in the Neuse River and its tributaries. There is also some hope that mussels — including the endangered dwarf wedge mussel — upstream from the dam will benefit from its removal. In April 1999, wildlife biologists reported that striped bass had returned to spawn in the lower half of the newly opened portion of the river, an area between Goldsboro and Raleigh, North Carolina. The Quaker Neck Dam Removal Project cost approximately \$180,000, but its initial success has

already resulted in two other North Carolina dams being removed for environmental purposes (Albemarle-Pamlico Sounds National Estuary Program 1999).



ARTIFICIAL REEF DEVELOPMENT PROJECT

Sarasota Bay National Estuary Program

The Sarasota Bay NEP has proposed that the decline in fish species in the area is directly linked to habitat destruction. Dredging operations and other channel modifications in the Sarasota area have resulted in uncharacteristically deep areas of the bay and an associated loss of fish habitat. To return some of the vital habitat to the bay, the Sarasota Bay NEP has developed a plan to install a series of artificial reefs throughout Sarasota Bay. Various types and sizes of artificial reefs are being constructed for different areas of the bay. Some of the reefs are small concrete reef balls, which are being located under docks and at the ends of larger reefs. In areas where the bottom is too soft to support reef balls, floating reefs are being used. PVC reefs are being installed in areas that can accommodate larger reefs. Preliminary tests indicate that all three types of artificial reefs appear to be successful in attracting juvenile fish populations. Initial studies of the PVC reefs showed

**ARTIFICIAL REEF
DEVELOPMENT PROJECT**
*Sarasota Bay National
Estuary Program*
Web: <http://www.sarasotabay.org>
Problem: Dredging operations and other impacts resulted in loss of fish habitat.
Solution: Construct and deploy artificial reefs to serve as juvenile fish habitat.

rapid colonization; within three months of installation, all surfaces were well covered by barnacles, sponges, algae, and other organisms. Fish of various sizes were also noted around the PVC reefs, and bottlenose dolphins and manatee were sited in the area. The Sarasota Bay NEP estimates that the bay presently supports 100 million more fish than in 1988; some of this increase can be attributed to the addition of artificial reefs. The Sarasota Bay NEP has funded this project since 1996. It is estimated that approximately \$40,000 has been spent on various forms of artificial reefs and that an additional \$30,000 was spent in FY2000 (Sarasota Bay National Estuary Program 1999).

PUBLIC EDUCATION AND OUTREACH

DELAWARE SHOREBIRD AMBASSADORS PROJECT *Delaware Estuary Program*

The Delaware Estuary Program, in partnership with the Delaware Division of Fish and Wildlife, has developed the Delaware Shorebird Ambassadors Project. Two shorebird "ambassadors" were hired to work in the Little Creek and Ted Harvey Wildlife Areas for five weeks during the spring shorebird migration. The ambassadors' primary function is to interact with visitors and to answer questions about shorebird viewing areas, provide guidance

**DELAWARE SHOREBIRD
AMBASSADORS PROJECT**
Delaware Estuary Program
Web: <http://www.delep.org>
Problem: Human disturbances during spring shorebird migration.
Solution: Short-term hiring of "ambassadors" to guide visitors and answer questions.



for responsible viewing, caution visitors about the birds' sensitivity to human disturbance, and to document responses of shorebirds to humans. The ambassadors were also available to answer questions about the birds and to distribute brochures. The Shorebird Ambassadors Project cost approximately \$1,200 per year (Delaware Estuary Program 1997).

ANGLER EDUCATION PROGRAM

Sarasota Bay National Estuary Program

As part of an action plan to increase Sarasota Bay fisheries, the Sarasota Bay NEP has initiated a program to educate anglers about catch-and-release and other angling practices that favor conservation. Educating anglers and boaters about the benefits of catch-and-release, and about practices that enhance fish habitat, such as limiting marine debris, and preservation and restoration of seagrass beds, will support other bay-area action plans for restoring fish habitat in Sarasota Bay. Two documents that have been developed by the Sarasota Bay NEP are the "Blueways Nature-Based Tourism Guide to

ANGLER EDUCATION PROGRAM

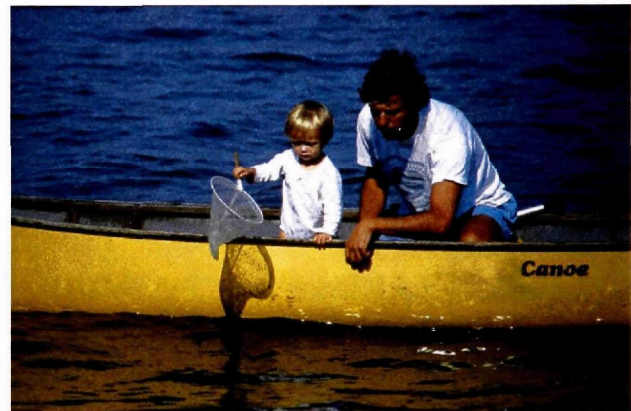
Sarasota Bay National Estuary Program

Web: <http://www.sarasotabay.org>

Problem: Destruction of fish habitat by boaters and anglers.

Solution: Develop educational materials that describe ways in which anglers and boaters can protect fish habitat.

Sarasota Bay" and the "Blueways Pocket Guide." Distribution of these documents is directly through the Sarasota Bay NEP or indirectly through agencies and citizens' groups that are involved in educating anglers in the Sarasota Bay area. Various agencies and groups currently assist the NEP in its efforts to emphasize conservation techniques by supporting development and distribution of literature, sponsoring boating classes, and other educational efforts specifically directed at the boater and angler. These NEP documents will assist and supplement the efforts of bay-area organizations in educating boaters and anglers in preserving fish habitat throughout the bay (Sarasota Bay National Estuary Program 1999).





INTRODUCED SPECIES

INTRODUCED SPECIES

Introduced species are defined as organisms that have been transported from one place to another, and survived and multiplied in the wild of their new location (Gulf of Mexico Program 1998). These organisms include both plant and animal species, which have been transplanted by accident, intent, or by nature. In many cases, introduced species are spread through human introduction, such as animals imported for pets or plants imported for ornamental use, or they can be incidental passengers on ships entering U.S. ports. Examples of introduced species include the Asian clam, brown mussel, Brazilian pepper, European green crab, and Asian mitten crab.



In most cases, introduced species cause some damage to the ecosystem, although the extent of damage varies with the region and type of species introduced. Introduced species have been known, in some cases, to displace native species and cause damage to local habitat. Introduced species can multiply rapidly because they have been removed from their natural predators or have little competition from other species to control their growth.

With an increasing number of foreign ships arriving in U.S. ports daily, the potential for introduction of new species is constantly in-

creasing because the ballast water on ships carry many of these species. Several federal agencies, including the U.S. Coast Guard and U.S. Department of Agriculture, are currently working to develop transport methods and inspection techniques that safeguard against introduction of foreign species. Other programs, including the U.S. Environmental Protection Agency's (EPA) National Estuary Program (NEP), are working to combat species that have already been introduced.

According to a survey of NEP directors, conducted in the fall of 1999, the following NEP considers introduced species a high-priority action item:

San Francisco (CA)

Note: Several other NEPs list introduced species as a concern, but not as a top priority.

This section highlights key management approaches and public education and outreach activities implemented by the NEPs to address the issue of introduced species.

MANAGEMENT ACTIONS

After the issues have been prioritized, the NEP develops a number of management actions to address each issue. The key to managing introduced species is to prevent their introduction and distribution. National awareness and effort are needed to prevent new species from being introduced. A similar national effort is needed to prevent the spread and distribution of species that have already been introduced. The NEP management actions for introduced species fall into three focus areas that the Nation, as a whole, needs to address: (1) regulation, (2) prevention, and (3) management. Management actions for each of these areas are presented below.

Regulation

In February 1999, President Clinton issued an executive order on invasive species to federal agencies to strengthen controls against the introduction of new species into the United States. He requested that regulations and controls be implemented to manage this problem by mid-year 2000. Several NEPs are now working with government task forces to address the issue of introduced species through the development of federal and state regulations. The San Francisco Estuary Project has employees and task-force stakeholders addressing the issue of introduced species on the west coast. Other programs, such as the Barataria-Terrebonne National Estuary Program, have Gulf of Mexico Program stakeholders, who are working on this issue on a regional scale. Some NEPs have been successful in developing local regulations for the discharge of ballast water. Beginning as early as the year 2000, but before 2003, the Port of Oakland will mandate ocean exchange of ballast water as a condition for docking (San Francisco Estuary Project 1999). Effective January 1, 2000, AB 703, the State of California's multi-agency Ballast Water Man-



Photo Credit: L. David Smith

agement and Control Program became effective. This legislation on ballast water management may be the most stringent in the country. It specifies mandatory mid-ocean ballast water exchange or retention of ballast water on board the ship. The law also mandates maintenance of a ballast water management plan, submission of a ballast water report form to the U.S. Coast Guard, and submission to random sampling of

the vessel for compliance checks (California State Lands Commission 2000).

PREVENTING INTRODUCTION OF NEW AQUATIC SPECIES TO CALIFORNIA

San Francisco Estuary Project

The State of California has implemented legislation to prevent the introduction of aquatic plant and fish species.

This legislation prohibits import of fish, amphibians, or detrimental aquatic plants into the state without prior approval. In addition, it is illegal, without prior inspection and approval, to introduce live fish, fresh-

PREVENTING INTRODUCTION OF NEW AQUATIC SPECIES TO CALIFORNIA

San Francisco Estuary Project

Web: <http://www.abag.ca.gov/bayarea/sfep/sfep.html>

Problem: Non-indigenous species are being introduced into the California ecosystem.

Solution: Legislation prohibiting the introduction of fish, amphibia, or aquatic plants without prior approval.

or salt-water animals, or aquatic plants into waters within the jurisdiction of the State of California. This state legislation attempts to prevent the intentional introduction of new species into the aquatic ecosystems of California.

Prevention

In the past, some new species have been deliberately introduced to an area. Intentional introduction of new species can occur on a small scale (e.g., a homeowner transplants vegetation originating in a different area of the United States) or on a larger scale (e.g., a state agency introduces a new species to control an existing pest species). Whether the introduction of a new species is carried out on a small scale or on a larger one, once the new species begins to spread out of control, this introduced species then often becomes a problem. Prevention of intentionally introduced species can be a difficult task, but one that must be attempted.

BALLAST WATER WORKSHOP TO PROMOTE DIALOGUE

Tampa Bay Estuary Program

The primary mission of the workshop on aquatic invasive species, held in Tampa in November

1999, was to promote a dialogue between the shipping and scientific communities about issues associated with ballast water discharge, and to explore methods and technologies available (or on the horizon) to prevent unwanted plants and animals from entering the bay in ballast water. A unique feature of the Tampa workshop was the use of round table discussions at lunch to promote idea exchange and open discussion of key issues surrounding ballast water management. A somewhat surprising response from all participants was that a regulatory mechanism was needed to drive both public and private participation in ballast water management and treatment strategies.

**BALLAST WATER WORKSHOP
TO PROMOTE DIALOGUE
Tampa Bay Estuary Program**

Web: <http://www.tbep.org>
Problem: Introductions of aquatic invasive species from ballast water releases.

Solution: Promote dialogue between shipping and scientific communities and explore methods available for prevention.

Management

Once introduced species have been released into an ecosystem and become a significant component of the population, native species will be affected and the entire balance of the ecosystem will change. Controls will be necessary, and the specific type of controls will depend on the introduced species as well as on other factors. Animal species, such as the nutria (*Myocastor coypus*) in Louisiana, can be controlled through hunting or trapping, and plant species, such as the kudzu vine (*Pueraria lobata*), may be controlled by herbicides or manual removal.

**NUTRIA HARVEST AND WETLAND
DEMONSTRATION PROJECT**

**Barataria-Terrebonne
National Estuary Program**

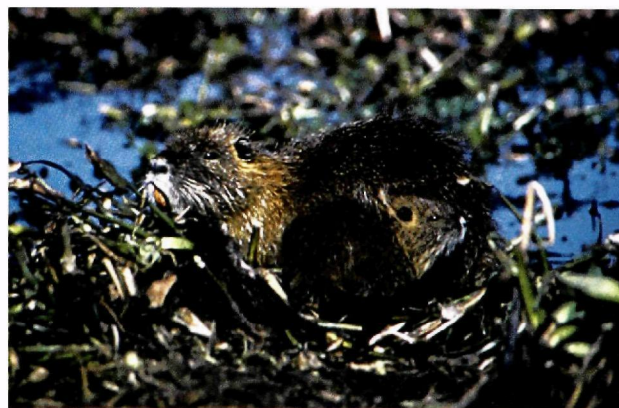
According to studies funded by the Barataria-Terrebonne NEP, the nutria, a voracious herbivore, has been responsible for the destruction of more than 80,000 acres in the Barataria-Terrebonne estuaries of Louisiana. This rodent was originally imported from South America to be evaluated as a furbearer. The nutria, which impact the estuaries along the Gulf of Mexico

today, are descendants of the original introduced exotic species. Natural predators, such as the American alligator, were unable to control the nutria populations and recent changes in national attitudes towards the fur industry have reduced nutria-trapping activities. To control the number of nutria in the Barataria-Terrebonne Estuary, it was determined that the most efficient method of control was trapping and that other markets for the animal needed to be developed. In 1997, under the Coastal Wetlands Planning, Protection, and Restoration Act, \$2 million was budgeted over four years to conduct the Nutria Harvest and Wetland Demonstration Project. This project is developing a national and international market for nutria meat for human consumption. In addition to market development, the project funds are being used to pay trappers for each nutria delivered to a licensed processor and to pay the processors for every pound of nutria meat sold. At the end of the four-year demonstration project, it is expected that the nutria meat markets will be self-sustaining. This project should help to maintain the nutria populations at a non-destructive level (Barataria-Terrebonne National Estuary Program 1998).

**NUTRIA HARVEST AND
WETLAND DEMONSTRATION
PROJECT**

**Barataria-Terrebonne
National Estuary Program**

Web: <http://www.btneep.org>
Problem: Destruction of marsh areas due to overpopulation of nutria in Louisiana wetlands.
Solution: Develop a national and international market for nutria meat.



PUBLIC EDUCATION AND OUTREACH

The most important factor in preventing new species from being introduced into an ecosystem is public education on the problems and issues. This can be accomplished through workshops, distribution of fact sheets, educational programs in schools, and other types of programs developed and organized by NEP volunteer groups. Educating the public about introduced species and their potential harm to the environment will help to minimize this problem.

INTRODUCED SPECIES WORKSHOPS

San Francisco Estuary Project

The San Francisco Estuary Project is working with the Sea Grant Program to develop and conduct workshops that bring together people from industry, government, and research to discuss the problem of introduced species and to examine approaches that can keep introduced species in check. The NEP has also assisted EPA in developing a public-private team to develop strategies for prevention and control of the giant cane plant (*Arundo donax*). The San Francisco Bay NEP newsletter, *Estuary*, has already included several articles on introduced species and management initiatives to control invasions. For some of its educational programs, developed specifically for teachers and classrooms, the San Francisco Estuary Project has included issues about introduced species in San Francisco Bay (San Francisco Estuary Project 1999).

INTRODUCED SPECIES WORKSHOPS

San Francisco Estuary Project

Web: <http://www.abag.ca.gov/bayarea/sfep/sfep.html>

Problem: Intentional introduction of non-native species.

Solution: Educational workshops, public-private teams to assist with species control, and newsletters and articles that focus public attention on the problem.

The campaign includes posters displayed at area boat ramps, bait shops, and waterfront parks; public service announcements; posting of potential invasive species pictures on websites; and the creation of a hotline or clearinghouse where people could learn more about invasive species and report sightings of unusual plants and animals.

"BEAUTIFUL BUT BAD" PUBLIC EDUCATION BROCHURE

Tampa Bay Estuary Program

Web: <http://www.tbep.org>

Problem: Uncontrolled spreading of Brazilian pepper plants.

Solution: Develop brochure, entitled "Beautiful But Bad," to provide identification and eradication information for shoreline homeowners.

"EYES ON THE BAY"

A CITIZEN MONITORING EFFORT FOR DETECTING INVASIVE SPECIES

Tampa Bay Estuary Program

The Tampa Bay Estuary Program's "Eyes on the Bay" provides for a comprehensive campaign to educate citizens about ecological problems associated with invasive species and enlist their support in reporting any invasive species they encounter in the bay. The campaign includes posters displayed at area boat ramps, bait shops and waterfront parks; public service announcements; posting of potential invasive species pictures on websites; and the creation of a hotline or clearinghouse where people could learn more about invasive species and report sightings of unusual plants and animals.

"EYES ON THE BAY" A CITIZEN MONITORING EFFORT FOR DETECTING INVASIVE SPECIES

Tampa Bay Estuary Project

Web: <http://www.tbep.org>

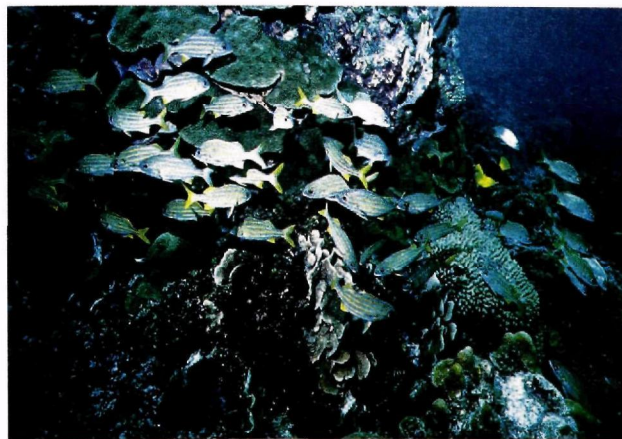
Problem: Invasive species in Tampa Bay.

Solution: Educate and enlist citizen support to identify and prevent invasive species.

"BEAUTIFUL BUT BAD" PUBLIC EDUCATION BROCHURE

Tampa Bay Estuary Program

The Tampa Bay Estuary Program has initiated a comprehensive campaign to educate citizens about ecological problems associated with invasive species and enlist their support in reporting any invasive species they encounter in the bay.





TOXICS

TOXIC CONTAMINATION

Toxic contaminants are natural or synthetic compounds that can cause adverse impacts on the estuarine ecosystem or directly on man. Within the estuary, toxic contaminants occur in the water, sediments, and within the tissues of plants and animals. Toxic compounds can be either inorganic (e.g., metals) or organic (e.g., hydrocarbons) in nature. These compounds may occur in available or reactive forms in the water column or as less available forms chemically bound in the sediments, where they may eventually change form, react, become ingested, or be released slowly over time.

Both point and nonpoint sources contribute toxic materials to an estuarine ecosystem. Point sources commonly include facilities that discharge municipal and industrial wastes. Chemical spills also act as point sources of contamination. Nonpoint sources are highly variable and more difficult to define. However, the most common nonpoint source of contamination is stormwater runoff from urban, residential, industrial, and agricultural land areas, and from marinas and piers along the shoreline. Parking lots and streets contribute various types of metallic and organic pollutants. In residential areas, chemicals and pesticides used in and around the home find their way into groundwater and storm runoff. Industrial sites are sources for a wide range of chemicals that are carried away by rainwater runoff. Farms and agricultural lands contribute pesticides and herbicides to the runoff stream. Along the shore, oil and grease, heavy metals, and petroleum hydrocarbons from marina activities can easily be washed into estuaries. A variety of metal and organic pollutants, such as mercury and nitrogen

compounds, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and "acid rain," also enter estuaries from atmospheric deposition. Toxic contaminants that have been tied up in the sediments can be resuspended, released, and available for incorporation into the food chain through disturbances such as marine construction or dredging operations.

According to a survey of NEP directors, conducted in the fall of 1999, the following 10 of the 28 NEPs consider toxic contamination a high-priority action item:

Albemarle-Pamlico (NC)
 Casco Bay (ME)
 Coastal Bend Bays and Estuaries (TX)
 Delaware Estuary (DE)
 Long Island Sound (NY, CT)
 New York - New Jersey Harbor (NY, NJ)
 Peconic Estuary (NY)
 Puget Sound (WA)
 San Francisco Estuary (CA)
 Santa Monica Bay (CA)

Toxic contamination of estuaries is one of the nation's most important environmental concerns. Various government agencies and programs, including the U.S. Environmental Protection Agency's (EPA) National Estuary Program (NEP), are addressing this concern. This section highlights key management approaches and public education and outreach activities implemented by the NEPs to address the issue of toxic contamination.

MANAGEMENT ACTIONS

Because the NEP generally does not become directly involved in the cleanup of toxic contamination, one way that the program can assist is through development and implementation of education programs for the public and industry. Another way that the NEP can become involved in this issue is by helping to develop cooperative agreements with various dischargers to lower the concentrations of contaminants in the discharge.

After the issues have been prioritized, the NEP develops a number of management actions to address each issue. The following are examples of management actions to address toxic contamination that have been successfully implemented by NEPs across the country. The management actions for toxic contamination presented all fall within the category of pollution prevention.

Prevention

DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS AND WASTELOAD ALLOCATIONS

Delaware Estuary Program

The Delaware Estuary Program is helping to reduce the amount of toxic contaminants discharged into the Delaware Estuary through the development of more stringent and uniform water quality criteria. The criteria, developed by the Toxics Advisory Committee (of the Delaware River Basin Commission, and the Delaware Estuary Program in cooperation with the states of Delaware, New Jersey, and Pennsylvania) are being used to develop wasteload allocations for point source discharges (NPDES permits) throughout the Delaware Estuary. Additional studies of nonpoint sources are also being conducted to develop load allocations and total maximum daily loads for the entire Delaware Estuary.

DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS AND WASTELOAD ALLOCATIONS

Delaware Estuary Program

Web: <http://www.delep.org>
Problem: Toxic contaminants discharged into Delaware Estuary from point and nonpoint sources.

Solution: Develop stringent and uniform water quality standards (TMDLs and wasteload allocations).

ware Estuary. As the more stringent water quality controls are established, toxic contamination within the Delaware Estuary will decrease (Delaware Estuary Program 1999). Total Maximum Daily Loads are being established for PCBs, volatile organic chemicals, and whole effluent toxicity.

REGIONAL MONITORING PROGRAM

San Francisco Estuary Project

The San Francisco Estuary Project has developed a Regional Monitoring Program, which includes 68 agencies and organizations that work in partnership to address issues of toxic contamination. The program provides a forum for dischargers and regulators to discuss solutions to toxic contamination problems. The Regional Monitoring Program, which has a \$3 million annual budget, is financed by dischargers in the San Francisco area. The monitoring program supports several interagency public/private coordinating committees and partnerships that focus on specific areas of toxic contamination, including pesticides in urban runoff, selenium in discharges from the oil industry, and copper pollution from automobile brake pads (EPA 1999a).

REGIONAL MONITORING PROGRAM

San Francisco Estuary Project

Web: <http://www.abag.ca.gov/bayarea/sfep/sfep.html>

Problem: Toxic contamination and uncoordinated monitoring efforts.

Solution: Implement inter-agency, coordinated monitoring program and provide forum to develop solutions.

HAZARDOUS WASTE REDUCTION PROGRAM

Narragansett Bay Estuary Program

The Narragansett Bay Estuary Program developed the Hazardous Waste Reduction Program to decrease the input of toxic chemicals to Narragansett Bay. The program helps businesses reduce their use of toxic and hazardous materials, and to dispose of these materials

properly. Set up as a partnership with the Rhode Island Department of Environmental

HAZARDOUS WASTE REDUCTION PROGRAM

Narragansett Bay Estuary Program

Web: <http://www.nbep.org>
Problem: Toxic contamination from small businesses and industry.

Solution: Technical assistance to businesses to reduce use and properly dispose of toxic materials.



Management and the University of Rhode Island, the Hazardous Waste Reduction Program provides technical assistance for pollution prevention, and has developed a system for conducting onsite hazardous waste assessments for local businesses and industries. The program has established a waste information "hotline," and provides technical information on source reduction, recycling, and chemical substitution-disposal alternatives. The Hazardous Waste Reduction Program proved to be so successful that it has become a state-funded, broad-based industrial pollution-prevention program. In addition to commercial assistance, the Hazardous Waste Reduction Program is now also focusing on household toxic and hazardous waste reduction. To prevent illegal disposal, the program has opened a household hazardous waste collection and treatment facility in Providence for household toxic wastes (Narragansett Bay Estuary Program 1999).

POLLUTION PREVENTION TECHNICAL ASSISTANCE TO SMALL BUSINESSES

Galveston Bay Estuary Program

Water and sediments in Galveston Bay have been contaminated with certain toxic chemicals.

One way that the Galveston Bay Estuary Program is addressing this problem is through the development of a program to provide small business with technical assistance for waste minimization and pollution prevention. The objective of the program, being

administered by the Galveston County Health District, is to reduce loadings of pollutants to Dickinson Bayou by implementation of waste minimization strategies and best management practices designed for small business. The activities of this program are being carried out jointly by the Small Business Technical Assistance and the Pollution Prevention and Recycling Divisions of the Texas Natural Resource Conservation Commission. Elements of the program include: (1) watershed survey to define problem areas and potential targets for the pollution prevention program, (2) workshop focused on introducing small businesses to the program, (3) site visits and audits of facilities to identify specific problem areas, (4) development of materials for technical assistance in implementing corrective actions, and (5) organization of a recognition event for small business participants (Galveston Bay Estuary Program 1999e).

POLLUTION PREVENTION TECHNICAL ASSISTANCE TO SMALL BUSINESS *Galveston Bay Estuary Program*

Web: <http://gbep.tamug.tamu.edu>

Problem: Toxic contamination from small businesses and industries.

Solution: Develop and implement a technical assistance program for waste minimization and best management practices designed for small business.

DEVELOPMENT OF SEDIMENT QUALITY INDICATORS

Tampa Bay Estuary Program

While much of Tampa Bay is relatively uncontaminated, several "hot spots" of sediment contamination exist, which are associated with urban/industrial runoff and/or large marinas or ports. Contaminants of concern (COCs) have been identified using a combination of sediment quality guidelines and risk assessment methods,

and consist primarily of metals, PAHs, PCBs and pesticides. Local, state and federal partners working through the Tampa Bay Estuary Program have adopted the use of sediment chemistry and benthic invertebrate community structure as the

**DEVELOPMENT OF
SEDIMENT QUALITY
INDICATORS**

Tampa Bay Estuary Program

Web: <http://www.tbep.org>

Problem: "Hot spots" of sediment contamination.

Solution: Use sediment quality indicators to estimate risks to benthic community and human health.

primary tools to provide a means of estimating the relative risks to the benthic community and to human health of contamination levels in "hot spot" areas. Specific numeric sediment concentration targets (identified as "clean") have been recommended for some COCs (i.e., concentration < sediment quality guidelines developed for Florida estuaries), and some benthic community structure metrics (i.e., indicator species [crustaceans] present) have been identified. Several questions remain, including how these two types of indicators can be best combined for sediment quality characterization. Results of the analyses are being used to prioritize management actions in the watersheds draining to highly contaminated areas, focusing on sources of those COCs in the sediments, which do not currently meet agreed-upon targets.

PUBLIC EDUCATION AND OUTREACH

SEAFOOD CONSUMPTION SAFETY PROGRAM FOR PUBLIC HEALTH PROTECTION

Galveston Bay Estuary Program

Galveston Bay is the state's largest estuarine source of seafood and is one of the major oyster producing areas in the country. Due to toxic contamination, seafood from some areas of Galveston Bay may potentially pose a public health risk because fish and shellfish are not routinely sampled or assessed for toxic chemicals. The Galveston Bay Estuary Program, in cooperation with the Texas Department of Health, has initiated a seafood monitoring program to assess the current risk of consuming

seafood contaminated by toxic substances.

The goals of the program are to characterize and monitor potential health risks to consumers of seafood and to educate the public on the identified risks (Galveston Bay Estuary Program

1999d). As a result of this program, some areas of the bay have been declared an advisory area for dioxin.

SEAFOOD CONSUMPTION SAFETY PROGRAM FOR PUBLIC HEALTH PROTECTION *Galveston Bay Estuary Program*

Web: [http://](http://gbep.tamug.tamu.edu)

gbep.tamug.tamu.edu

Problem: Potentially contaminated seafood poses health risks to consumers.

Solution: Develop a program for routine monitoring of toxic contaminants in fish and shellfish, and notify the public of associated risks.



BOATER EDUCATION PROGRAM

Casco Bay Estuary Project

The Casco Bay Estuary Project has identified recreational boating as an important source of toxic pollution in sensitive habitat areas. To help educate boaters on the proper disposal of toxic chemicals, the Casco Bay Estuary Project, the Friends of Casco Bay, and the Wharf and Marina Operators Association have developed

"A Guide to Boating Services and Environmental Information in Casco Bay." This guide has been designed to educate boaters on low-impact practices, non-toxic boat products, and the need

BOATER EDUCATION PROGRAM

Casco Bay Estuary Project

Web: [http://](http://www.cascobay.usm.maine.edu)

www.cascobay.usm.maine.edu

Problem: Boaters are not informed of sensitive habitat areas and not knowledgeable about disposal of toxic boat products.

Solution: Develop a nautical chart of Casco Bay that identifies sensitive areas and includes useful information on the proper disposal of toxic boat products.

to protect sensitive harbors and habitat. The guide illustrates a nautical chart of Casco Bay on one side and presents a myriad of boating information on the back. The Casco Bay Estuary Project spent approximately \$10,000 to develop the chart, which was distributed to boaters during the summer of 1998. To ensure that new boaters are informed and that veteran boaters are reminded of these practices, the Casco Bay Estuary Project has reserved funding to distribute and restock materials (Casco Bay Estuary Project 1998).

FLORIDA YARDS AND NEIGHBORHOODS PROGRAM

Sarasota Bay National Estuary Program

Modeling studies of Sarasota Bay indicate that significant quantities of nutrients and pesticides enter the estuary from residential and commercial areas. To increase native habitat, conserve potable water, and decrease the concentrations of toxic chemicals in stormwater runoff that eventually enters Sarasota Bay, the Sarasota Bay NEP is implementing the Florida Yards and Neighborhoods Program as part of its public outreach program. The Florida Yards and Neighbor-

FLORIDA YARDS AND NEIGHBORHOODS PROGRAM

Sarasota Bay Estuary Program

Web: <http://www.sarasotabay.org>

Problem: Runoff from residential and commercial areas transports nutrients and pesticides to Sarasota Bay.
Solution: Promotion of landscaping with native plants to reduce use of fertilizers and pesticides, to conserve water, and to create more habitat.

hoods Program is a basinwide campaign to improve residential landscape design and maintenance. The program promotes environmentally sound landscaping with native plants that require less water, fertilizers, and pesticides (Sarasota Bay National Estuary Program 1999).

PARTNERSHIP TO CLEAN UP ILLEGAL DUMP SITES

Charlotte Harbor National Estuary Program

Charlotte Harbor NEP volunteers have worked together to help solve the problem of illegal dumps sites. Working with the Polk County Solid Waste Office, Charlotte Harbor NEP volunteers are cleaning up illegal dump sites found along the Peace River. Polk County provided funds and made community service workers

available to clean the sites of concern. Two deputy sheriffs also gathered samples to determine if the trash collected was from businesses or individuals. Criminal charges will be levied against any businesses found to have been the source of the trash. To promote public awareness and prevent future dumping, Channel 9, a Lakeland, Florida, area cable station, covered the issue.

PARTNERSHIP TO CLEAN UP ILLEGAL DUMP SITES

Charlotte Harbor National Estuary Program

Web: <http://www.charlotteharbornep.com/>

Problem: Illegal dump sites along the Peace River.
Solution: Build partnership and coordinate volunteers to clean up dump sites and promote public awareness for future prevention.

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FINANCING

FINANCING

To complete the numerous management actions that each National Estuary Program (NEP) develops, funding must be secured. All NEPs are started with base funding provided by the U.S. Environmental Protection Agency (EPA) for at least three years, but additional funding is always necessary. Additional funding often comes from various government and private sources, which normally assist with the implementation of the specific action items and programs. Examples of supplemental funding sources that have been available to some NEPs include federal government agencies, state government agencies, and donations.

Federal Grants

A significant portion of the money expended thus far for Comprehensive Conservation and Management Plan (CCMP) development has come from the EPA. EPA supplies the base funds for CCMP implementation through various agreements and grants to assist the specific NEP in implementing their management actions. Apart from the NEP, federal government agencies have developed grants to encourage private organizations or state and local governments to conduct research in specific environmental areas. The process of securing funding through one of these grant programs usually involves groups writing a grant proposal that is submitted to the governing federal agency, where it is then voted upon based on the information supplied in the proposal. Although some monetary resources are required to write the grant proposal, these could be small relative to the amount of money potentially available through the specific grant.

The Albemarle-Pamlico Sounds NEP, for example, received \$307,000 from EPA's annual wetlands grant to assist with specific projects within the Albemarle-Pamlico drainage area. Another example of a NEP successfully implementing management actions using grant funds is found in the Mobile Bay Estuary Program. This Tier-V estuary program has received \$150,000 in federal grants to study various issues of concern to the estuary, including atmospheric deposition and oyster-bed restoration. Some federal agencies, such as the U.S. Fish and Wildlife Service (USFWS), have developed grants specifically to encourage private or local governmental groups to help restore fish and wildlife habitat and populations. Examples of this type of assistance include the USFWS Wildlife Conservation and Appreciation Fund and the Federal Aid in Sport Fish Restoration.

Several NEPs have been successful in obtaining federal grants from various agencies to assist in the control and mitigation of pathogen contamination. Funds from the Clean Vessel Act have been used to build pumpout facilities and funds from Section 312 of the Clean Water Act have been used to designate "No Discharge Zones." Some NEPs have successfully accessed Clean Water Act Section 319 funds to control erosion and to implement sediment-retention practices on farmland, which helps to control the number of pathogens that can contaminate the water.

**NATIONAL COASTAL WETLANDS
CONSERVATION GRANT PROGRAM**
*Delaware Estuary, Long Island Sound,
and Tillamook Bay*

The National Coastal Wetlands Conservation Grant Program (USFWS) has provided funds to the Delaware Estuary for the restoration of 964 acres of marsh, Delaware Inland Bays for the purchase of 26 acres of contiguous wetlands and upland forest buffer, Long Island Sound for the restoration of 350 acres of habitat, and Tillamook Bay for the restoration and protection of 300 acres of estuarine wetlands.

**NOAA'S COMMUNITY-BASED
RESTORATION PROGRAM**
*Delaware Inland Bays, Indian River Lagoon,
and Tampa Bay*

The National Oceanic and Atmospheric Administration has provided funds through their Community-Based Restoration Program to Delaware Inland Bays for the restoration of submerged aquatic vegetation, Indian River Lagoon for the eradication of invasive plant species to protect mangrove habitat, and Tampa Bay for a high school wetland nursery program.



State and Local Support

Each individual NEP was established as a partnership between EPA and a state or local government body to work together to identify and address the environmental issues affecting the estuary. Along with EPA funds, the local sponsoring partner also provides financial resources to administer the NEP and to implement the management actions. In several cases, the states supply this funding through the involvement of various state agencies (such as

Department of Environmental Protection, Department of Human Health, and water management districts), which are mandated to assist the NEPs with implementing their action plans. The Tampa Bay Estuary Program has 15 involved agencies, each of which has identified and agreed to implement projects that meet the overall NEP goals. In another example, a local government commission provided the Peconic Estuary Program with \$50 million for mitigating open-space stormwater runoff programs.

In some cases, legislation is passed to provide a NEP with limited funding. The Texas Legislature has provided \$900,000 to the Galveston Bay NEP and \$1 million to the Coastal Bend Bays and Estuaries Program. Another option for state funding is for the NEP to be identified through a specific line item in the participating state's General Fund, as in the case of the Delaware Center for Inland Bays. This funding from the Delaware Legislature supports the outreach and research efforts of the NEP and has been extremely useful in leveraging other funding sources.

While the Barataria-Terrebonne NEP has not been a direct recipient of legislative funding, projects funded under the Coastal Wetland Planning, Protection, and Restoration Act have implemented actions plans in the Barataria-Terrebonne Management Plan. The Narragansett Bay Estuary Program has been successful in accessing over \$200,000 in funds from Rhode Island's Oil Spill Prevention and Response Fund.

**NEW YORK CLEAN WATER/CLEAN AIR
BOND ACT**

Peconic Estuary Program

The voters of New York, in 1996, passed the Clean Water/Clean Air Bond Act, which has as one of its goals the restoration of aquatic habitats. This Act provides \$30 million jointly for the Peconic Estuary and the South Shore Estuarine Reserve. A portion of these funds will be used for aquatic habitat restoration projects.

STATE-FUNDED INCENTIVE PROGRAM***Casco Bay Estuary Project***

For mitigating pathogen contamination, funds are generally distributed directly to state and local agencies responsible for upgrading combined sewer overflow facilities. However, pathogen contamination can also be successfully mitigated on a smaller scale. For example, the Casco Bay Estuary Project, in cooperation with the State of Maine, has successfully implemented a program that works with homeowners to remove sand filter septic systems in exchange for acceptable sewage treatment systems. The State of Maine agreed to pay the homeowner up to 90 percent of the removal costs, as well as some funds to the Casco Bay Estuary Project for managing the program in Casco Bay.

SUFFOLK COUNTY GENERAL SALES TAX***Peconic Estuary Program***

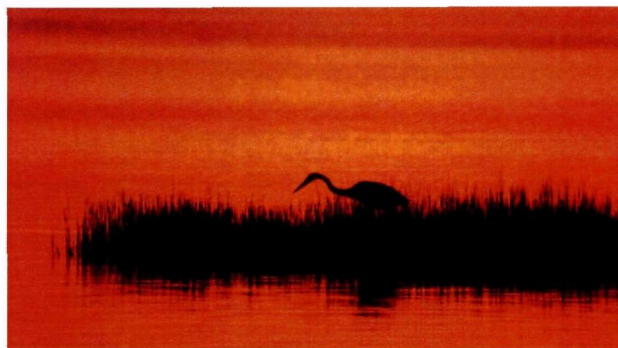
The Peconic Estuary Program will receive funding from a general $\frac{1}{4}$ percent sales tax in Suffolk County, New York. These sales tax revenues, approximately \$260 million over 13 years (beginning December 1, 2000), will be used for three distinct categories: open space acquisition (\$100 million), farmland easements (\$60 million), and water quality improvement projects (\$100 million), including nonpoint source abatement and control, pollution prevention initiatives, and aquatic habitat restoration projects recommended by the Peconic Estuary Program.

RHODE ISLAND'S OIL SPILL PREVENTION AND RESPONSE FUND***Narragansett Bay Estuary Program***

The Narragansett Bay Estuary Program has been successful in accessing over \$200,000 in funds from Rhode Island's Oil Spill Prevention and Response Fund (OSPAR) to inventory and analyze sites for restoration feasibility. The OSPAR fund, derived from a \$0.05/barrel tax on petroleum products that are shipped through Narragansett Bay, includes language that allows funds to be used for habitat inventory and assessment.

SARASOTA COUNTY STORMWATER ENVIRONMENTAL UTILITY***Sarasota Bay National Estuary Program***

The Sarasota County Stormwater Environmental Utility generates funds annually to finance watershed planning and projects. Stormwater runoff accounts for 56 percent of the nitrogen input to Sarasota Bay, so the utility provides a long term funding source for addressing a high priority issue in Sarasota Bay. Residential fees are being assessed by watershed as designs are unveiled. For example, a \$30 million retrofit project on Phillippi Creek (a NEP priority area) has recently been completed. Funds are also being used to support environmental education and the Florida Yards and Neighborhoods Program.

**Donations**

In addition to federal and state funds, some NEPs receive donations. Most NEPs receive some cash donations from communities and businesses, as well as donations of real estate from land trusts and estates. Many NEPs have increased donations by establishing a non-profit organization to allow the donations to be tax deductible.

Another way that NEPs collect funds is through the sale of a special state license plate. The specially designed license plate costs the operator more than the standard plate, but the excess funds are provided to the program. Community and business donations and money from the sale of license plates should be viewed as surplus funds.

LICENSE PLATE PROGRAM

Indian River Lagoon National Estuary Program

The Indian River Lagoon License Plate Program was established as a means to protect and restore lagoon habitat and to provide the public with information on environmental issues impacting the Indian River Lagoon. Eighty percent of the proceeds from the License Plate Program fund a variety of projects, including reconnection of impounded salt marshes, shoreline stabilization, spoil island and mangrove restoration, and stormwater treatment. The remaining twenty percent funds exhibits, videos, and learning centers. Since its inception, the License Plate program has seen revenue growth from an initial level of \$150,000 to around \$400,000. Total sales of license plates are now well over \$2 million.

Penalty Funds

The last funding source for some NEPs is penalty money. This is generally money received from a court settlement in which a company has been found responsible and is required to pay a penalty. For several NEPs, funds have been specifically mandated by the court or state agencies to assist them in imple-



menting their action items. Penalty monies vary in amount, but the funds are always welcome and helpful. Examples of funds obtained from penalties and fines include (1) \$4 million received by The Bay Foundation of Morro Bay from Pacific Gas and Electric, (2) \$1.5 million received by the Coastal Bend Bays and Estuaries Program in 2000 from a settlement between EPA/Texas Natural Resource Conservation Commission and Koch Petroleum, and (3) \$40,000 received by the Delaware Estuary

Program from the *Exxon Valdez* settlement. The latter funds were used for upland habitat restoration and a "backyard habitat enhancement" program for the public. However, until the monies are actually mandated by the courts, penalties and fines are not reliable sources of funding but, when they are received, they are extremely helpful to implementation of the program.

EXXON VALDEZ SETTLEMENT

Delaware Estuary Program

The Delaware Estuary Program received \$40,000 from the *Exxon Valdez* settlement. These funds were used for upland habitat restoration and a "backyard habitat enhancement" program for the public.

FUNDING FROM LEGAL SETTLEMENT

Morro Bay National Estuary Program

The Bay Foundation of Morro Bay is a 501(c)(3) corporation established to manage and disperse funds for the implementation of the Morro Bay NEP Management Plan. Substantial funds were received from a legal settlement that involving a private industry that violated permit conditions of the Regional Water Quality Control Board. Those funds have thus far been used toward the purchase of sensitive habitats and conservation easements within the watershed, and the design of sedimentation traps, among other projects. In all cases, the settlement funds are used to leverage larger amounts of money targeted to the action plans.

MASSACHUSETTS ENVIRONMENTAL TRUST

Buzzards Bay Project and Massachusetts Bays Program

The Buzzards Bay Project and Massachusetts Bays Program have collaborated with the Massachusetts Environmental Trust, a quasi-public environmental philanthropy established by the Massachusetts Legislature through the settlement of a federal lawsuit over the pollution of Boston Harbor, to establish a challenge fund to provide match funding for federal grants pursued by the NEPs for implementation activities.

SELENIUM MITIGATION LITIGATION***San Francisco Estuary Project***

The San Francisco Bay Regional Water Quality Control Board received penalty funds from Unocal through the Selenium Mitigation Litigation. The San Francisco Bay Estuary Project managed the education and outreach portion of the settlement, which amounted to \$500,000. In addition, Friends of the Estu-

ary—a nonprofit arm of the San Francisco Estuary Project—has received several hundred thousand dollars in penalty funds through the State of California's Supplemental Environmental Project Program. Through this program, a fine is levied and in lieu of paying the fine, the discharger is allowed to fund an education or restoration project.

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GLOSSARY

action plan: Specific strategy to addresses a management area or priority issue (e.g., water and sediment quality; living resources management; land use and water resources management) or problems and sources (e.g., toxics, pathogens, habitat loss).

Action Plan Demonstration Project: A small-scale project designed to address one of the major problems in the estuary. Successful projects will be considered for large-scale implementation.

Citizens' Advisory Committee: The major role of the Citizens' Advisory Committee (CAC) is to provide a structured mechanism for citizens' input to the NEP and assist in the disseminating relevant information to the public. This committee works closely with the project director and public information coordinator in developing and promoting the public education and participation program.

Clean Water Act: A piece of legislation passed by Congress in 1972; its goal is to "allow for protection, and propagation of fish, shellfish, and wildlife and to allow for recreation in and on the water" (known as the fishable/swimmable goal). Its objective is to "restore and maintain the chemical, physical, and biological integrity of the nation's waters."

Finance Committee: Considers matters of finance in regards to actions proposed by the Management Conference.

implementation: Simple term that represents a complex process consisting of interconnected responsibilities. In addition to carrying out multiple environmental restoration and protection actions, implementation involves coordinating the ongoing efforts of a number of entities, monitoring the effectiveness of actions as they are implemented, and modification or enhancement of the management plan as new information arises.

Management Conference: The collection of individuals responsible for developing action plans for the Management Plan.

National Estuary Program (NEP): A voluntary watershed protection program established by Congress in 1987, under amendments to the *Clean Water Act*, in response to the threat posed by deteriorating coastal environments. By establishing the NEP, the intent of Congress was to identify nationally significant estuaries

threatened by pollution, development, or overuse and to promote the preparation of comprehensive management plans to protect and improve water quality and enhance living resources.

Policy Committee: Appointed to establish general policies and goals for the National Estuary Program and to execute ultimate authority in Program administration. This committee reviews and approves all substantial expenditures of funds under the Program; appoints members of the various Management Conference committees and subcommittees and the Program's staff; approves the work plans and evaluates progress of the Program towards established goals; and provides broad-based support for the Program and its implementation in policy and political matters. The Policy Committee has developed and adopted bylaws to govern its activities and will modify those bylaws should it become necessary.

Scientific and Technical Advisory Committee: The major role is to provide technical support to Program staff during the planning and interpretive phases of the NEP. It is the scientific voice of the estuary program, identifying and defining the estuary's problems; assists in developing annual and three-year workplans, reviews draft documents and makes recommendations to the Management Committee on the document's technical merit, designing and evaluating an effective information management system; developing requests for proposals; and reviewing and evaluating proposals received and making recommendations on projects to be funded. Additional duties may be assigned at the direction of the Policy Committee and Management Committee. Membership is open-ended and includes representatives from federal, state, and local government as well as universities, industry, and environmental interests.

status and trends: Description of the past and current conditions of the estuary, and predictions about the future conditions of the estuary should current trends continue.

study area: Sampling location within the estuary.

watershed management: Holistic approach that targets hydrologically defined basins (i.e., watersheds) where pollution poses the greatest risk to human health and/or ecological resources, or where especially valuable areas are under threat, and manages these watersheds as ecological systems.

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CONTACTS

For more information on the National Estuary Program, visit their website: <http://www.epa.gov/owow/estuaries>.

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Barataria-Terrebonne Estuary Program

P.O. Box 2663
Nicholas State University Campus
Thibodaux, LA 70310
phone: 504-447-0868 or 800-259-0869
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Barnegat Bay Estuary Program

Ocean County Planning Board
P.O. Box 2191
Toms River, NJ 08754-2191
phone: 732-286-7877
fax: 732-244-8396
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Buzzards Bay Project

2870 Cranberry Highway
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phone: 508-291-3625
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<http://www.buzzardsbay.org/>

Casco Bay Estuary Project

University of Southern Maine
P.O. Box 9300
49 Exeter Street
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Charlotte Harbor Estuary Program

SW Florida Regional Planning Council
P.O. Box 3455
4980 Bayline Dr 4th Fl.
North Fort Myers, FL 33917-3455
phone: 941-995-1777
fax: 941-656-7724
<http://www.charlotteharbornep.com/>

Coastal Bend Bays and Estuaries Program

1305 N. Shoreline Blvd., Suite 205
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phone: 361-885-6204
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811 SW Naito Parkway, Suite 120
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Delaware Estuary Program

Delaware River Basin Commission
P.O. Box 7360
25 State Police Drive
West Trenton, NJ 08628-0360
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Center for the Inland Bays
P.O. Box 297
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Lewes, DE 19958
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Galveston Bay Estuary Program

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Webster, TX 77598
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Indian River Lagoon NEP

Indian River Lagoon NEP
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Long Island Sound Study

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888 Washington Boulevard
Stamford, CT 06904-2152
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fax: 203-977-1546
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Maryland Coastal Bays Program

9609 Stephen Decatur Highway
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fax: 410-213-2574
<http://www.dnr.state.md.us/coastalbays/>

Massachusetts Bays Program

251 Causeway Street, Suite 900
Boston, MA 02114
phone: 617-626-1231
fax: 617-626-1240
<http://www.state.ma.us/massbays/>

Mobile Bay Estuary Program

4172 Commanders Drive
Mobile, AL 36615
phone: 251-431-6409
fax: 251-431-6450
<http://www.mobilebaynep.com/>

Morro Bay NEP

601 Embarcadero, Ste. 11
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Narragansett Bay Estuary Program

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New York - New Jersey Harbor

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Peconic Estuary Program

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<http://www.epa.gov/owow/estuaries/pb.htm>

Puget Sound Water Quality Action Team

P.O. Box 40900
Olympia, WA 98504-0900
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San Francisco Estuary Project

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San Juan Bay NEP

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320 W. Fourth St., 4th St., Suite 200
Los Angeles, CA 90013
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<http://www.smbay.org/>

Sarasota Bay Project

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INDEX

A

acid rain: T-1
 Agricultural Nitrogen Management Committee: N-6
 Albemarle-Pamlico Sounds: H-1, P-2, F-1, N-1, N-3,
 FW-1, FW-2, FW-3, T-1, FN-1
 algal blooms: i, I-4, I-7, N-3, N-8
 anadromous fish: FW-2
 Angler Education Program: FW-4
 artificial reef: FW-3

B

Bac Attackers: P-9
 ballast water: I-5, IS-1, IS-2, IS-3
 Ballast Water Management and Control Program: IS-2
 Barataria-Terrebonne: I-8, H-1, H-3, IS-2, IS-3, FN-2
 Barataria-Terrebonne Shellfish Challenge Initiative: P-8
 Barnegat Bay: H-8, P-7
 Bay Nitrate Monitoring: P-9
 Bay-Delta Environmental Report Card: I-8, I-9
 Beautiful But Bad: IS-4
 Benthic Invaders: P-9
 Biotechnical Barb Structure and Gravel Bar Stabilization
 Project: H-4
 Blueways Nature-Based Tourism Guide: FW-4
 Blueways Pocket Guide: FW-4
 boater education: P-7, T-4
 brown tide: N-1
 Buzzards Bay: H-1, P-2, P-4, P-6, FN-4

C

Casco Bay: I-10, H-1, P-2, P-3, P-4, T-1, T-4, FN-3
 Casco Bay Initiative: P-3, P-4
 Charlotte Harbor: H-1, H-8, F-4, FW-1, T-5, F-3
 Charlotte Harbor Reef Association: H-8
 Chesapeake Bay: N-1
 Christmas Tree Marsh Restoration Program: H-3
 Clean Air Act: N-5
 Clean Vessel Act: P-7, FN-1
 Clean Water Act: i, I-1, I-6, P-4, P-7, FN-1
 Clean Water/Clean Air Bond Act: N-4, FN-2
 Coastal America Partnership Awards: H-9
 Coastal Bend Bays and Estuaries: H-1, F-2, T-1, FN-2,
 FN-4
 Coastal Management Branch: i, I-2

Coastal Wetland Planning, Protection, and Restoration
 Act: FN-2
 Community-Based Restoration Program: FN-2
 Comprehensive Conservation and Management Plan: I-1,
 FN-1
 conservation easements: H-7, H-8, FN-4
 constructed wetlands: P-6
 contaminants of concern: T-3
 copper: I-10, T-2
 Critical Lands Protection Strategy: H-2
 Critical Natural Resource Areas: H-2

D

Dawn Patrol: P-9
 Delaware Estuary: H-1, H-4, F-2, F-3, FW-2, FW-3, T-1,
 T-2, FN-2, FN-4
 Delaware Inland Bays: H-1, N-1, FN-2
 Delaware River Basin Commission: F-2, T-2
 Department of Agriculture: H-3, H-9, IS-1
 Department of Commerce: H-3
 Department of the Interior: H-3
 Department of Water Resources: N-5
 Dickinson Bay Oyster Reef/Wetland Restoration
 Demonstration Project: H-5
 dioxin: T-4
 dissolved oxygen: i, I-4, I-7, H-3, P-9, N-1, N-2, N-3, N-5
 Drain Rangers: P-9
 dredged material: H-3, H-6, H-8
 Ducks Unlimited: H-4

E

E. coli: P-1, P-9
 Endangered Species Act: FW-1
 Enterococcus: P-1
 Environmental Excellence Award: H-6
 Exxon Valdez: FN-4
 Eyes on the Bay: IS-4

F

fecal coliform: P-1, P-9
 Federal Aid in Sport Fish Restoration: FN-1
 fish kills: i, I-4, N-1, N-3
 fish passageways: H-8
 floating reefs: FW-3
 Florida Yards and Neighborhoods: F-4, T-5, FN-3
 Friends of Casco Bay: P-4, T-4
 Friends of the Estuary: P-8, FN-5

G

Galveston Bay: H-1, H-5, H-8, H-9, P-6, T-3, T-4, FN-2
 Geographic Information System: N-7
 Great Bay Coast Watch: P-3
 Grizzle Figg legislation: N-2
 Gulf of Mexico Program: P-8, IS-1, IS-2

H

Habitat Restoration and Protection Masterplan: H-7
 Hazardous Waste Reduction Program: T-2
 heavy metals: I-5, T-1
 hepatitis: P-1
 household hazardous waste: T-3
 household toxic waste: T-3

I

Indian River Lagoon: H-1, N-1, N-5, FW-1, FN-2, FN-4
 industrial waste: T-1

K

Koch Petroleum: FN-4

L

Lacey Act: FW-1
 Lake Naomi Wetland Restoration Project: H-4
 land acquisition: H-7, H-8
 license plate: FN-3, FN-4
 License Plate Program: FN-4
 Long Island Sound: I-8, H-1, H-5, P-2, P-3, P-4, N-1, N-2, N-3, N-5, N-6, FW-1, T-1, FN-2
 Louisiana Coastal Restoration Program: H-3
 Lower Columbia River: I-9, H-1

M

mangrove: H-6, H-7, H-9, FN-2
 Marine Contracting Group: H-8
 marine sanitation device: P-7
 Maryland Coastal Bays: N-1
 Massachusetts Bays: H-6, H-10, P-2, P-5, P-6, FN-4
 Massachusetts Bays Education Alliance: H-10
 Massachusetts Bays Watershed Stewardship Guide: H-10
 Massachusetts Environmental Trust: FN-4
 mercury: I-10, T-1
 Mobile Bay: H-1, N-1, FN-1
 Morro Bay: H-1, P-2, P-8, P-9, FN-4
 Most Probable Number: P-1

N

Narragansett Bay: H-1, P-3, P-7, T-2, T-3, FN-2, PN-3
 Narragansett Bay Estuary Program Marina Pumpout
 Siting Plan: P-7
 National Coastal Wetlands Conservation Grant Program:
 FN-2
 National Oceanic and Atmospheric Administration: P-8,
 FN-2

National Shellfish Sanitation Program: P-1, P-2, P-3
 National Wetland Inventory: I-6
 Natural Resources Conservation Service: H-5
 New Hampshire Estuaries: P-2
 New York-New Jersey Harbor: I-8, H-1, P-2, N-1, T-1
 No Discharge Zones: P-7, FN-1
 Nonpoint Education for Municipal Officials: N-6
 Norwalk viruses: P-1
 NPDES permits: T-2
 Nutria Harvest and Wetland Demonstration Project: IS-3
 Nutrient-Sensitive Waters Management Strategy: N-3

O

Oil Spill Prevention and Response Fund: FN-2, FN-3
 on-site sewage disposal system: P-3
 onsite sewage facilities: F-2
 open space acquisition: N-4, FN-3
 optimum salinity ranges: F-2
 OSPAR: FN-3
 osprey: FW-2
 ozone pollution: N-6

P

Pacific Gas and Electric: FN-4
 PAHs: I-5, T-1, T-4
 PCBs: I-5, T-1, T-2, T-4
 Peconic Estuary: H-1, H-2, H-7, P-2, N-1, N-4, N-6, N-7,
 FW-1, T-1, FN-2, FN-3
 penalty funds: FN-4, FN-5
 petroleum hydrocarbons: T-1
 Pfiesteria: I-4, N-1
 Pollutant Load Reduction Model: N-5
 Preservation 2000: H-8
 Puget Sound: H-1, FW-1, T-1
 pumpout facility: P-7, FN-1
 PVC reefs: FW-3

Q

Quaker Neck Dam: FW-2

R

recycling: T-3
 red tide: N-1
 reef balls: H-8, FW-3
 Reef Balls Foundation: H-8
 reef berms: H-5
 Regional Monitoring Program for Trace Substances: I-10
 residential fees: FN-3
 riparian vegetation: H-4

S

salinity: I-4, I-5, H-7, P-9, F-1, F-2, F-3
 salinity standards: F-3
 San Francisco Bay: I-8, I-9, I-10, H-1, H-7, F-1, FW-1,
 IS-1, IS-2, IS-4, T-1, T-2, FN-5

San Francisco Bay Joint Venture Wetlands Restoration
Project: H-7

San Francisco Estuary Institute: I-10

San Juan Bay: H-1, -2, N-1

sand filter septic system: FN-3

Sanitary Survey: P-1, P-7

Santa Monica Bay: H-1, P-1, P-2, P-5, FW-1

Santa Monica Bay Epidemiological Study: P-5

Sarasota Bay: H-1, H-6, H-9, F-4, N-1, N-2, FW-3, FW-4,
T-5, FN-3

Save Our Rivers: H-8

Sea Grant Program: IS-4

seafood consumption safety program: T-4

seafood monitoring program: T-4

sea-level rise: H-3

sediment chemistry: T-4

sediment concentration targets: T-4

sediment contamination: T-3, T-4

sediment fences: H-3

sediment quality guidelines: T-3, T-4

sediment quality indicators: T-4

sediment supply: H-3

selenium: T-2, FN-5

Selenium Mitigation Litigation: FN-5

septic systems: I-4, P-1, P-2, P-3, P-6, P-7, N-1, N-2,
N-4, FN-3

sewage pollution indicators: P-1

sewage treatment plant: I-4, I-5, P-1, F-3, N-1, N-2, N-3,
N-4

sewage treatment system: FN-3

sewer extension: P-6, P-7

Shellfish Bed Restoration Program: P-5

Shellfish Project Team: P-3

Shorebird Ambassadors Project: FW-3, FW-4

shoreline stabilization: H-5, FN-4

Small Business Technical Assistance: T-3

South Shore Estuarine Reserve: FN-2

State-Funded Incentive Program: FN-3

Stoney Run-Fox Point Restoration and Osprey Recovery
Project: FW-2

Stormwater Environmental Utility: FN-3

Stream Profiles: P-9

stream restoration: H-4

subsidence: H-3, H-8, H-9

Supplemental Environmental Project Program: FN-5

sustainable development: F-2

T

Tampa Bay: H-1, H-7, H-9, P-2, F-4, N-4, IS-2, IS-3,
IS-4, T-3, T-4, FN-2

Tampa Bay Nitrogen Management Consortium: N-4

tax credit: N-6

tax revenues: FN-3

Ted Harvey Wildlife Area: FW-3

The Bay Foundation: P-8, FN-4

Tide gates: H-2, H-3

Tillamook Bay: H-1, H-2, H-4, P-2, P-6, FW-1, FN-2

Tillamook County Performance Partnership: H-2

Total Maximum Daily Load: N-3, N-4, T-2

Toxics Advisory Committee: T-2

U

U.S. Army Corps of Engineers: I-6, H-3, H-8, FW-2

U.S. Coast Guard: FW-1, IS-1, IS-2

U.S. Environmental Protection Agency: i, I-1, H-1, P-2,
F-1, FW-1, IS-1, T-1, FN-1

U.S. Fish and Wildlife Service: I-6, I-7, H-4, P-7, FW-1,
FN-1

U.S. Geological Survey: I-6, I-7

U.S. National Park Service: I-7

Unocal: FN-5

urban runoff: P-4, P-5, F-2, N-3, N-4, T-2

urban runoff management: F-2, N-3

V

Vibrio vulnificus: P-1

Voluntary Inspection and Information Assistance
Program: P-6

Volunteer Monitoring Program: P-8

W

waste minimization: T-3

wasteload allocations: T-2

wastewater reclamation: F-3

wastewater reuse: F-2, F-3, F-4

water conservation rate structure: F-3

water rights: F-1

Watershed Education Training: H-10

Watershed Stewardship Training: H-10

wetland mosaic: H-4

wetland nursery program: H-9, FN-2

Wetlands Health Assessment Program: H-6

Wetlands Restoration Unit: H-5

Wharf and Marina Operators Association: T-4

Wildlife Conservation and Appreciation Fund: FN-1

wildlife guilds: H-7

X

Xeriscaping: F-4