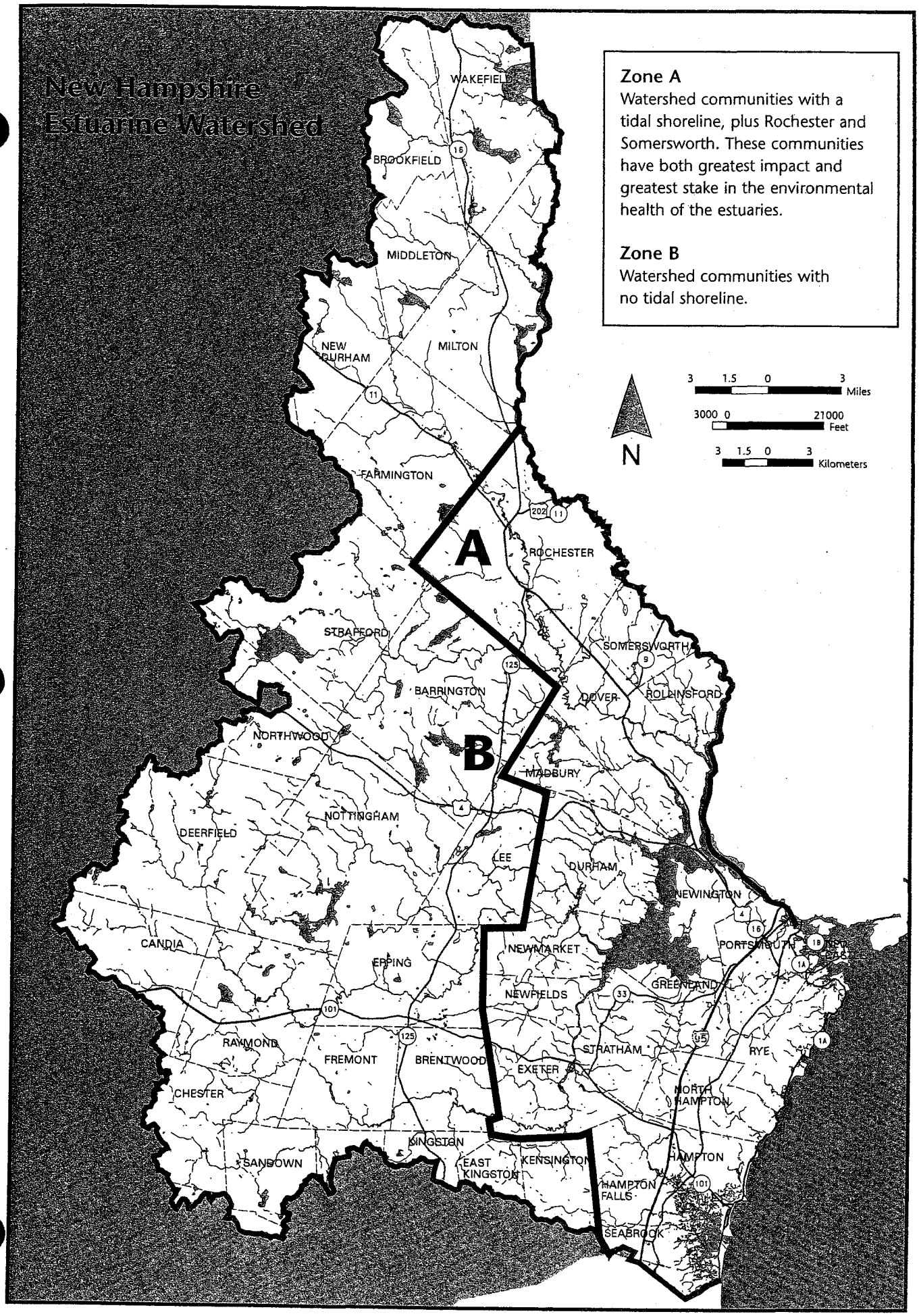
EXHIBIT K

NEW HAMPSHIRE
ESTUARIES PROJECT

MANAGEMENT PLAN

2000


New Hampshire Estuarine Watershed
Zone A
Watershed communities with a tidal shoreline, plus Rochester and Somersworth. These communities have both greatest impact and greatest stake in the environmental health of the estuaries.
Zone B
Watershed communities with no tidal shoreline.
3 1.5 0 3 Miles
3000 0 21000 Feet
3 1.5 0 3 Kilometers
N
A
B
WAKEFIELD
BROOKFIELD
MIDDLETON
NEW DURHAM
MILTON
FARMINGTON
ROCHESTER
SOMERSWORTH
ROLLINSFORD
DOVER
STRAFFORD
BARRINGTON
NORTHWOOD
MADBURY
NOTTINGHAM
DEERFIELD
LEE
DURHAM
NEWINGTON
PORTSMOUTH
CANDIA
EPPING
NEWMARKET
GREENLAND
NEWFIELDS
RAYMOND
FREMONT
BRENTWOOD
EXETER
STRATHAM
RYE
CHESTER
NORTH HAMPTON
KINGSTON
SANDOWN
EAST KINGSTON
KENSINGTON
HAMPTON
HAMPTON FALLS
SEABROOK

ACKNOWLEDGEMENTS

NEW HAMPSHIRE ESTUARIES PROJECT MANAGEMENT PLAN PRODUCTION

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A Technical Characterization of Estuarine and Coastal New Hampshire, edited by Dr. Stephen H. Jones, Jackson Estuarine Laboratory, University of New Hampshire, 1999 is the source of charts, graphs, and much of the technical information found in this Management Plan.

Regulation and Management, A Base Program Analysis authored by Carl Paulsen, 1999, is the source of policy and management information found in this Management Plan.

This Management Plan and more information about the estuaries is available on the New Hampshire Estuaries Project website: www.state.nh.us/nhep

For copies of the *Management Plan, Technical Characterization, Base Programs Analysis, State of the Estuaries Report,* and the *Executive Summary for the Management Plan,* contact the N.H. Estuaries Project office in Portsmouth.

NEW HAMPSHIRE ESTUARIES PROJECT **2000**

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TABLE OF CONTENTS

APPENDICES

PREFACE

This Comprehensive Conservation and Management Plan of the New Hampshire Estuaries Project presents a broad framework and specific list of actions to protect and enhance the environmental quality of the estuaries of the State of New Hampshire. It is intended to be a guide for all who use, enjoy, or care about the state's estuarine resources.

The NHEP Management Plan addresses the environmental quality of the entire watershed draining to New Hampshire coastal waters, but focuses action efforts on the lands surrounding the Great Bay and Hampton-Seabrook Estuaries. Due to the national significance of their natural resources, the New Hampshire estuaries were selected for assistance and support from the National Estuaries Program. Although these estuaries are by no means pristine, much progress has already been made in correcting problems. Upgrades to sewage treatment plants, reopened shellfish beds, restoration of degraded salt marshes, increased acreage of permanently protected habitat, and improved planning for future development all indicate the power of partnerships forged at the local level. This Management Plan builds on these improvements and partnerships and focuses on this positive direction.

From its start, the New Hampshire Estuaries Project has aimed for real improvements to the environment. The idea that the only legitimate reason for planning is to prepare for implementation was often mentioned at NHEP meetings. Thus, the planning phase of the project was guided by the principle that enthusiasm for implementation would not be generated by volumes of scientific studies on every environmental issue, but by clear demonstrations of problems and solutions at the local level. The common theme of NHEP work was improvement and protection of estuarine water quality – the foundation of the estuaries' value as wildlife habitat, as a recreational resource, and as a key element to the Seacoast economy. Shellfish were chosen as a tangible, easily understood indicator to measure improvements to water quality.

A diverse group participated in the development of the Plan, with considerable input from the public along the way. The Plan is the result of a three-year, collaborative process that required countless meetings, long discussions, creative thinking,, and hard-won compromises. The Action Plans crafted by these volunteers are practical, realistic, and ready for implementation. This document could not have been produced without their patience and dedication.

The Management Plan outlines actions formulated around five themes:

1. Water Quality
2. Land Use, Development, and Habitat Protection
3. Shellfish
4. Habitat Restoration
5. Public Outreach and Education

Actions are largely intended to either prevent problems, identify and correct problems, or educate and involve specific target audiences. The actions are not presented as activities to be implemented solely by the NHEP; rather, they are intended as a guide for government agencies, recreational users, businesses, educators, and members of the public who have worked, and will continue to work, toward the over-arching goal of a clean, healthy estuarine environment. The Plan includes suggested funding and provisions for monitoring progress over the long term.

This is an ambitious plan. While some actions can be implemented immediately, others require more time. Over the next several years, we will continually evaluate the state of the estuaries, measure progress, and adjust the actions to accommodate current realities. With the enthusiasm and stewardship of all who live near, work on, or simply enjoy the estuaries and their bountiful resources, we will achieve our goal of protecting these priceless resources for generations to come.

The following is a summary of actions that will help us achieve our goal.

ACTION PLANS

WATER QUALITY ACTION PLANS

Wastewater Treatment Facilities 4-17

WQ-1 Evaluate Wastewater Treatment Facility impacts on estuarine water quality, and seek practical options at the state level for secondary and tertiary or alternative treatment where appropriate.

WQ-2 Evaluate the suitability of UV alternatives to chlorine in wastewater post- treatment for the Seacoast communities.

WQ-3 Prioritize and then upgrade facilities to reduce bacterial pollution from hydraulic overloading of Seacoast wastewater treatment facilities (WWTFs).

Illicit Connections in Urban Areas 4-26

WQ-4A Establish on-going training and support for municipal personnel in monitoring storm drainage systems for illicit connections.

WQ-4B Assist Seacoast communities in completing and maintaining maps of sewer and stormwater drainage infrastructure systems.

WQ-4C Eliminate illicit connections in Seacoast communities.

Illegal Direct Discharges 4-33

WQ-5 Conduct shoreline surveys for pollution sources.

WQ-6 Promote collaboration of state and local officials (conservation commissions, health officers, building inspectors, et al.) to locate and eliminate illegal discharges into surface waters.

WQ-7 Provide incentives to fix or eliminate illegal direct discharges such as grey water pipes, failing septic systems, and agricultural runoff.

Stormwater 4-40

WQ-8 Research the effectiveness of innovative stormwater treatment technologies for existing urban areas in New Hampshire, and communicate the results.

WQ-9 Ensure that water quality and quantity impacts from new development or redevelopment are minimized to the maximum extent practical at the planning board stage of development.

WQ-10 Research the use and effectiveness of the Stormwater Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire. Revise, publish, and promote the Handbook.

LND-25 Encourage municipal designation of Prime Wetlands and 100-foot buffers (or equivalent protection).

LND-25A Create a traveling Prime Wetlands Display.

LND-25B Provide training and project assistance for towns interested in utilizing the Method for the Comparative Evaluation of Non-tidal Wetlands in New Hampshire.

LND-25C Work with local planning boards and conservation commissions on regulatory approaches to wetlands conservation.

LND-25D Create and/or enhance local land conservation programs with emphasis on high value wetlands and buffers.

Habitat Protection 5-86

LND-26 Support implementation of state and federal land protection programs (e.g., Conservation and Reinvestment Act, Land and Community Heritage, Teaming With Wildlife, Land and Water Conservation Fund, Coastal Initiative Program, Farmland Preservation Program).

LND-27 Support the efforts of the Great Bay Resource Protection Partnership.

LND-28 Encourage towns to dedicate current-use change tax penalties to conservation commissions for the purpose of natural resource acquisition, easements, restoration, and conservation land management.

LND-29 Provide technical assistance in land protection and management to regional land trusts and municipal conservation commissions.

LND-30 Develop and encourage use of biomonitoring standards to evaluate water quality.

LND-31 Use results of biomonitoring and water quality monitoring to prioritize watershed areas for protection and remediation.

LND-32 Encourage municipalities to incorporate wildlife habitat protection into local master plans by promoting NH Fish and Game's *Identifying and Protecting Significant Wildlife Habitat: A Guide for Towns* and other activities.

LND-33 Develop a model local planning approach to encourage the identification and maintenance of contiguous habitat blocks.

LND-34 Encourage appropriate buffers around important wildlife areas and rare or exemplary natural communities.

LND-35 Maintain current-use program.

LND-36 Encourage conservation easements.

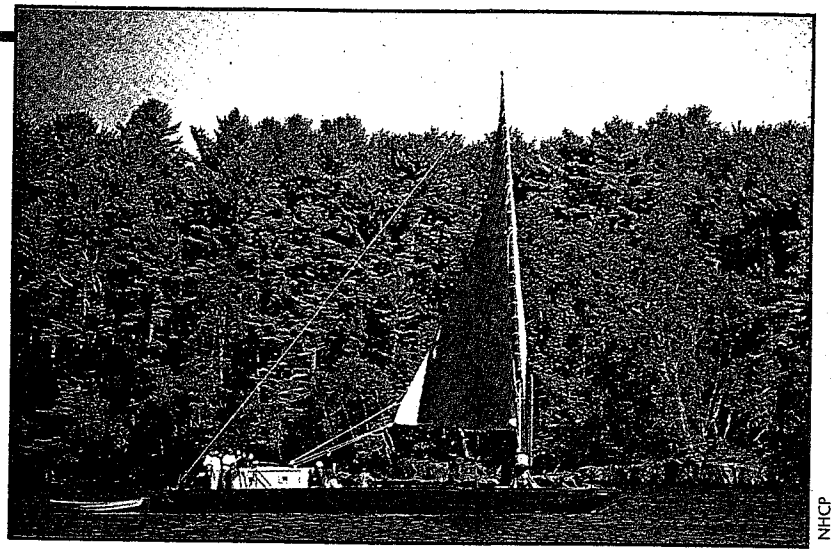
SHELLFISH RESOURCES ACTION PLANS

HABITAT RESTORATION ACTION PLANS

PUBLIC OUTREACH AND EDUCATION ACTION PLANS

INTRODUCTION TO THE PLAN

1



NHCP

Gundalow on Great Bay

The cultural and natural history of New Hampshire's Seacoast has long been shaped by the bountiful resources of its estuaries. The Seacoast's natural beauty and resource wealth, and access to markets, education, and recreation make the region a magnet for people and businesses. Continuing population growth is the greatest threat to the environmental health of the state's estuaries including Great Bay, Little Bay , and Hampton/Seabrook Harbor (hereafter referred to as the "estuaries"). The *New Hampshire Estuaries Project Comprehensive Conservation and Management Plan* is a working document designed to help Seacoast communities protect, manage, and use their natural resource legacy responsibly, for the benefit of present and future generations.

THE TEAM

The planning phase of the NHEP has been guided by a 30-member Management Committee, chaired by the Director of the Office of State Planning, with assistance from four Project Teams: Water Quality, Land Use, Shellfish and Living Resources, and Outreach and Education. All the members of the Management Committee and the four Project Teams together make up the NHEP Management Conference – a group of approximately 75 individuals representing the interests of area citizens; recreational resource-users; the business, academic and scientific communities; local, state, and federal agencies and governments; and environmental organizations. The release of the draft *Management Plan* in December 1999 marked the conclusion of the primary planning phase of the project. This final Management Plan was revised following public comment and review. After approval, the final *Management Plan* will move into the implementation phase. The Management Committee will work to initiate, oversee, track, evaluate, and update implementation of the Action Plans.

DOCUMENT ORGANIZATION

This *Plan* reflects the work of many individuals, agencies, and organizations.

Chapter 2: State of the Estuaries is a thumbnail summary of the current status and trends of the environmental condition of the estuaries, based on a detailed analysis of current scientific research and knowledge of the estuaries completed for the NHEP.

Chapter 3: A Vision for New Hampshire's Estuaries outlines a consensus vision of people working together to protect and enhance the natural resources of the estuaries and the Seacoast region. This common vision was developed by the NHEP with the participation of citizens, local officials, University of New Hampshire scientists and educators, representatives of environmental organizations, businesses, and state and federal agencies. All aspects of the NHEP planning process involved this same broad representation. *Chapter 3* presents a view of the possible – a realistic, reachable state of the estuaries for 2005 and beyond.

The key to understanding and implementing the *Plan* is recognizing that everything in the estuarine ecosystem is connected to everything else. The *NHEP Plan* focuses on water quality because it is related to nearly all the priority problems identified for the estuaries, and because progress can be measured and accounted for. However, all five of the priority concerns – water quality, land use and habitat, shellfish resources, habitat restoration, and public outreach and education – are related to each other. All are essential aspects of the whole ecosystem and of the *Plan.*

These priorities are discussed in *Chapter 4: Water Quality; Chapter 5: Land Use, Development, and Habitat Protection; Chapter 6: Shellfish Resources; Chapter 7: Habitat Restoration; and Chapter 8: Public Outreach and Involvement.* These chapters provide more detailed background on estuarine environmental conditions, the most serious threats to the ecological health of the estuaries, and what can be done to protect and improve the estuarine environment. Each chapter contains an introduction, a statement of why the issue is important, the problems or challenges to be resolved, a summary of pertinent existing regulatory and management programs, and a series of detailed Action Plans.

Chapter 9: Regulation and Management reviews the institutional framework for managing estuaries at the local, regional, state and federal level.

Chapter 10: Implementation and Financing outlines strategies and funding sources, and *Chapter 11: Summary of Recommended Actions* ranks the Action Plans by priority.

Chapter 11: Monitoring Plan includes research and technical development needs and a monitoring plan to track progress and help ensure that efforts to protect New Hampshire's estuaries are responsive, dynamic, and effective.

ACTION PLANS

The Action Plans in this document were drafted by the NHEP Project Teams, refined based on suggestions from the public gathered at a series of open forums, and reviewed and revised by the NHEP Management Committee following the comment period on the Draft *Plan.*

Each Action Plan begins with a background statement and a list of actions or activities to achieve the desired outcome. Each Action Plan also includes a list of responsible parties, an estimate of costs and funding sources, a review of any anticipated regulatory needs, the expected benefits, monitoring and/or enforcement requirements, and a priority ranking in relation to the overall *Management Plan.*

The total estimated costs for all the Action Plans proposed in the *Plan* far exceed the financial resources at hand. The NHEP Management Committee has reviewed all the Action Plans and assigned priority rankings for implementation.

Highest priority actions are those deemed critical to achieving *Plan* goals, and will be pursued by the NHEP in the first four years of implementation (listed in Chapter 12, p. 12-2).

High priority actions were rated less critical to achieving *Plan* goals, and will receive less emphasis in the first four years of implementation.

Priority actions were considered good ideas to be pursued as time and resources allow.

Thanks to the contributions and leveraging afforded by partnerships forged within the NHEP, a modest amount of implementation funding can accomplish a significant amount of work, as some projects can be integrated into the work plans of Seacoast cities and towns, state agencies, and environmental organizations. This cooperation is made possible by the extensive human resources and expertise among partner agencies, institutions, and organizations; the consistency of program and organizational missions; and three years of active collaboration in project planning. The *Plan* also identifies potential funding from a variety of sources. As funding is obtained, related Action Plans will be implemented.

THE NATIONAL ESTUARY PROGRAM

The New Hampshire Estuaries Project is part of the National Estuaries Program (NEP), established by Congress in 1987 to recognize and protect "estuaries of national significance." The National Estuary Program is administered by the U.S. Environmental Protection Agency (EPA). Each estuary program completes four basic steps:

1. Identify the major threats to the estuary through a review of scientific information and management structure, by sponsoring new research as needed, and enlisting citizens, business groups, and other stakeholders in creating a common vision for the estuary's future.
2. Develop a Comprehensive Conservation and Management Plan (CCMP) that sets specific goals and allocates responsibility for achieving the goals among the NEP partners, regulatory agencies, local governments, and citizen or interest groups. This *Management Plan* is the New Hampshire Estuaries Project's CCMP.
3. Implement the Plan, working with all the various partners. Flexibility is emphasized to allow local governments and citizens to choose the most cost-effective and environmentally beneficial solutions for their communities to meet the Plan's goals.
4. Monitor progress made toward the Plan goals to determine the effectiveness of actions taken, and to focus on areas where problems are greatest.

PROJECT AREA

The NHEP project area covers the entire watershed for the estuaries. Towns as far west as Candia and as far north as Wakefield are within the drainage basin. Although approximately one third of the watershed lies in the state of Maine, the NHEP is focused on the New Hampshire portion. In recognition of the importance of proximity to the estuaries, the project was divided into two areas: Zone A and Zone B. Zone A municipalities are those towns that border on tidal waters, plus Rochester and Somersworth. Zone B municipalities are those in the drainage area but with no tidal shoreline. The BPA review of the local management framework focuses primarily on Zone A municipalities (see inside cover).

A Dynamic Plan

Estuaries are dynamic natural systems, subject to constant change. Change in the estuarine environment is as sure as the ebb and flow of the tides, and can be as powerful as the currents in the Piscataqua River. Because estuaries are complex, interconnected ecosystems, even a small change in one area can affect the whole system. Human activities add dramatically to changing conditions in the estuaries – both improving and degrading environmental conditions. The spirit of this *Plan* is to maximize the positive effects.

Recent decades have demonstrated how environmental quality and ecological health can rebound from a history of pollution and neglect. But increasing population and development pressures in New Hampshire's Seacoast region could degrade water quality and add stress to these sensitive ecosystems. Events both within the estuarine watersheds and in the ocean or world could have direct and indirect effects on our estuaries.

Scientists have learned much about the healthy functioning of estuaries, and about New Hampshire's Great Bay and coastal estuaries in particular. Still our scientific understanding is far from adequate. Researchers are also seeking solutions to estuarine environmental problems and ways to prevent future problems. The *NHEP Management Plan* is a working document designed to guide the protection and enhancement of the estuaries. It includes research and technical development needs and a monitoring plan to help ensure responsive, dynamic, and effective efforts to protect New Hampshire's estuaries. If implemented with flexibility this *Plan* can help the state and Seacoast communities respond quickly and efficiently to changing needs and conditions, and to new scientific knowledge and technical progress.

The New Hampshire Estuaries Project invites everyone who is interested to review the *Plan* and find ways to get involved in the many efforts to protect and improve the environmental quality and quality of life in the region.

STATE OF THE ESTUARIES 2

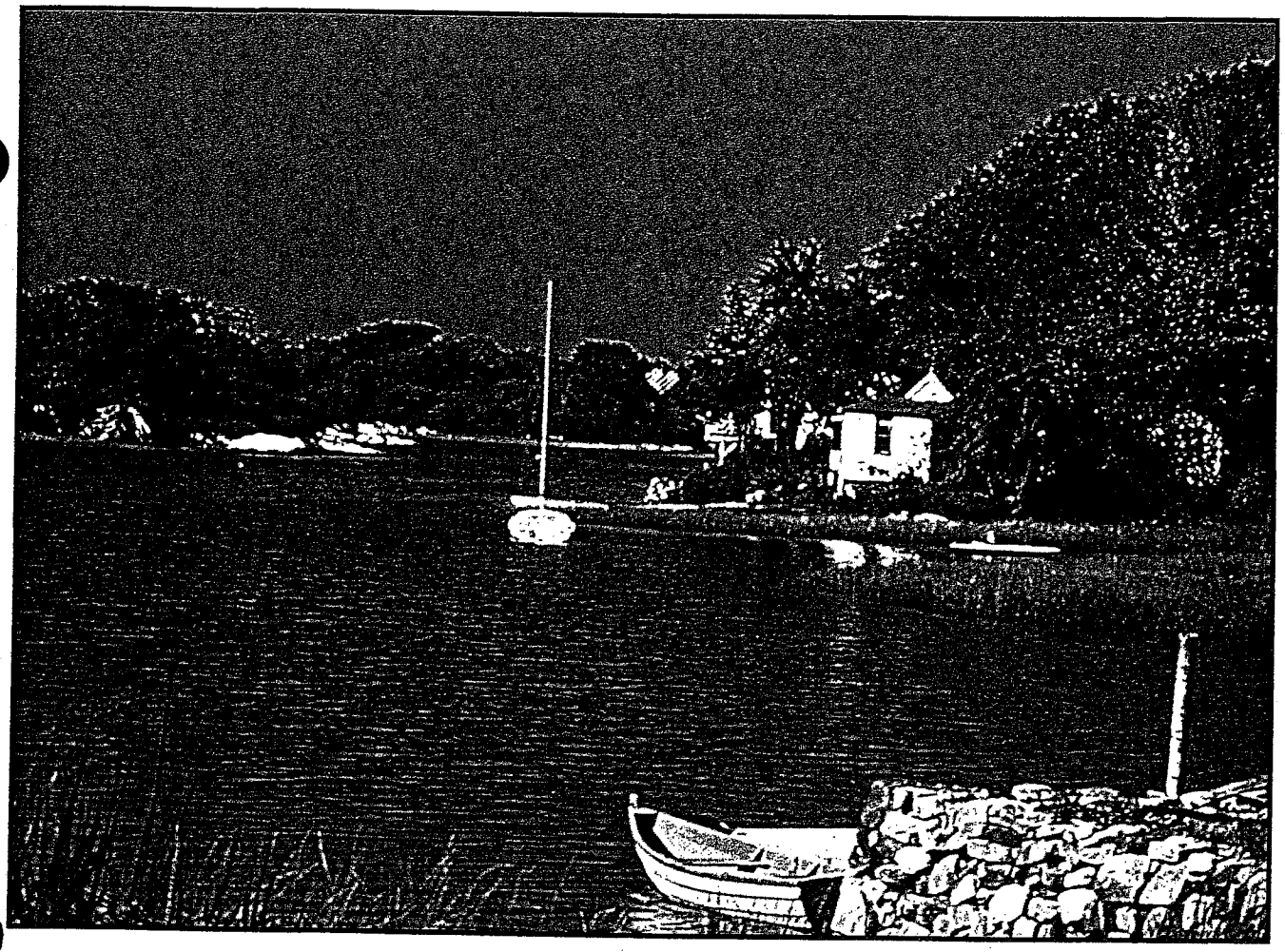
Estuaries are a vital component of the natural, aesthetic, and economic character of coastal New Hampshire. The cultural and natural history of the region has long been shaped by the abundant resources of New Hampshire's estuaries. Archaeological evidence shows that long before European colonization, people were drawn to New Hampshire's estuaries for the bountiful fish, shellfish, and game; to grow crops on the rich soils along the rivers; and to navigate the waterways.


GBNERR

Crommet Creek, Great Bay

The first European settlements in New Hampshire were located at the waters' edge to take advantage of the extraordinary fisheries of the rich estuaries and the nearby Gulf of Maine. Cod, lobster, alewives, sturgeon, menhaden, clams, and oysters sustained the first Europeans and formed the foundation of the early colonial economy. Coastal New Hampshire's link to the estuaries was further strengthened when the forests of the Great Bay watershed were harvested to supply the growing needs of colonial shipbuilding as new boatyards sprang up along the tidewaters. Soon after, enterprising industrialists looked to the tidal rivers and creeks of coastal New Hampshire for waterpower to drive mills and factories. Industry prospered with the combination of abundant waterpower, plentiful natural resources, and access to worldwide markets afforded by tidewater locations.

Today New Hampshire's estuaries still contribute to the economic, aesthetic, and environmental character of our state. However, the very attractions of the coastal location and resources pose a threat due to the affects of population growth and development on the environmental condition of the estuaries that supports the region's prosperity and appeal.



GBNERR

Little Harbor

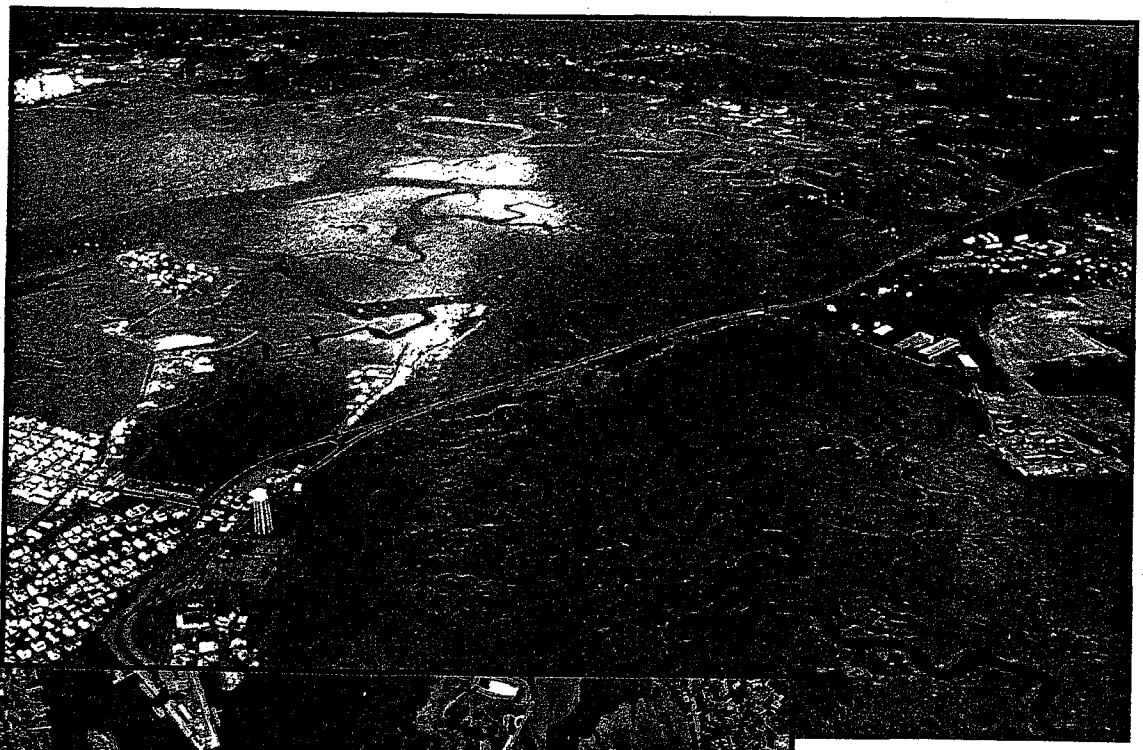
New Hampshire's estuaries face threats that imperil Seacoast traditions of fishing, shellfishing, and other water-dependent activities. Polluted stormwater runoff, overburdened septic systems, and wastewater treatment facility and industrial discharges, all threaten the environmental quality of our estuaries. These threats represent dangers to regional water quality, as well as to the host of living things that depend on New Hampshire's estuaries for their well-being, and make the estuaries so resource-rich.

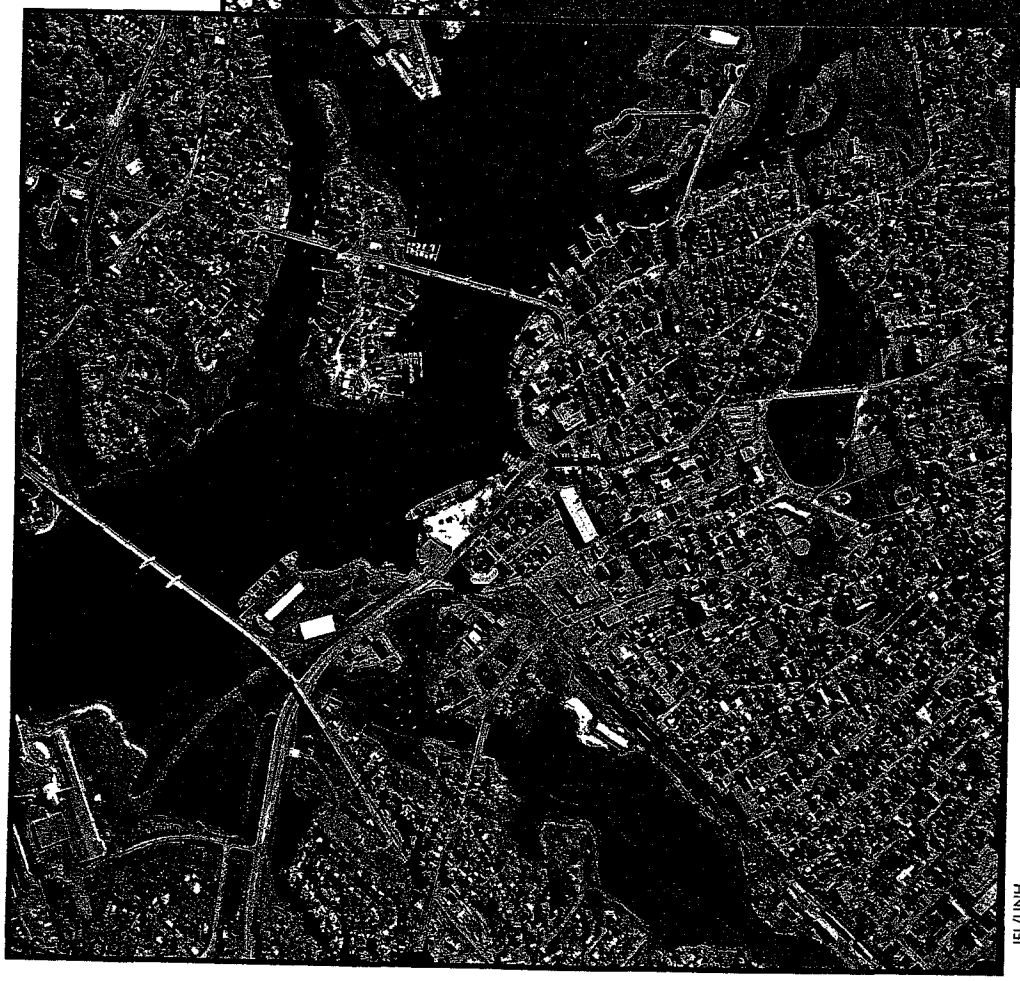
The activities of area residents and visitors have profound impacts on the estuarine system. Boats put oil and other pollutants in the water, disturb plant and animal life, and erode banks. Shoreline development removes protective plant cover, disturbs soils, increases runoff, and disrupts wildlife habitat and corridors and scenic views. Population growth and development throughout the region add to stormwater problems and burden wastewater treatment systems.

New Hampshire's estuaries provide a coveted coastal atmosphere and setting for life along the coast, as they have throughout history. Located within an hour of Boston, Manchester, and Portland, this unique and beautiful land- and seascape attracts residents, businesses, and tourists, making the New Hampshire Seacoast one of the fastest-growing areas in New England – and compounding the pressures of development on the estuaries. We must use these resources responsibly, to safeguard this legacy for future generations.

WHAT IS AN ESTUARY?

An estuary is a semi-enclosed embayment where freshwaters from rivers and streams mix with saltwater from the ocean. Estuaries are extraordinarily productive and diverse environments because of a unique set of conditions that create unusually nutrient-rich, protected waters. Many biologists consider estuaries among the most productive environments on earth.

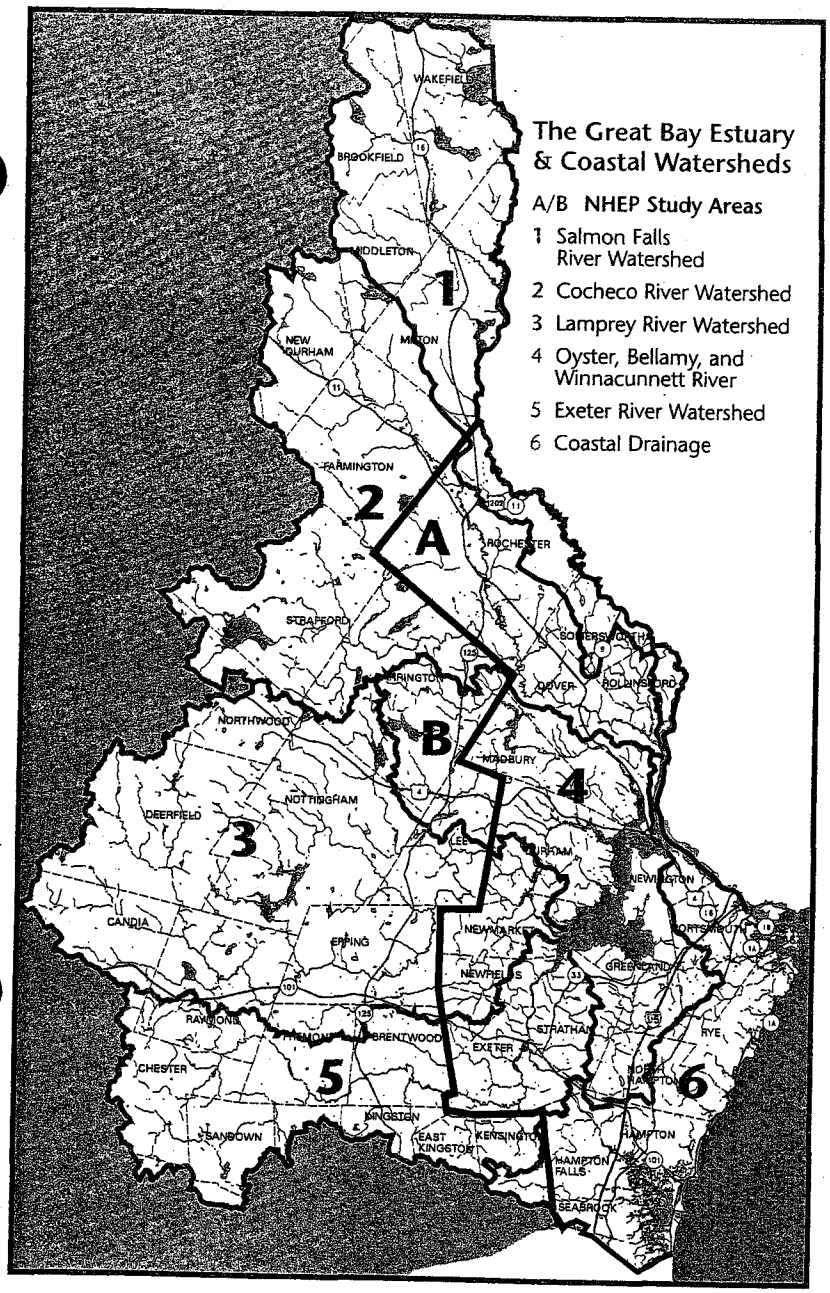




Above: the Hampton-Seabrook Estuary

Left: South and North Mill Ponds, Portsmouth

JEL/UNH



Tidal Tributaries: Salmon Falls/Piscataqua River, Cocheco River, Bellamy River, Oyster River, Lamprey River, Squamscott River, Winnicut River.

NEW HAMPSHIRE'S ESTUARIES

With its Old Man of the Mountains icon, New Hampshire is more often associated with the White Mountains than with marine or estuarine habitat. However, New Hampshire has over 230 miles of sensitive tidal shoreline in addition to 18 miles of open-ocean coastline on the Gulf of Maine.

New Hampshire's estuaries are a varied collection of bays, tidal rivers, and salt marsh systems. The Great Bay and Hampton-Seabrook estuaries are the largest distinct estuaries in New Hampshire. Great Bay, Little Bay, the Squamscott River, and the tidal portions of the Lamprey, Oyster, Bellamy, Cocheco, and Salmon Falls Rivers, the Piscataqua River, Little Harbor, Rye Harbor, Hampton-Seabrook Harbor, and many smaller tidal tributaries are all part of New Hampshire's diverse estuarine systems.

Project Area

These watershed areas encompass the New Hampshire Estuaries Project study area which includes 43 municipalities, and are the focus of the actions included in the *Management Plan.* (See map of the New Hampshire estuaries watersheds on the inside cover of this *Plan.*)

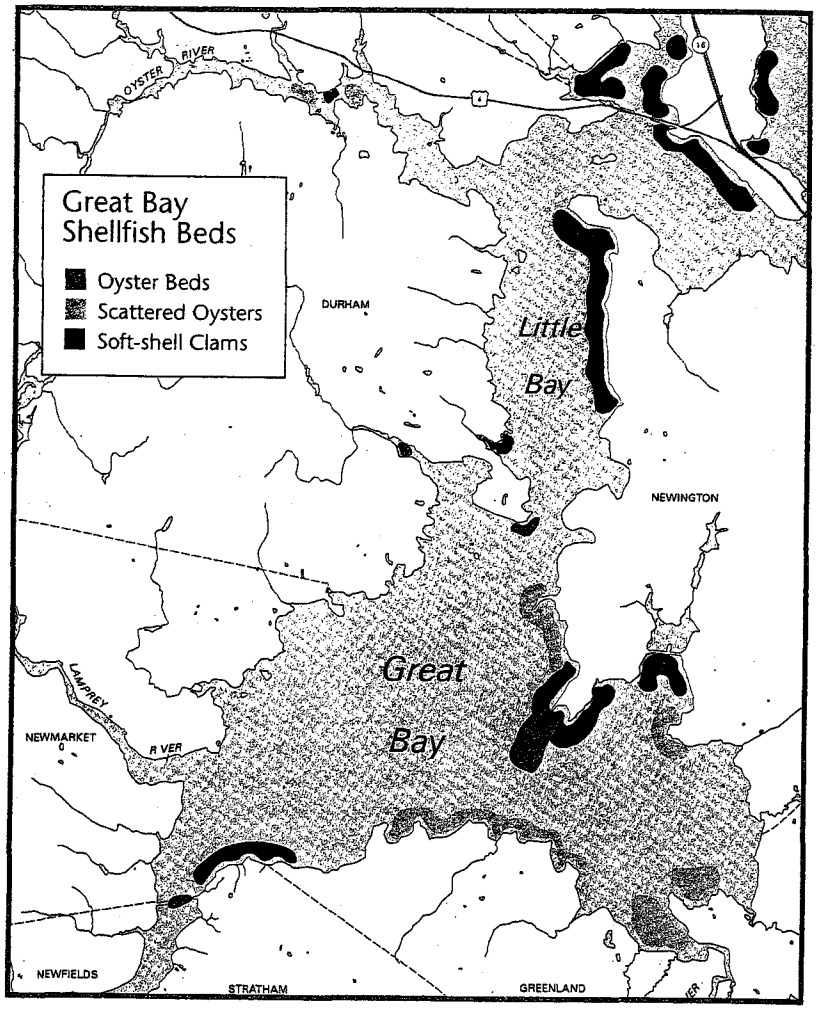
The entire NHEP area of 43 towns is divided into Zone A and Zone B. The 19 communities of Zone A include all municipalities with tidal shoreline, plus Rochester and Somersworth. Many NHEP Action Plans focus on Zone A cities and towns since they have both the greatest impact and the greatest stake in the environmental health of the estuaries.

Great Bay

The Great Bay Estuary covers 17 square miles with nearly 150 miles of tidal shoreline. Great Bay is unusual because of its inland location, more than five miles up the Piscataqua River from the ocean. Due to its inland location, Great Bay's tidal exchange with the ocean is slow, requiring up to 18 days or 36 tide cycles for water entering the head of the estuary to move to the ocean. With much of Great Bay's shorelines still largely undeveloped, it has

been called "the unknown treasure of the New Hampshire Seacoast."

Recreational shellfishers harvest oysters and clams; fishing enthusiasts pursue striped bass, bluefish, herring, or smelt; lobstering is a commercial and recreational activity, and eels are trapped for bait and for export. Birders from all over the country and the world come to view migratory birds against this picturesque backdrop. Great Bay is the state's principal waterfowl overwintering site, and a focus area for the North American Waterfowl Management Plan. The Great Bay National Wildlife Refuge was established on just over 1,000 acres of the former Pease Air Force Base.

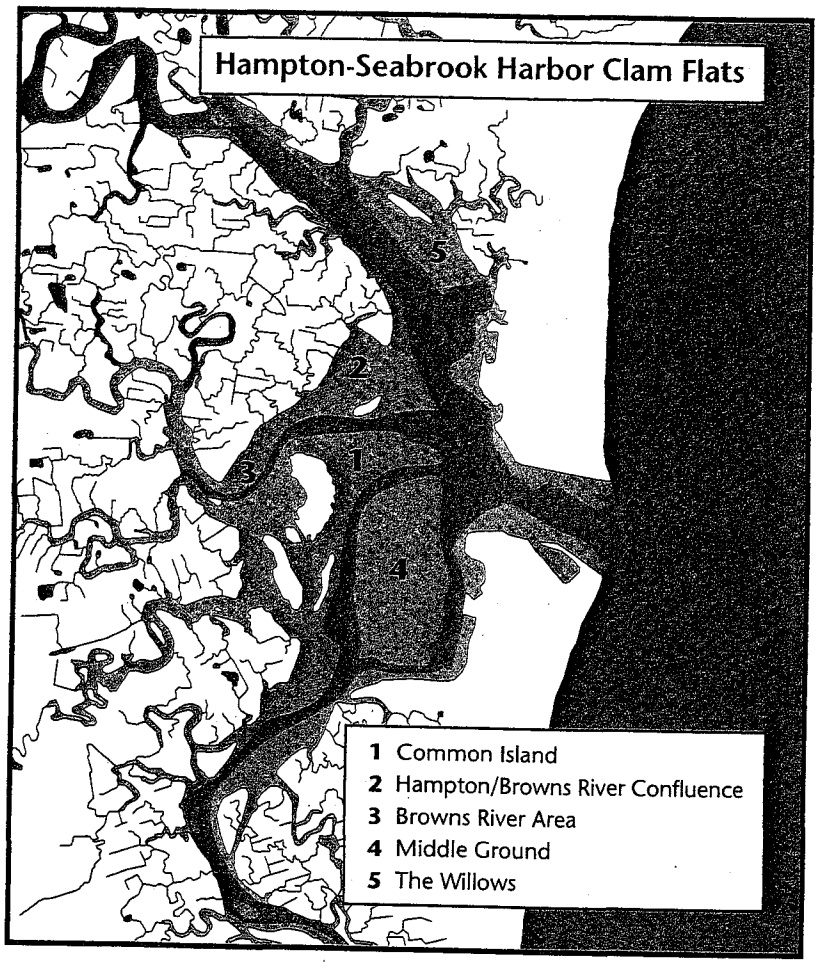


Great Bay's relatively undisturbed natural setting attracts scientists, researchers, and teachers interested in estuarine and marine processes, or salt marsh, mudflat, eelgrass, and other habitats. The University of New Hampshire, a land-grant, sea-grant, and space-grant university, is located in Durham within the Oyster River watershed of the Great Bay estuarine system. The University of New Hampshire and New Hampshire's Seacoast have become a nationally and internationally recognized center for research, teaching, and development of practical applications of marine and estuarine science and technology.

Recognized as an estuarine system of national significance, Great Bay is the site of the Great Bay National Estuarine Research Reserve and the University of New Hampshire's Jackson Estuarine Laboratory. The National Oceanic and Atmospheric Administration recently joined with the University of New Hampshire to establish the Cooperative Institute for Coastal and Estuarine Environmental Technology at UNH. The new Joint Hydrographic Center and the Center for Coastal and Ocean Mapping at UNH have drawn the top researchers in this emerging field.

Hampton-Seabrook Harbor

Hampton-Seabrook Harbor encompasses 475 acres of water at high tide. Characterized by extensive salt marshes and separated from the ocean by a series of barrier beaches, this estuary represents a more typical estuarine system. This estuary's 5,000 acres of contiguous salt marsh make it by far the largest salt marsh in the state. Hampton-Seabrook Harbor provides the backdrop for Hampton Beach, one of the busiest tourist attractions and vacation spots in the state. It is also the site of the North Atlantic Energy Service Corporation's Seabrook Station, a nuclear-powered electric generation facility.



Although surrounded by the busy seacoast communities of Seabrook, Hampton, Hampton Falls, and North Hampton, the Hampton-Seabrook Estuary hosts the best clamming in the state. Several thousand New Hampshire residents purchase shellfish licenses each year, most to dig the softshell or steamer clams of the Hampton-Seabrook Estuary.

Estuarine Watersheds

New Hampshire's estuaries are linked to the surrounding upland areas by the freshwater that drains through the Great Bay and coastal watersheds. On its course to the ocean, water collects a variety of materials of both natural and human origin, with profound impacts on the estuaries.

The 43 cities and towns in the 980 square-mile Great Bay and coastal watersheds are linked by water. From rainwater to groundwater, puddles to tidal rivers, across municipal and political boundaries, water moves unerringly through these watersheds along its course to the ocean. Each watershed resident is responsible for safeguarding our mutual interest in the water and natural character of the area, and for leaving a positive environmental legacy of improving the environmental condition of New Hampshire's estuaries.

New Hampshire has benefitted from its close association with the estuaries, but the estuaries themselves have paid a dear price for this association. Rivers that once supported substantial runs of anadromous fish (species that live in saltwater but spawn in freshwater), such as Atlantic salmon, American shad, and alewives and other river herring, now host minimal returns or none at all. Over-harvest and poor estuarine water quality have contributed to declines of seasonal fish populations that depend on estuaries as spawning and nursery grounds.

For many years, our estuaries were used as convenient dumping grounds for sewage and industrial wastes. The industrial history of the Great Bay and coastal watersheds are chronicled in the toxic materials trapped in sediments throughout the estuaries. Dams that once ran mills and factories now restrict freshwater flow and collect sediments. Much of New Hampshire's valuable salt marsh habitat has been lost or degraded to some degree by filling and constriction of tidal flows for roads and development, and by historic ditching and draining for harvesting salt marsh hay and to control mosquitoes. Today we are responsible for dealing with both historic and present-day sources of estuarine contamination.

A REPORT CARD ON NEW HAMPSHIRE'S ESTUARIES

The good news is that our estuaries remain among New Hampshire's crown jewels. The estuaries are a natural and cultural resource treasure. After a long history of sewage and industrial pollution, water quality has improved significantly over the last two decades. The estuaries contain valuable and productive habitats that support diverse species, some rare or endangered.

The bad news is that work remains to be done. Cleaning up the water of the estuaries is critical to the health of resources such as shellfish, and for people to use and enjoy estuarine resources.

The priority water quality problems include:

- Bacterial contamination from runoff from impervious areas, waste water treatment facilities (WWTFs) overloading and malfunctions, illegal direct discharges and cross-connections, and faulty septic systems;
- Nutrient contamination from WWTFs and non-point sources such as tributaries, surface runoff, septic systems, etc.;
- Toxic contaminants from historic industrial sites, oil spills, industrial and municipal wastewater, and stormwater runoff;
- Sediments from upland watersheds or rivers from runoff.

The priority living resource problems include:

- Oyster population declines
- Clam density declines
- Loss or fragmentation of wildlife habitat
- Degraded salt marshes

The management approaches for addressing these problems include:

- Stormwater management
- Elimination or reduction of pollution from WWTFs, cross-connections, and illegal discharges
- Outreach to local and regional planners
- Shellfish resource and sanitation management
- Land conservation
- Shoreland protection
- Limiting sprawl development

Habitat Protection

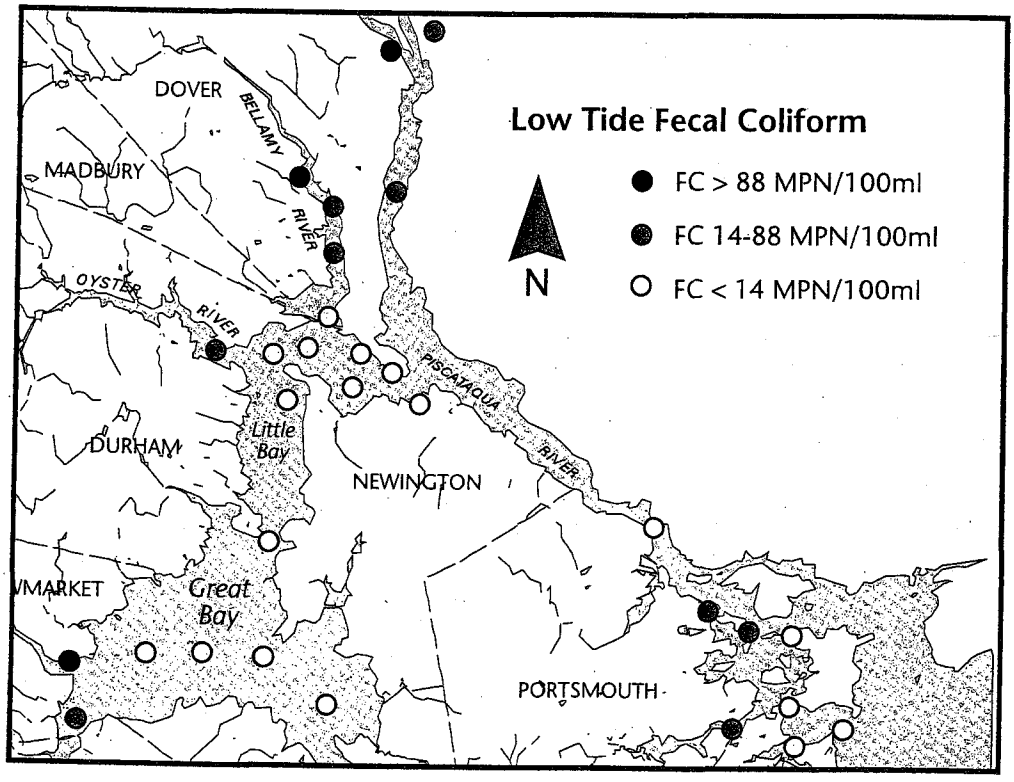
Improving water quality, and improving and restoring habitats and resource management will help address most of these problems. Growth and development present the greatest environmental challenges to the estuaries. In addition to solving existing problems, planning and preventive actions in the estuarine watersheds are needed to protect the estuaries from the increasing pressures of growth and development.

Water Quality

Water quality, an important indicator of environmental health, has a profound influence on the condition of nearly all estuarine habitats, plants, and animals. Water transports and redistributes harmful bacteria, excess nutrients, and toxic materials. Stormwater runoff contributes to degraded water quality and threatens many natural resources throughout the coastal watersheds.

Stormwater contaminates New Hampshire's estuarine waters with pathogenic bacteria and viruses, nutrients, sediment, trace metals and other toxins from roadways, parking lots, roofs, and residential and agricultural areas. Runoff from impervious surfaces carries bacteria and sediments, and is a significant source of trace metal and toxic organic contaminants. Storm runoff from disturbed areas carries sediments and associated nutrients. Runoff resulting from rainfall and snowmelt events in urban and urbanizing areas is the most common source of bacterial contamination in New Hampshire estuaries. This is due to a combination of inflow and infiltration to sewer pipes, overloaded wastewater treatment plants and combined sewer overflows (CSOs), and non-point source runoff. Bacterial contamination is the chief cause of shellfish bed closures.

Non-point source pollution (NPS) is water pollution that comes from diffuse sources and is carried to surface water by rainfall, snowmelt, or groundwater movement. NH DES estimates that over 90% of impairments to lakes, ponds,



Average levels, 1988-98. Levels greater than 14MPN/100ml lead to shellfish harvesting closures.

rivers, and streams statewide are due to non-point sources. Water quality monitoring studies show that non-point sources are a significant problem in New Hampshire coastal waters and tributaries, especially for bacterial contamination. Stormwater runoff can collect, transport, and deposit fecal bacteria, excess nutrients, oils and greases, toxic contaminants from pesticide and herbicide applications, toxic metals, and sediments eroded from shorelines and construction sites. Stormwater runoff, which can include storm sewer cross-connections, is considered the number one water quality problem facing the Seacoast region, and is a factor in keeping some shellfish beds closed.

Point source pollution, typified by both permitted and illegal direct discharges, is a continuing challenge to the environmental character of the coastal watersheds. Wastewater treatment facilities, industrial discharges, and power plants are the most common point sources. While these discharges are closely monitored and regulated through state and federal permitting processes, the demands of regional economic and residential growth challenge wastewater treatment plant capacities, spur demand for electric power, and accelerate the production of industrial waste products. Point source pollution, often characterized by continual low level contaminant loading, tends to increase proportionally with regional growth.

New Hampshire's estuaries are also subject to contamination from the air. **Atmospheric deposition** from both outside and within the state's borders is now recognized as an important source of pollutants to surface waters across the state. Lead, mercury, and nitrogen compounds are deposited directly into surface waters or onto upland watershed areas and delivered to the estuaries in stormwater runoff.

COASTAL AIR QUALITY

An ozone monitoring station at Rye Harbor no longer records levels of ozone that exceed the standards set by the US EPA. Earlier in the 1990s, ozone levels regularly violated EPA's one-hour ozone standard, indicating that the New Hampshire Seacoast, including Great Bay Estuary, had high tropospheric ozone levels. All of Rockingham County was within the ozone non-attainment region, therefore the estuary was in ozone non-attainment. New Hampshire no longer has any areas in violation of this standard.

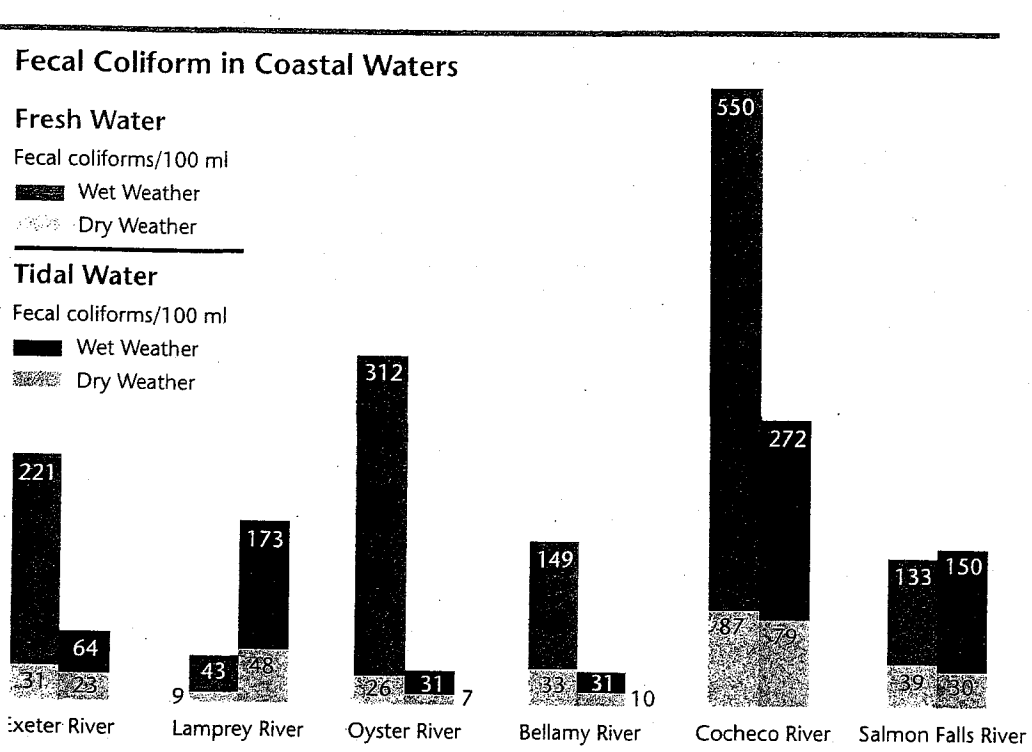
However, EPA recently created a more stringent ozone standard, based on an eight-hour average. Once EPA designates areas of attainment and non-attainment New Hampshire may have some areas that do not meet the eight-hour ozone standard. Air pollution presents health hazards to people and to wildlife, and pollutes surface water as atmospheric deposition. Still, citizens attending NHEP public meetings ranked air quality low in priority, probably because most Seacoast air pollution is beyond the reach of local control.

New Hampshire and other East Coast states affected by ozone pollution carried by air currents from other regions have joined together to form the Ozone Transport Assessment Group (OTAG) to study the problem and seek appropriate actions. Nitrogen oxides (NOx) and volatile organic compounds (VOCs) react together in sunlight to produce low level, or tropospheric, ozone. OTAG studies indicate that NOx is the limiting factor in the photoreaction of NOx and VOC. Of all the NOx generated in New Hampshire, 63% is from mobile sources (motor vehicles) while 24% is from point sources and 13% is from area sources. OTAG data also indicate that the majority of New Hampshire's ozone results from NOx emissions that occur to the south and west, or "upwind." The NH DES has petitioned EPA to mitigate the upwind emissions of NOx by requiring upwind sources to reduce their Nox emissions, in an attempt to reduce New Hampshire's ambient tropospheric ozone concentrations.

The Ozone Transport Assessment Group (OTAG) has completed their policy recommendations and submitted them to EPA for their action. Based on OTAG's data, EPA has proposed new NOx emissions figures that are directed at sources upwind of New Hampshire.

NH DES has also convened a Global Climate Change Workgroup representing a wide range of interests from virtually every sector throughout the state. Their charge is to suggest measures to NH DES to reduce emissions of greenhouse gases cost effectively and without detriment to the economy. There are currently no regulations at the state or federal level aimed specifically at controlling greenhouse gases.

Geometric mean fecal coliforms (colonies/100 ml) in water collected during dry weather and storm events for three consecutive years in tributaries to the Great Bay Estuary: 1993-96.



Bacteria

Fecal coliform bacteria in water is a warning of sewage contamination and may indicate the presence of disease-causing organisms. Found throughout New Hampshire's estuaries, fecal bacteria come from a variety of sources: faulty septic systems, overboard-marine toilet discharges, wastewater treatment facility overflows, and sanitary sewer-stormwater system cross connections. Cross connections occur when sanitary sewers leak – or are illegally connected – into stormwater systems, causing discharge of sewage-contaminated stormwater directly into surface waters. Waterfowl, pet, and livestock waste can also contribute to bacterial contamination. Because of the public health risks associated with these bacteria, fecal coliform levels are routinely monitored throughout coastal New Hampshire in both wet and dry weather. Shellfish beds are closed to harvesting when fecal coliform levels in water exceed 14 per 100 ml.

Although coliform counts in tidal rivers have been reduced dramatically since 1960, water quality sampling throughout the Great Bay Estuary tracks a pattern of elevated counts coming from urban runoff and wastewater treatment plants. Despite significant improvements in recent decades, wastewater treatment facilities (WWTF) in the Seacoast do not meet their required treatment standards 100% of the time. Factors affecting WWTF performance include equipment problems, operational changes, operator errors, storm events, and changes in waste stream. The most severe incidences of bacterial contamination from WWTFs follow rain events that cause systems to overflow.

Bacterial concentrations in New Hampshire estuaries are highest during or immediately after rainfall, indicating that much of the bacterial pollution comes from contaminated stormwater runoff. Storm-associated bacterial pollution has been found in all the primary rivers in the Great Bay watershed, with the highest levels found in the Cocheco River.

High background concentrations of bacteria in the Cocheco River under dry-weather conditions suggest ongoing sewage pollution. Cross-connections that add untreated waste to stormwater systems through cracked pipes and illegal connections are the most likely sources of dry-weather bacterial pollution. Stormwater systems then deliver contaminated water directly to the Cocheco River and streams flowing into Great Bay.

Nutrients

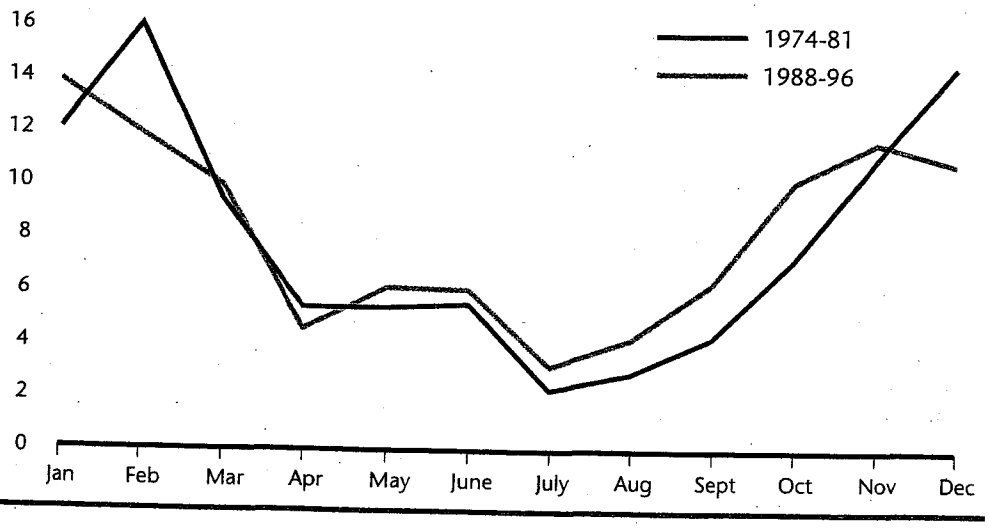
Estuarine systems are especially sensitive to excess nitrogen. Nitrogen is a naturally occurring nutrient essential for plants and algae. But too much nitrogen can promote unrestrained growth of nuisance algae. As these algae blooms die and decompose, they rob the water of oxygen, harming or killing estuarine and marine life.

Nutrient loading is the continual addition of nutrients from natural and human sources. The nutrient load to Great Bay from its tributary rivers comes from both point and non-point sources, and from atmospheric deposition. Nutrient loading occurs in all New Hampshire estuaries and their tributaries. Evidence suggests that nutrient concentrations within the main area of Great Bay have not changed significantly over the past twenty years. No widespread eutrophication effects have been observed. However, local isolated incidents of reduced oxygen levels and intense phytoplankton blooms have been observed in some freshwater tributaries of the Great Bay Estuary. Documented effects of phytoplankton blooms in other areas are rare. Thus, eutrophication and related impacts do not appear to be an imminent widespread problem.

No data is available on nutrient loading in Hampton-Seabrook, Rye, and Little harbors. But given the 80% tidal exchange twice a day, excess nutrients are not believed to be a problem.

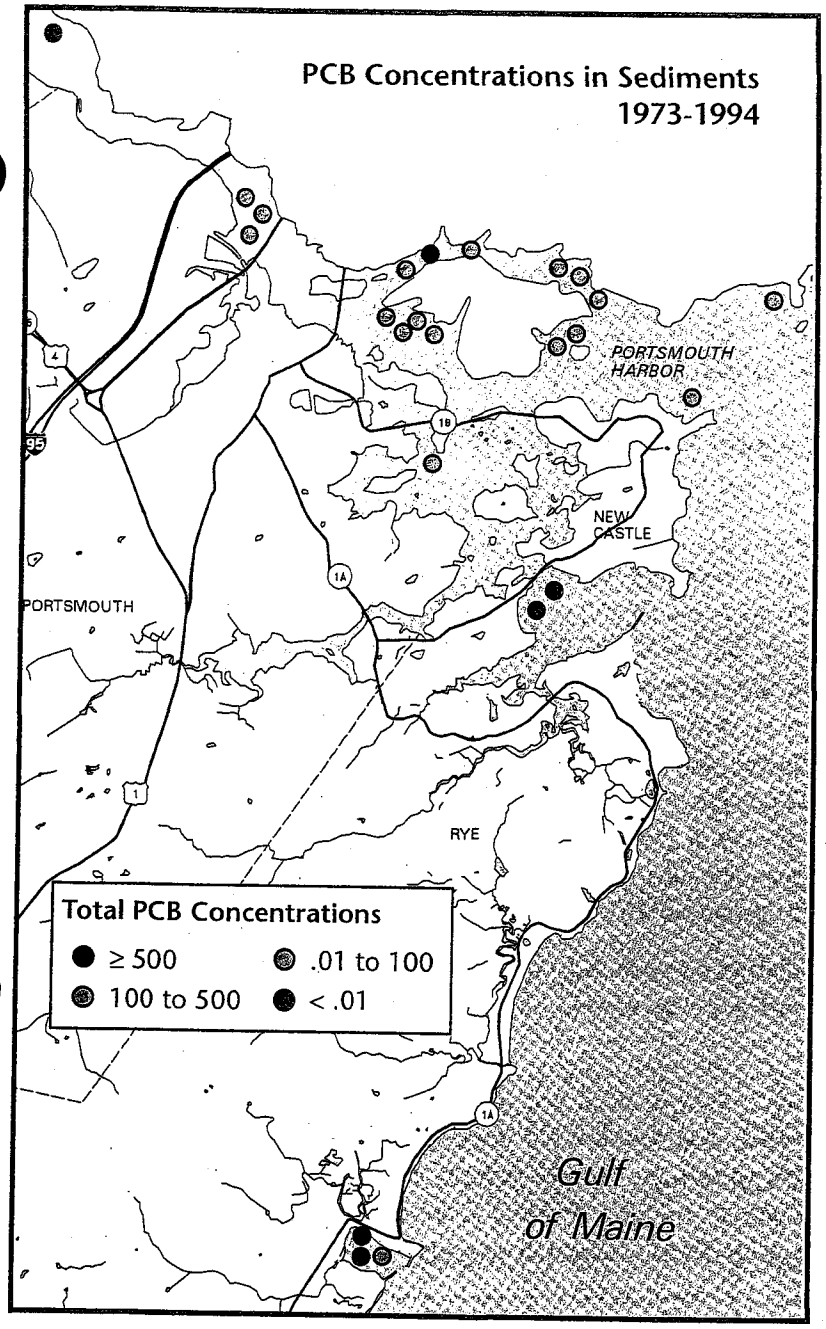
However, sources of nutrient contaminants such as wastewater treatment facility effluent, lawn fertilizer residue, septic systems, and runoff from impervious surfaces, will increase with human population growth and development pressures. For this reason, it is important to continue to monitor nutrient levels in New Hampshire's estuaries as a safeguard against gross nutrient contamination.

Dissolved Inorganic Nitrogen



Monthly mean dissolved inorganic nitrogen at Adams Point in Great Bay for the years 1973-81 and 1988-96.

Nutrient concentrations within the main area of Great Bay have not changed significantly over the past 20 years.



Spatial distribution of PCB concentrations showing hot spots in Hampton Harbor and near the Portsmouth Naval Shipyard.

Toxic Materials

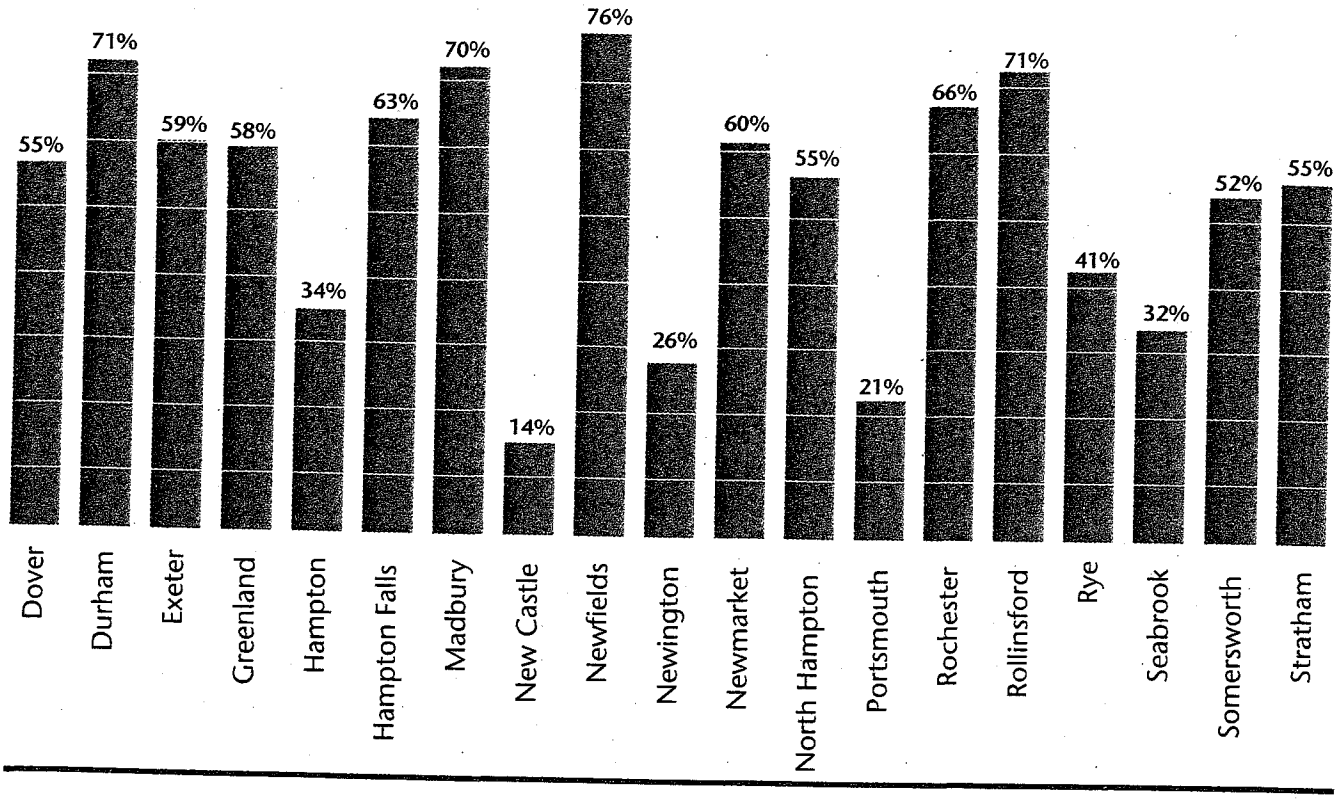
Heavy metal and toxic organic compounds are found throughout New Hampshire's estuaries. The Portsmouth Naval Shipyard, the former Pease Air Force Base, and a few other locations exhibit particularly elevated concentrations of some toxic contaminants. The most common toxic contaminants are chromium, lead, mercury, copper, zinc, and PCBs. A warning has been issued against consuming lobster tomalley due to PCB levels. DDT and other organic pollutants are present at elevated levels at some sites, but not at concentrations of concern to humans and other living things in most cases. Concentrations may warrant limited, localized concern, but remediation is complicated, with issues of stirring up and redistributing contaminants, disposing of dredgespoil, etc.

From colonial times mills, tanneries, and factories were built on the banks of our coastal rivers for their waterpower, shipping access, and easy waste disposal. A legacy of toxic contamination remains stored in the fine-grained sediments dispersed throughout the estuaries. Currently small doses of toxins enter the estuaries from permitted and monitored discharges, pesticides, atmospheric deposition, and occasional oil spills. Other suspected sources include municipal discharges, stormwater runoff, and groundwater contaminated with leachate from hazardous waste disposal sites.

Land Use and Regional Growth

Many of the threats to the environmental character of our estuaries are the direct result of human activities, including development of land for residential, commercial, industrial, and other uses. Continued population growth and development in the coastal region will add more impervious surfaces – paved areas, buildings, etc. – and add to the potential for increased stormwater-related, non-point source pollution. Negative impacts on both water quality and living resources can be managed through careful planning of development. New Hampshire communities – especially those with urbanized areas near surface waters – need technologies that effectively treat runoff.

Potentially Developable Land in the 19 Coastal New Hampshire Municipalities, 1998



The greatest threats to water quality, habitat, and quality of life from land use and development are:

See p. 5-2 for a map of potentially developable land described above.

Impervious surfaces created in the built environment add to the volume and velocity of stormwater, sending more pollutants and sediments through drains and tributaries or directly into the estuaries.

Shoreland development can destroy the natural buffering of vegetated and wooded soils against erosion and runoff, destroys wildlife habitat and travel corridors, and alters scenic vistas from both shore and water.

Sprawl development fragments wildlife habitat and corridors and reduces open space.

In the 19 New Hampshire towns with tidal shoreline (NHEP Zone A), approximately 30% of the land is currently developed. Studies indicate an additional remaining 15% is undevelopable due to permanent conservation and wetlands restrictions. Up to 55% of the total land area within these towns could potentially be developed, i.e., land with no legal restrictions or physical constraints that would prevent development. Future development will magnify runoff-associated problems and create new natural resource management issues by increasing impervious surfaces and destroying or degrading riparian and wetland habitats.

Shorelands are under particularly intense residential development pressure because many people desire to live by water in a coastal area. Shoreland development can impair a riparian area's ability to protect water quality and

provide habitat to several important wildlife species. Recent analyses indicate 35% of New Hampshire's tidal shoreland – defined as a strip of land extending 300 feet from the water's edge – is already developed. Just 16% of tidal shoreland is permanently protected, with an additional 21% likely to remain undeveloped because of natural resource constraints. But approximately 28% of the state's tidal shorelands remain open and developable. Both shoreland preservation and conscientious development of shorelands require careful planning and attention.

Natural Resources

The rich diversity of habitats found in New Hampshire's estuaries support a great variety of plants, animals, and fish, including rare and endangered species. Botanists have identified 67 rare plant species within the Great Bay and coastal watersheds, a dozen associated with estuarine environments.

These estuarine habitats include salt marshes, eelgrass beds, algal beds, rocky intertidal areas, barrier beaches, dunes, mud and sandflats, clam and oyster beds, and subtidal bottom habitats with substrate ranging from mud to cobble and boulders. The NH Coastal Program and the UNH Complex Systems Research Center are developing geographic information system (GIS) data to map the location and extent of these various habitat areas.

Protecting and buffering the variety of habitats found throughout the Great Bay and coastal watersheds safeguards the area's unique natural character, and supports the survival of the species that use and depend on these habitats. Preserving and protecting these important habitats demands careful planning as development pressures grow and human uses within the watershed increase.

Land Use Regulations for 19 Estuarine Communities in Coastal New Hampshire

Regulation	Number of Towns with Regulations	% Towns with Regulations
Master Plan	19	100%
Erosion Control	18	95%
Stormwater Control	17	89%
Wetland Protection	17	89%
Septic Control	15	79%
Gravel Extraction	14	74%
Open Space	13	68%
Floodplain Ordinances	13	68%
Aquifer Protection	12	63%
Shoreland Protection	12	63%
Chemicals/Toxics	8	42%
Growth Management	8	42%
Water Resource Management Protection Plan	5	26%
Marinas	4	21%
Impact Studies	3	16%
Biosolids	2	11%
Review Committees	2	11%

THE NHEP BASE PROGRAM ANALYSIS AND TECHNICAL CHARACTERIZATION

See Chapter 9 for more detailed recommendations from the Base Programs Analysis.

The National Estuaries Program requires a *Base Program Analysis* (BPA) of existing local and state regulatory and management programs for protecting estuarine resources. Gathering this background information was an essential step for the NHEP in designing a realistic and workable *Management Plan.* The NHEP Base Program Analysis, *Regulation and Management of New Hampshire's Estuaries,* evaluated the effectiveness of the existing framework, and provided valuable insight for identifying priority issues and management road-blocks.

The Water Quality; Land Use, Development, and Habitat Protection; Shellfish Resources; and Habitat Restoration chapters of the NHEP *Management Plan* and the Action Plans each have a technical or scientific component taken from *A Technical Characterization of Estuarine and Coastal New Hampshire,* and a regulatory and management section derived from the BPA. The *Technical Characterization* is a detailed review and analysis of current scientific research and knowledge of New Hampshire's estuaries, and is the source for most of the scientific and technical information contained in this *Management Plan.* Both the *Base Program Analysis* and the *Technical Characterization* are available from the NHEP.

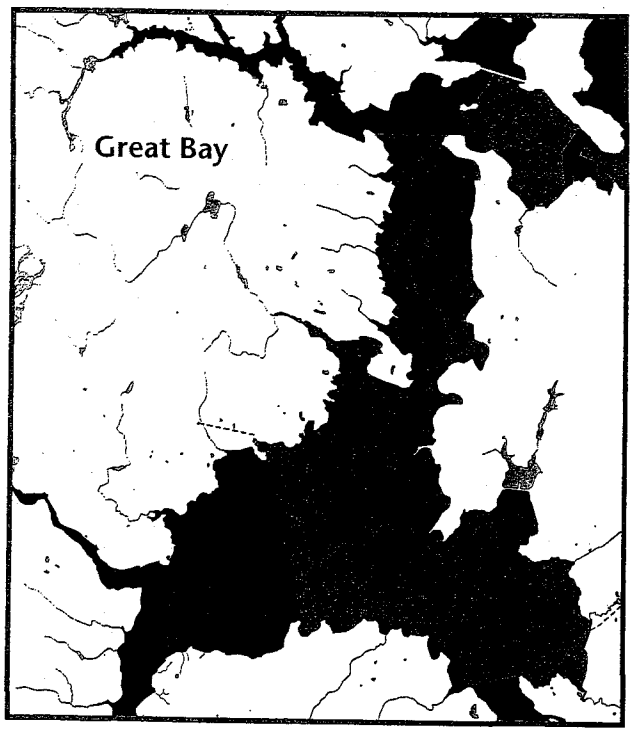
The *BPA* found a reasonably strong regulatory framework for natural resource protection of the estuaries. Programs for shoreland and wetland protection are sound, as are the point source permit program and septic regulations. While regulations for living resource conservation are adequate, follow through is limited in some cases.

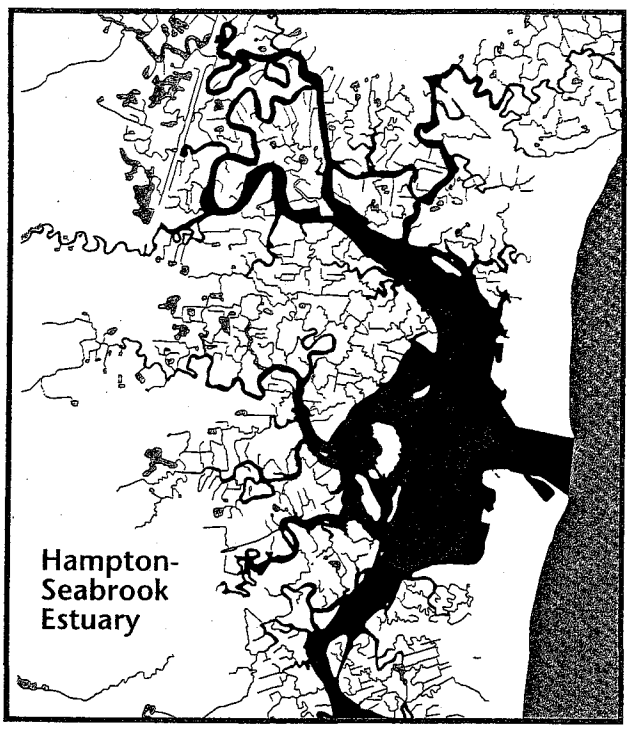
Most other regulatory programs rely on voluntary efforts and Best Management Practices (BMPs) to protect water quality. The effectiveness of this approach depends on BMPs keeping up with constant progress in treatment technologies and scientific understanding. Non-point source and stormwater control BMPs are currently being reviewed and updated.

The BPA identified several additional regulatory and management shortcomings. State stormwater and erosion control regulations apply only when areas of 100,000 square feet or more are disturbed (50,000 square feet in protected shoreland). Shoreland regulations are complicated. Wetlands mitigation practices lack clarity. Protection for vernal pools and wetland drainages is limited. NH Department of Transportation policy on site disturbances and stormwater runoff is unclear. A limited number of communities have used local regulations to address some of the state-level gaps, such as shoreland protection and stormwater and erosion controls.

Regulatory enforcement and site-specific monitoring are also important estuarine management issues. For example, current septic system maintenance and performance requirements are often unenforceable due to the large numbers of systems in each community. Enforcement of local regulations and adequate on-site monitoring can be an administrative burden for volunteer, part-time municipal officials.

1998 Shellfish Water Classifications





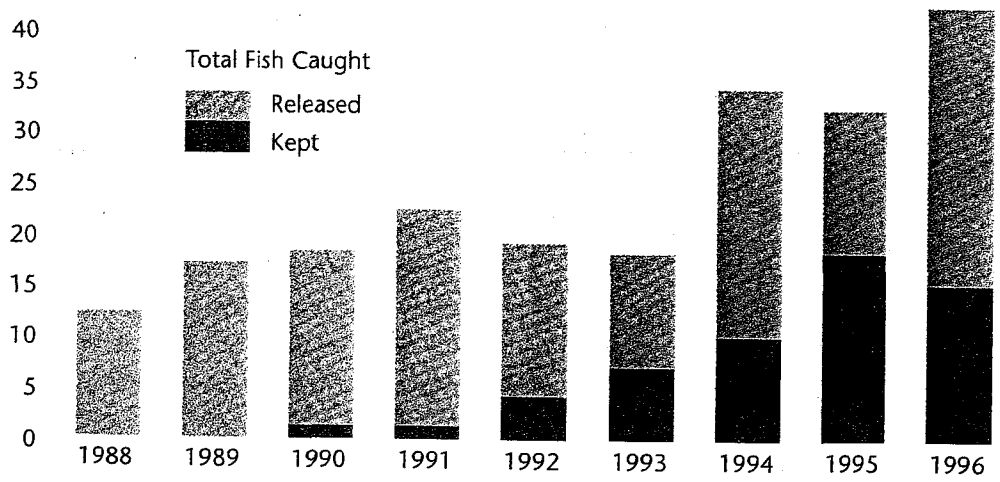
Shellfish Resources

Shellfish in New Hampshire are limited to recreational harvest only, because the state does not have a US Food & Drug Administration approved program for commercial harvesting. Shellfish harvest is a popular recreational pursuit in New Hampshire. However, oyster resources in the Great Bay Estuary have declined in recent years. From 1991 to 1996 oyster density reductions in three beds of recreational importance ranged from 42% to 69%. Other oyster beds have lost significant bed acreage, especially in the Oyster and Bellamy rivers. Oyster harvests reflect these declines: a 1991 study estimated a total harvest of 5,000 bushels of oysters by 1,000 license holders, but by 1997 the estimated harvest had declined to 2,700 bushels by 661 harvesters. Predation, limited availability of suitable larvae-attachment substrate, disease, harvest pressure, and a variety of management issues are likely factors in these declines.

Softshell clam resources in the Hampton-Seabrook Estuary are well documented. Adult populations on three particular flats of the estuary peaked in abundance in the early-to-mid 1980s, then declined sharply through the late 1980s. This decline was most likely due to intense recreational and illegal harvest pressure.

After the flats were closed to harvesting in the late 1980s, adult clam densities began to recover. Conditional reopening of the flats to harvest in 1994 appears not to have significantly affected the resource. From 1990 to 1995 adult clam densities quadrupled on the Middle Ground flat, while Common Island densities remained essentially unchanged. Clam densities in the Hampton River decreased by 50%. One suspected cause of this decrease is a lethal form of leukemia in clams. Little information is available on the softshell clam resources of the Great Bay Estuary and the Little Harbor-Back Channel area.

Tagged Striped Bass Catches



Striped bass caught in New Hampshire with U.S. Fish and Wildlife Service tags: 1988-96.

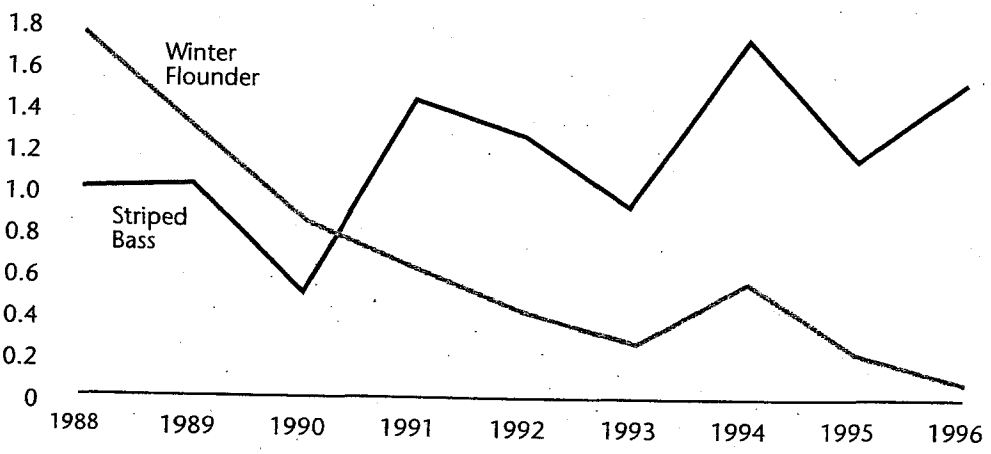
Finfish

A region-wide moratorium and subsequent harvest restrictions on striped bass in the 1980s and 1990s have resulted in dramatic gains in the seasonal occurrence of stripers in New Hampshire waters. Catches of both legal and undersized striped bass tagged by the U.S. Fish and Wildlife Service have increased steadily since 1988. Biologists and anglers generally confirm that fish of all sizes have increased in abundance.

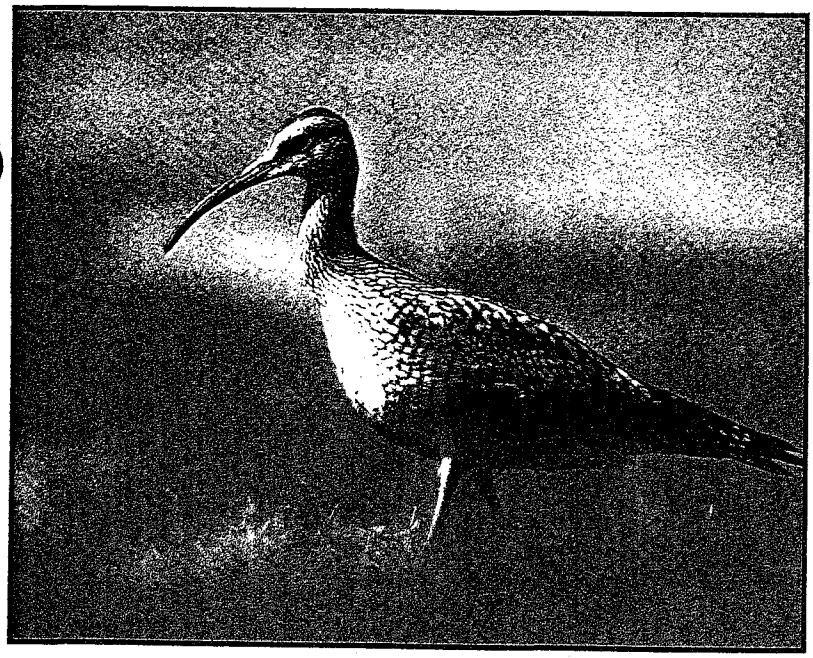
Recreational anglers have not enjoyed this same abundance with winter flounder. Catch per unit effort declined steadily from 1988 to 1993, rose briefly in 1994 and 1995, and then decreased again in 1996. Although juvenile fish appear abundant in the estuaries, adult populations have declined due to commercial harvest pressure in the Gulf of Maine. Commercial landings of winter flounder show a similar, steady decline.

Rainbow smelt catches have varied greatly at several locations in the Great Bay Estuary – peaking in the late 1980s, declining sharply in the early 1990s, and increasing in the mid 1990s. From 1975 to 1996 spring returns of river herring (alewife and blueback) declined in the Exeter, Lamprey, and Taylor rivers, but increased in the Oyster and Cocheco rivers.

Finfish Catches



Catch per trip of striped bass and winter flounder. Based on survey information.



Whimbrel

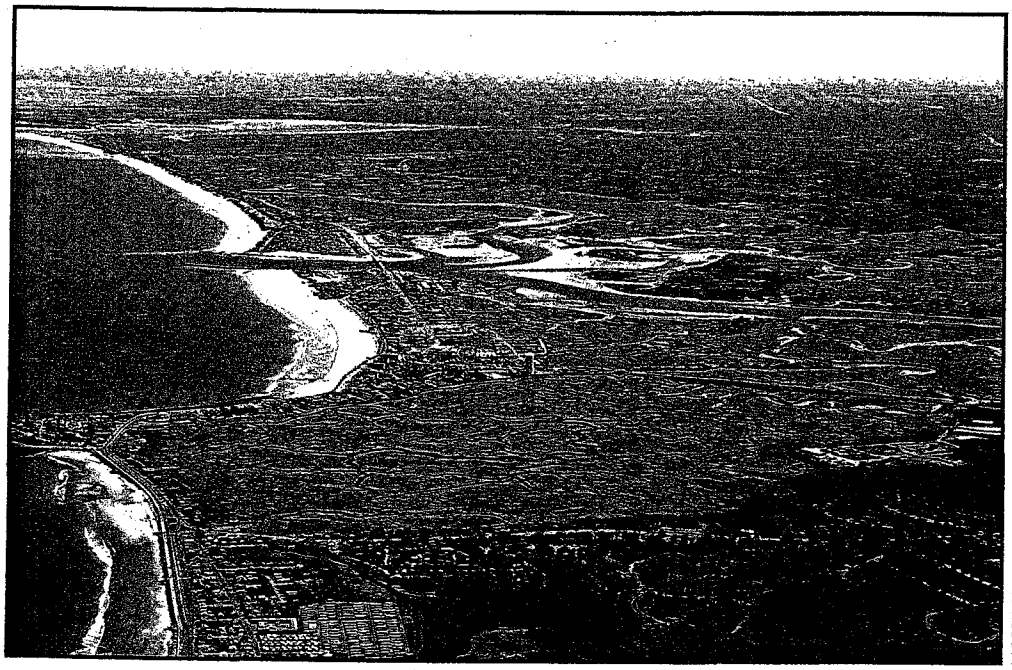
Waterfowl and Shorebirds

The Seacoast is the principal wintering location for waterfowl in New Hampshire, with 75% of the state's overwintering waterfowl found on Great Bay. State, federal, and locally controlled reserves and sanctuaries in the Great Bay area provide over 6,300 acres of wetlands salt marsh and upland habitat. As a result, Great Bay is an important destination for birders interested in a variety of waterfowl and shorebirds. Great Bay is also a focus area for the North American Waterfowl Management Plan. The Great Bay National Estuarine Research Reserve lists over 170 species by season and abundance on its checklist of the birds of Great Bay. A recent mid-winter survey recorded mallards, black ducks, greater and lesser scaup, goldeneye, bufflehead, red-breasted mergansers, and Canada geese as the predominant waterfowl.

Salt Marsh

The 5,000-acre salt marsh of the Hampton-Seabrook Estuary is the largest contiguous salt marsh in the state. Tidal marshes of the Great Bay Estuary total 2,230 acres, with the most extensive salt marshes found along the lower Piscataqua River, the Squamscott River, and Great Bay itself. The fringing marshes of the Great Bay Estuary wind along tidal shorelines between the low tide line and adjacent upland areas, wherever the soils, elevations, and tidal action are favorable.

The Hampton-Seabrook Estuary



GBNERR

MORRISON

Nearly all salt marshes in New Hampshire were subjected to ditching and draining at one time or another into the first half of this century, in attempts to control mosquitoes or increase harvest of salt marsh hay. Present salt marsh acreage in the state is half of what it once was, with most of the lost acreage filled for residential and industrial development and road or rail construction. Total salt marsh acreage has remained the same over the past decade. However, past development of salt marshes and road and railroad crossings have restricted water circulation and tidal flow within the remaining marshes. These changes in the natural tidal flow have degraded salt marsh function, with impacts including growth of invasive species such as purple loosestrife and *Phragmites australis* or common reed.

Recently a number of salt marshes in New Hampshire have been successfully restored by re-establishing tidal flow and freshwater exchange. Most of these projects have re-established tidal flow and exchange to marshes where tides were restricted by undersized or damaged culverts, water control structures, and/or berms of debris or dredge spoil. Recovery of marsh functions and habitat has been rapid and successful. By 1999 the collaborative efforts of many different agencies and landowners had restored or enhanced over 430 acres of salt marsh in New Hampshire.

Eelgrass

Eelgrass beds or meadows form subtidal and intertidal seagrass habitats which cover the greatest area of all habitat types in the Great Bay Estuary. Eelgrass habitats are important as breeding and nursery grounds for finfish, shellfish, and other invertebrates, and as feeding grounds for many fish, invertebrates, and birds. Eelgrass stabilizes bottom sediments, and may also filter nutrients, suspended sediments, and contaminants from estuarine waters.

Eelgrass

Eelgrass wasting disease (caused by the myxomycete *laburinthula sp.)* was first recognized in Great Bay in the 1940s. In the late 1980s wasting disease caused dramatic eelgrass declines in the Great Bay Estuary, arousing great concern into the early 1990s. However, historical eelgrass beds have made an impressive recovery of acreage and densities, and new beds have been observed in areas previously devoid of eelgrass. While overall the resource is improving, recovery of lost eelgrass areas has been significantly slower in Little Bay.

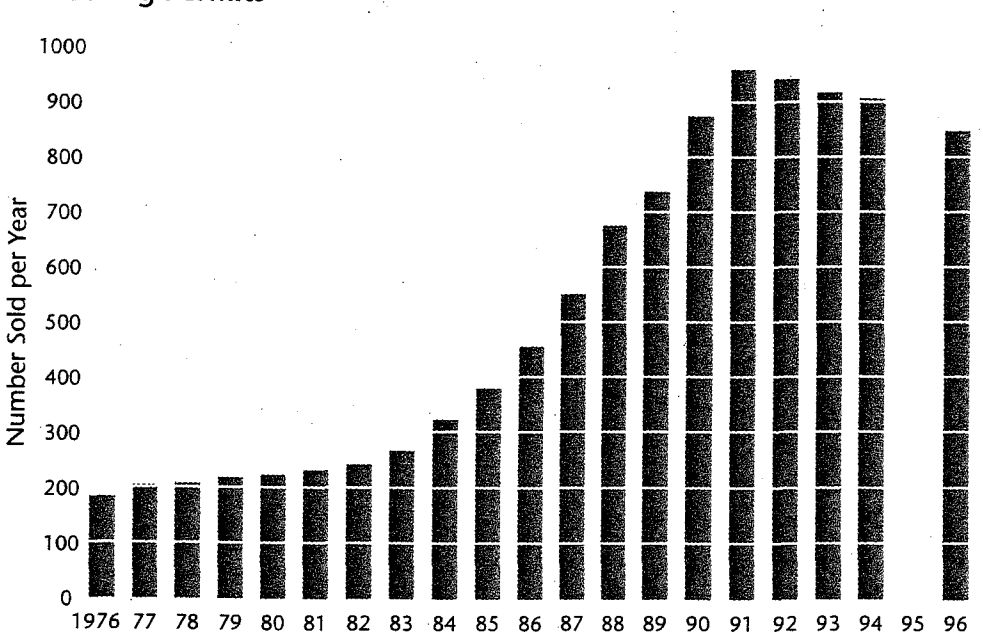
Eelgrass restoration efforts have been conducted at several sites in the Great Bay Estuary, including Little Bay where beds killed by the wasting disease have not recovered in over 10 years. Eelgrass restoration projects have also been undertaken in Rye Harbor and the Piscataqua River adjacent to the State Port Facility expansion.

Recreational and Commercial Uses

Recreational Tourism and Boating

Tourism and recreation are important to the Seacoast economy. Tourism is the region's second-largest industry, with over 15% of jobs tourism-related. Important recreational activities include boating, fishing and shellfishing, sailing, day cruises, and tours. Boating has grown in popularity since the 1980s, with over 8,500 boats registered for tidal waters in 1992. Annual mooring permit sales grew dramatically in the 1980s and into early 1990s, but have leveled off since the NH Port Authority implemented a harbor management plan. Canoeing, rowing, kayaking, and windsurfing are also popular activities in the estuaries.

Annual mooring permit sales by the New Hampshire Port Authority: 1976-1996



Commercial Fishing

The American lobster is the most important commercially harvested species in New Hampshire, yielding about $16 million annually. Lobsters migrate into the estuaries during late spring, with some moving well into Great Bay during the summer. Despite fishing pressure in estuarine and ocean areas from 300 lobster fishers, landings remained relatively stable during the 1990s, averaging almost 1.6 million pounds annually from 1992 to 1997. In 1996 a summer oil spill and an October salinity drop caused by a particularly heavy rainfall event (greater than 12 inches of rain in two days in some areas) had negative impacts on lobsters, particularly those in traps at the time of the events. Mortality estimates are not available, but slightly lower 1997 lobster catches may be partly due to these events.

Landings of cod and winter flounder, also important to New Hampshire's commercial fishing fleet, consistently declined from 1992 to 1997. Spiny dogfish, shrimp, sea urchin, and other species have gained importance to the state's fishing industry. Recent catch records suggest that these species may also be succumbing to increased fishing pressure.

WATER QUALITY OBJECTIVES

Goal #1: Ensure the New Hampshire's estuarine waters and tributaries will meet standards for pathogenic bacteria including fecal coliform, *E. coli,* and Enterocci.

MANAGEMENT OBJECTIVES

Objective 1

Achieve water quality in Great Bay and Hampton Harbor that meets shellfish harvest standards (14 counts of fecal coliform/100 ml) by 2010.

Objective 2

Minimize beach closures due to failure to meet water quality standards for tidal waters (Enterococci levels not exceeding 104 counts/ 100 ml. in any one sample).

Objective 3

Increase water bodies in the NH coastal watershed designated 'swimmable' by achieving state water quality standards (*E. coli* levels not exceeding 406 counts/100 ml in any one sample. For designated beaches, *E. coli* should not exceed 88 counts/100 ml.)

Objective 4

Reduce the number of known illicit connections in the NH coastal watershed by 50% by 2010.

Objective 5

Achieve 50% reduction of known illegal discharges into Great Bay, Hampton Harbor and the tributaries by 2010.

ACTION PLANS

WQ-3 Prioritize and upgrade facilities to reduce bacterial pollution from hydraulic overloading of wastewater treatment facilities. (High)

WQ-4A Establish ongoing training and support for municipal personnel in monitoring storm drainage systems for illicit connections. (Highest)

WQ-4B Assist seacoast communities in completing and maintaining maps of sewer and stormwater drainage infrastructure. (Highest)

SHL-2 Identify sources of and reduce or eliminate contaminants in NH's estuarine watersheds. (Priority)

SHL 5 Regularly collect and monitor water quality to identify sources and reduce or eliminate contaminants. (Highest)

WQ-4C Eliminate illicit connections in seacoast communities. (Highest)

WQ-5 Conduct shoreline surveys for pollution sources. (Highest)

WQ-6 Promote collaboration of state and local officials to locate and eliminate illegal discharges into surface waters. (High)

WQ-7 Provide incentives to fix or elimiate illegal direct discharges such as grey water pipes, failing septic systems, and agricultural runoff. (Highest)

WQ-8 Research the effectiveness of innovative stormwater treatment technologies. (Highest)

WQ-13 Provide septic system maintenance information directly to shoreline property owners. (Highest)

WQ-14 Encourage the use of alternative technologies for failing septic systems. (High)

Goal #2: Ensure the New Hampshire's estuarine waters, tributaries, sediments, and edible portions of fish, shellfish, other aquatic life, and wildlife will meet standards for priority contaminants such as, metals, PCBs, PAHs, and oil and grease.

MANAGEMENT OBJECTIVES

Objective 1

Develop baseline of toxic impacts on ecological and human health by tracking toxic contaminants in water, sediment, and indicator species: blue mussels (Gulfwatch); tomcod, lobsters and winter flounder (Coastal 2000).

Long-term: Reduce toxic contaminants levels in water, sediment and indicator species so that no levels persist or accumulate according to:

- FDA guideline levels
- State water standards in Ws 1700
- Sediment levels below ER-M levels

(References for standards found in Appendix 3.)

ACTION PLANS

WQ-2 Evaluate the suitability of UV alternatives to chlorine in wastewater post-treatment. (High)

WQ-4B Assist seacoast communities in completing and maintaining maps of sewer and stormwater drainage infrastructure. (Highest)

WQ-7 Provide incentives to fix or eliminate illegal direct discharges such as grey water pipes, failing septic systems, and agricultural runoff. (Highest)

SHL-6 Periodically collect and monitor shellfish tissue samples as appropriate for toxins and biotoxins. (Highest)

WQ-11 Revise state industrial discharge permit criteria in response to new processing technology and re-evaluate existing permits. (Priority)

WQ-12A Acknowledge and support the oil spill prevention and response activities of the Piscataqua River Cooperative. (Priority)

WQ-12B Enhance oil spill clean up efforts through predeployment infrastructure and development of high-speed current barriers. (High)

WQ-15 Support efforts to reduce deposition of atmospheric pollutants. (Priority)

Goal #3: Ensure the New Hampshire's estuarine waters and tributaries will meet standards for organic and inorganic nutrients, specifically nitrogen, phosphorous, chlorophyll A (freshwater), dissolved oxygen, and biological oxygen demand (BOD).

MANAGEMENT OBJECTIVES

Objective 1

Maintain inorganic nutrients, nitrogen, phosphorous and chlorophyll a in Great Bay, Hampton Harbor and their tributaries at 1998-2000 NERR baseline levels.

Objective 2

Maintain organic nutrients in Great Bay, Hampton Harbor and their tributaries at 1994-1996 NERR baseline levels.

Objective 3

Maintain dissolved oxygen levels at:

>4 mg/L for tidal rivers

>6 mg/L for embayments

(Great Bay and Little Bay)

> 7 mg/L for oceanic areas

(Hampton Harbor and Atlantic Coast)

Objective 4

Maintain NPDES permit levels for BOD at wastewater facilities in the NH coastal watershed.

ACTION PLANS

WQ-1 Evaluate Wastewater Treatment Facility impacts on estuarine water quality and seek practical options at the state level for secondary and tertiary or alternative treatments. (High)

WQ-5 Conduct shoreline surveys for pollution sources. (Highest)

WQ-6 Promote collaboration of state and local officials to locate and eliminate illegal discharges into surface waters. (High)

WQ-7 Provide incentives to fix or eliminate illegal direct discharges such as grey water pipes, failing septic systems, and agricultural runoff. (Highest)

WQ-8 Research the effectiveness of innovative stormwater treatment technologies. (Highest)

WQ-9 Ensure water quality and quantity impacts from new development and redevelopment are minimized at the planning board stage. (High)

WQ-10 Research, revise, publish and promote the Stormwater Management and Erosion and Sediment Control Handbooks for Urban and Developing Areas. (Highest)

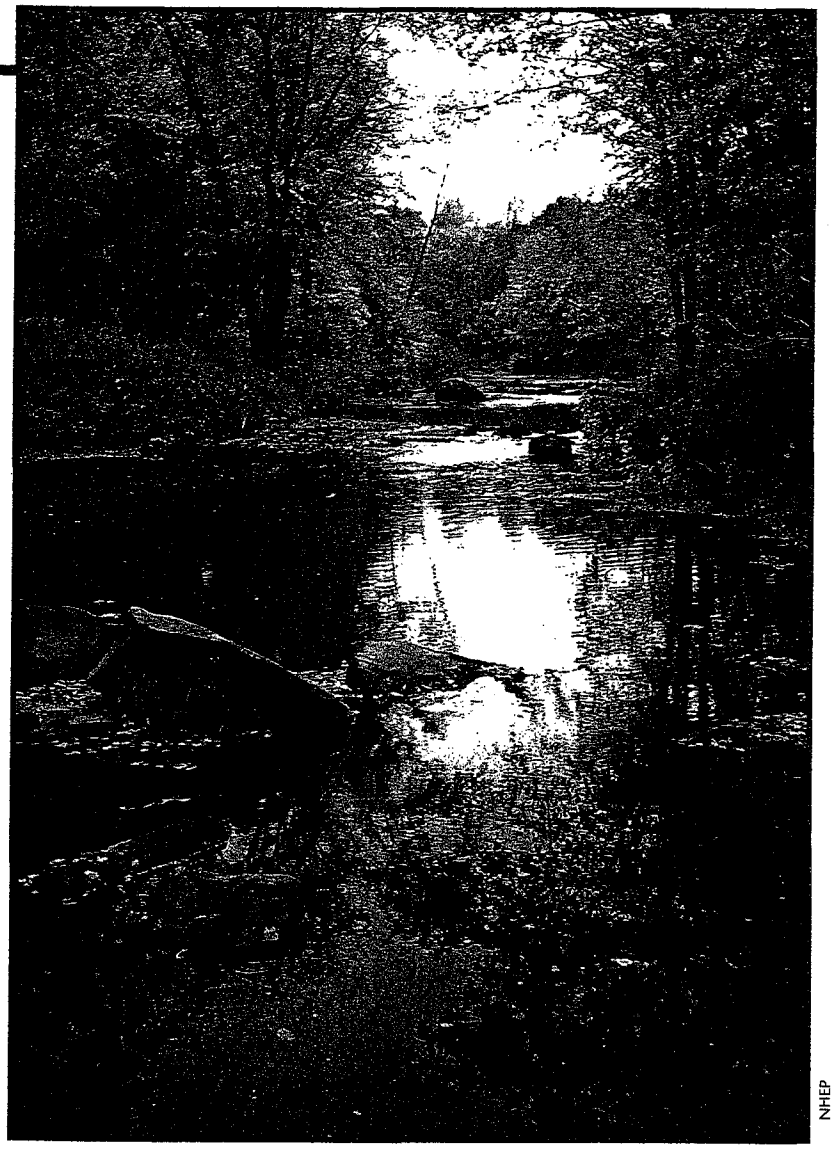
WQ-11 Revise industrial discharge permit criteria in response to new processing technology and re-evaluate existing permits. (Priority)

WQ-15 Support efforts to reduce deposition of atmospheric pollutants. (Priority)

WATER QUALITY

4

Clean water is essential for healthy estuaries. Water is the basic life-sustaining element linking all the characteristic features of New Hampshire's estuarine environment. Efforts to improve water quality drive the Action Plans developed to address the priority problems threatening the estuary. The NHEP focuses on improving water quality as the most effective way to attain measurable environmental improvements, and to communicate to citizens and decision-makers the need to protect all aspects of our region's natural resources. Improving and protecting estuarine water quality calls for correcting current problems and pollution sources, and for preventing future problems as New Hampshire's Seacoast region continues to grow.



NHEP

Upper Cocheco River, New Hampshire

The mixing of ocean saltwater with inland and coastal freshwaters creates the unique and highly productive conditions of the estuaries. These special environmental conditions are reflected in the richness of estuarine habitats. Estuaries play a unique role as nurseries for living resources of not only the estuarine, but also marine and upland ecosystems.

Pollutants in New Hampshire's estuaries include bacterial, toxic, and nutrient contaminants from municipal and industrial wastewater treatment facilities, septic systems, sediments, fertilizers, other runoff, plus oil spills and contaminated sites in the watersheds. Current and future sources of contamination must be reduced and prevented. Most of these water quality problems are directly related to human activities.

WHY IT MATTERS

Clean water is essential to the rich variety of unique habitats and diverse plant and animal communities found in New Hampshire's estuaries. Clean water is also vital for many human activities at the heart of the Seacoast economy and cultural traditions. Groundwater, precipitation, wetlands, and surface waters of the rivers, lakes, streams, and the Gulf of Maine of the Atlantic Ocean all affect water quality in the estuaries, reflecting the complexity and interconnected nature of estuarine systems. Human activities and natural processes influencing any of these water sources ultimately influence the water quality of the estuaries.

The priority water quality contaminants in New Hampshire's estuaries are:

- Pathogenic microorganisms (fecal-borne bacteria and viruses) from improperly treated sewage, urban stormwater runoff, and other non-point sources;
- Nutrients from sewage treatment plants and non-point sources such as tributaries, surface runoff, septic systems, atmospheric deposition, etc.;
- Toxic contaminants (organic chemicals and heavy metals, from oil, solvents, pesticides) from historic industrial sources and from current industrial and municipal wastewater and atmospheric deposits;
- Sediments from upland watersheds or rivers carried into the estuaries by runoff.

THE CHALLENGE

Pollution abatement efforts in New Hampshire's estuaries began in the 1940s, and continue today. Much progress was made through the 1970s and 1980s and into the 1990s, with the installation and upgrading of municipal wastewater treatment systems. Water quality and habitat areas have recovered significantly. Bacterial contamination has been decreasing in the last decade in most of the state's coastal areas, largely due to upgraded wastewater treatment facilities (WWTFs).

But pollution problems remain and continuing vigilance and planning is needed to protect estuarine water quality from the pressures of population growth and development. Treatment plant hydraulic overloading including pump station overflows and bypasses, combined sewer overflows (CSOs), and illicit connections to storm sewers all contribute human sanitary waste to estuarine waters. The shellfish beds are closed when treatment plants fail, pump stations overflow, and CSOs discharge. Non-point sources of pollutants also increase with added development. *Chapter 5: Land Use, Development, and Habitat Protection* addresses non-point source pollution through actions to limit impervious cover and sprawl, and to protect tidal and freshwater wetlands, groundwater, and shorelands.

While there are no grossly contaminated areas, all New Hampshire estuarine waters are subject to **bacterial contamination** for some time each year. Fecal coliform bacteria are measured as indicators of sewage contamination,

to warn of threats to public health and safety. People can become ill from eating contaminated shellfish or from contact with water polluted with pathogenic microorganisms. Concentrations of these indicator bacteria are generally quite low throughout the estuaries, and estuarine water quality supports most uses in most areas. Still, contaminants persist in all estuarine waters and at levels – especially during or after rainfall or snowmelt runoff events – that require limiting uses such as shellfish harvesting to protect human health. Stormwater runoff carries pollutants into estuarine waters from combined sewer overflows, impervious areas like roadways, parking lots and roofs, ineffective septic systems, vessel discharge, pet waste, and possibly waterfowl.

Heavy metals and toxic compounds are also found throughout the estuaries, with higher levels concentrated around Seavey Island and the Portsmouth Naval Shipyard and other hot spots including Rye Harbor. Much of the toxic contamination in New Hampshire's estuaries is the legacy of historic industrial activities in the

BACTERIAL CONTAMINATION

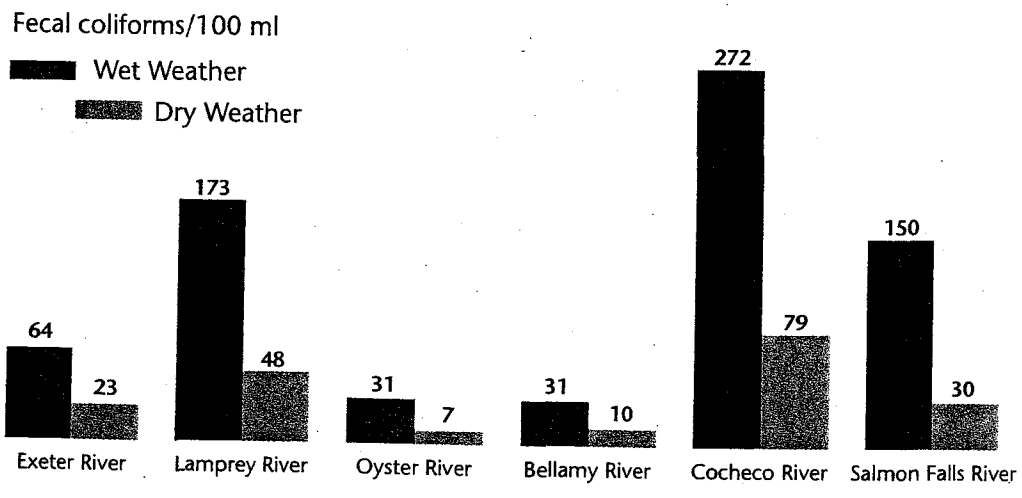
A three-year study of how storm events affect water quality in the tributaries of the Great Bay Estuary confirmed urban runoff as a source of contamination. Fecal coliform bacteria are monitored as an indicator of pathogenic microorganisms. Concentrations are generally quite low in many areas, at a level of water quality that supports most uses. However, elevated concentrations of fecal coliforms were detected in all areas following rainfall events. Stormwater bacterial contamination of the Great Bay Estuary is well documented, and efforts continue to identify the sources. Recent studies found many sources of stormwater contamination in coastal New Hampshire towns – including stormwater drains, sewer pipes, stormwater treatment systems, and animal feces.

Evidence suggests these sources are prime suspects:

- Runoff from impervious areas
- Illicit connections
- Wastewater treatment system overflows
- Faulty septic systems
- Vessel discharges
- Waterfowl and large bird populations such as pigeons and starlings

Rainfall-related contamination causes closure of shellfish beds to harvesting, as discussed in *Chapter 6: Shellfish Resources*. Potential sources of bacterial contamination near and within New Hampshire's shellfish waters include wastewater treatment facilities effluent, stormdrains, parking lots, roadways, snow dump sites, etc.

Fecal Coliform in Tidal Water



Geometric mean fecal coliforms in tidal water, collected during dry weather and storm events in tributaries to the Great Bay Estuary: 1993-96.

Suspected sources of high wet weather counts in the Cocheco RIver are illicit connections and leaking sewer pipes.

EXCESS NUTRIENTS

Nitrogen is a naturally occurring nutrient essential for plant and algae growth. However, too much nitrogen can ultimately reduce water oxygen levels, with potentially catastrophic consequences for many estuarine creatures. Nutrients in the estuaries come from natural sources such as watershed sediments, wildlife, organic debris (leaves and other vegetation), and groundwater, as well as from point and non-point sources caused by human activity, including atmospheric deposition from power plants, etc. Nitrogen and phosphorus are the two most important nutrients in terms of pollution since they usually have the most impact in aquatic ecosystems. Nitrogen is generally believed to be the nutrient of greatest concern in estuarine and marine waters, although phosphorus has been identified as primary nutrient concern in some situations.

Point sources – primarily municipal and industrial wastewater treatment plants – contribute 41% of nutrient pollutants to the estuaries. Nearly half (48%) of the nutrient loading to Great Bay comes from non-point sources, including urban runoff, stormwater conduits, on-site wastewater treatment (septic) systems, lawn fertilizers, agricultural runoff, and waterfowl and other natural processes. Atmospheric deposition of nitrogenous compounds from the burning of fossil fuels accounts for the remaining 11%. Water contamination from atmospheric deposition is not easily managed. But while non-point sources include nutrients from natural sources, all point source pollution is caused by human activity, and can be managed. Loading from point sources becomes more important for planning for future development and nutrient reduction.

Less is known about nutrient loading in the Hampton-Seabrook Estuary. While point sources and non-point sources of nutrients exist around the Hampton-Seabrook Estuary, the problems associated with nutrient loading are minimized because 80% of the water in the estuary is exchanged with the ocean with each tide cycle.

Excess nitrogen in water can stimulate rapid, unchecked growth of algae and plants, potentially resulting in eutrophication. When such blooms die, their decomposition depletes oxygen in the water, suffocating shellfish and other marine life. All New Hampshire estuaries and their tributaries are subject to nutrient loading, but nutrient concentrations in Great Bay have been largely stable over the last 20 years. No widespread eutrophication has been observed. Isolated incidents of reduced oxygen and phytoplankton (tiny plants that float in water) blooms have occurred in some of the freshwater tributaries of Great Bay – in the impoundments behind the dams at the head of the tide on the Salmon Falls, Cocheco, Oyster, and Lamprey Rivers – and in Portsmouth's North Mill and South Mill Ponds.

EPA-New England, local watershed groups such as the Lamprey River Watershed Association, and the states of Maine and New Hampshire have documented evidence of eutrophication, particularly from point sources, in certain river segments. Total maximum daily load (TMDL) studies of the Salmon Falls River, the Lamprey River below the Epping treatment plant, and the Cocheco River below the Rochester treatment plant have resulted in upgrades to tertiary treatment for the Epping and Rochester WWTFs. Five Salmon Falls River point sources will likely have tighter nutrient limits in their reissued NPDES permits.

While eutrophication and related impacts do not appear to be imminent problems, sources of nutrient contaminants (wastewater treatment effluent, lawn fertilizers, septic systems, and runoff from impervious surfaces) will increase with further population growth and development.

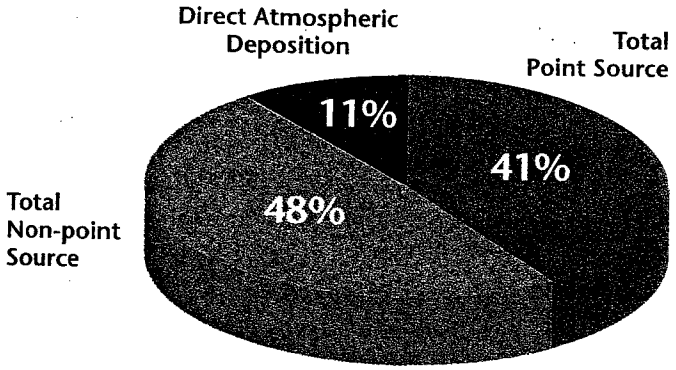
watershed. Other documented sources include oil spills, municipal waste discharges, defense facilities and Superfund sites, stormwater runoff, and groundwater contaminated by hazardous wastes. Numerous oil spills have, to varying extents, adversely affected estuarine life and habitats. Elevated tissue concentrations of toxic contaminants in lobster tomalley, bluefish, and other living resources have caused human consumption advisories, and raise a warning for the whole estuarine system. Toxic levels in sediments are a continuing concern requiring monitoring and risk assessment for activities such as dredging or construction.

Nutrients are continually added to New Hampshire's coastal waters from both natural and human sources. Although nutrient loading occurs in all New Hampshire estuaries and tributaries, no significant change in the nutrient levels of Great Bay has occurred over the last 20 years. No widespread eutrophication–the process by which excess nutrients stimulate excessive algae and plant growth that can deplete oxygen and kill marine life when it decomposes – has been observed. However, intense phytoplankton blooms and reduced oxygen concentrations have occurred as isolated local events in the Great Bay Estuary.

Eutrophication and related impacts do not appear to be imminent threats, but as population and development increase so will sources of nutrient contamination from wastewater treatment facilities, septic systems, lawn fertilizer runoff, runoff from impervious surfaces, and air deposition. The cumulative impacts of these sources could eventually cause nutrient-related problems in the estuaries if current waste treatment technologies and land use plans and regulations continue unchanged. WWTFs are the major source of nitrogen and phosphorus. Strategies to reduce nutrient loading and bacterial contamination from WWTFs are needed to protect water quality in the estuaries, but these will be expensive.

Water quality problems are often the result of large numbers of people in and around the estuaries. People have been and must continue to be part of the solution as well. Outreach and education efforts are the key to many of the actions planned to improve water quality in New Hampshire's estuaries. Many opportunities exist for Seacoast residents to participate in this *Plan* – as homeowners, landowners, business owners and managers, as citizens and taxpayers, as community leaders, municipal and state agency staffers, and volunteers.

Sources of Nitrogen Loading to the Great Bay Estuary

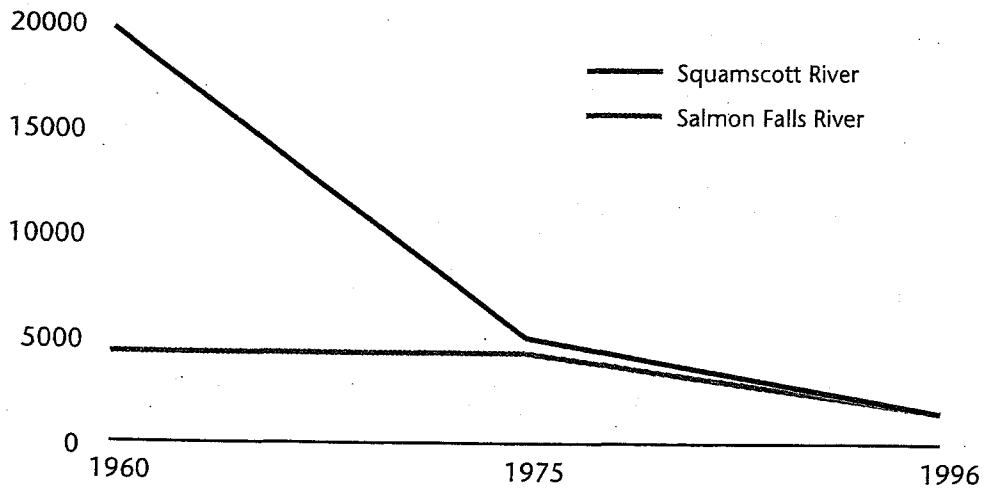


Wastewater Treatment Systems

Despite significant improvements in recent decades, Seacoast WWTFs still do not meet their required treatment standards 100% of the time. Factors affecting plant performance include storm events, waste stream changes, equipment breakdowns, and operator error. The most severe incidences of bacterial contamination follow rainfall runoff events and treatment process upsets at WWTFs. While dramatic reduction in fecal coliform counts has occurred in tidal rivers like the Squamscott since 1960 due to upgrades required by federal legislation, water quality sampling throughout the Great Bay Estuary tracks a pattern of elevated counts coming from urban runoff and WWTFs. Both routine and storm-related effluent nutrient contribution varies with individual WWTFs. Based on total nitrogen concentrations measured in effluent and

Total coliforms (colonies/100 ml) in the Exeter/Squamscott and Salmon Falls rivers

Total Coliforms 1960-1996



average effluent volume reported by the plants, the largest nitrogen contributions to the Great Bay Estuary are, in descending order, the Portsmouth, Rochester, Dover, Exeter, Berwick, and Kittery WWTFs.

WWTFs are not the only part of municipal treatment systems that can cause pollution problems. The Seacoast region was the first area of settlement in New Hampshire, and some of the infrastructure in the older cities and towns is old and difficult to replace or maintain. Leaking sewer pipes are suspected in most urban communities. Sewer system maintenance and keeping stormwater and sewage separated are critical to water quality. In addition, projected growth in the region will require increased capacity at some facilities.

Stormwater poses difficulties for several municipal sewage treatment systems in the region. When overburdened by stormwater, facilities bypass pumping stations and discharge inadequately treated sewage directly into tidal waters. Combined sewer overflows (CSOs) have been gradually eliminated from several Seacoast communities. The two remaining CSOs in Portsmouth are significant sources of bacterial contamination to Little and Portsmouth Harbors. Exeter's one remaining CSO is responsible for contaminated water draining into the Squamscott River. Eliminating these last CSOs will be expensive, but would end their storm-related major releases of bacteria

and nutrients into tidal waters. In 1999, Exeter appropriated $1.7 million to address their CSO problem by 2000.

Stormwater drain systems in several Seacoast towns contain high concentrations of fecal contaminants, even in dry weather, suggesting leaks from sewer pipes or illicit connections of sewage discharging into the storm drains. Many illicit connections have recently been identified and eliminated in Dover and Newmarket.

Stormwater

Stormwater runoff is water from rainfall and snowmelt that runs along the surface of the ground. In an undisturbed natural setting, plant cover slows the movement of stormwater, allowing more time for the water to soak in. Plant roots and organic matter also help absorb and hold water. Thus vegetation allows the soil to act as a natural filter for contaminants, and for plants to take up and use nutrients carried in the water. Slowing the passage of stormwater also reduces its ability to erode soils and deposit them as sediments in surface waters.

Stormwater runoff carries a variety of pollutants. Amounts and types depend on the nature of the precipitation and the surfaces over which the water flows. Building and development replaces naturally vegetated land with hard, impervious surfaces – roads, pavement, roofs, etc. – that cause stormwater from large areas to flow and collect swiftly, accumulating contaminants before it discharges into storm drains and surface waters. This results in increased erosion, flooding, and water pollution. The faster water moves, the more soil is eroded and carried into surface waters as sediment. As more impervious surface covers the landscape, less rainfall is absorbed. Loss of open land reduces buffering of wetlands and surface waters, increasing flooding problems. Stormwater picks up and carries contaminants from vehicles, fertilizers and pesticides, sewers, atmospheric deposition, pets, and industrial and commercial sites, often delivering them directly to nearby surface waters.

Stormwater runoff contaminates New Hampshire's estuarine waters with pathogenic bacteria and viruses, nutrients, sediment, trace metals and other toxins. Runoff from impervious surfaces is a significant source of both trace metal and toxic organic contaminants. Runoff resulting from rainfall and snowmelt events in urban and urbanizing areas is the most common source of bacterial contamination in New Hampshire estuaries. This is due to a combination of inflow and infiltration to sewer pipes, overloaded wastewater treatment plants and combined sewer overflows (CSOs), and non-point source runoff.

Water from rains or melting snow washes contaminants from roadways, parking lots and other paved surfaces, rooftops, construction sites, fertilized lawns, farms, and faulty septic systems into drains, ditches, and tributaries of the estuaries. Contamination from these kinds of diffuse sources is called non-point source pollution. While the U.S. EPA estimates 60% of surface water pollution nationally is non-point related, non-point sources are estimated to contribute 48% of the annual nutrient load to Great Bay. Point sources – primarily municipal wastewater treatment plants – contribute 41%. Continued population growth and development in the coastal region will add more impervious surfaces – paved areas, buildings, etc. – potentially

causing more stormwater-related pollution, as well as adding pressure to WWTFs and sanitary sewer systems.

Stormwater also poses significant problems for municipal sanitary sewer systems. Often stormwater infiltrates old sanitary sewer systems, overburdening pipes, pumping stations, and wastewater treatment facilities. To avoid damage to the system, operators discharge the excess raw sewage and stormwater volume without treatment. These discharges are referred to as Combined Sewer Overflows or CSOs.

ANMP

North Mill Pond, Portsmouth

Other Direct Discharges

In addition to the 18 New Hampshire and three Maine WWTFs, a number of industrial and other plants hold National Pollutant Discharge Elimination System (NPDES) permits for discharges into New Hampshire's tidal waters. Industrial discharge permits include 11 facilities in New Hampshire and three in Maine, two power plants that discharge into the Piscataqua River and Seabrook Station (a nuclear power plant) which discharges into the Atlantic Ocean, and three water treatment plants in the Great Bay Estuary.

Shoreline surveys continue to reveal illegal direct sewage discharges in many areas. Remaining small illegal sewage discharges may be contributing to the high bacterial counts found in many tributaries of the tidal rivers and bays.

Septic Systems

Many shoreline areas in the more rural and suburban areas around the estuaries and their tributaries are still served by septic systems. Studies in Seabrook show that septic systems have the potential to contaminate tidal waters when the systems are located close to shore, especially in more densely populated areas with high water tables and coarse, excessively well-drained soils. Seabrook has nearly finished connecting all homes and businesses to their new sewer system. But septic systems are still common along much of the state's tidal shorelines, and failing, poorly maintained, or inadequate systems are a problem.

REGULATORY AND MANAGEMENT PROGRAMS

Non-point Source Pollution

Non-point source pollution is all pollution that does not come from a single source or pipe and may be difficult to locate. Much non-point source pollution results from stormwater runoff. **Federal** control of non-point source pollution stems from the Clean Water Act and Coastal Zone Management Act, and focuses on non-regulatory approaches. Amendments to the Clean Water Act in 1987 required states to develop non-point source management programs in order to receive Clean Water Act Section 319 funds.

The 1990 reauthorization of the Coastal Zone Management Act (CZMA) required states receiving CZMA funds to develop coastal non-point source programs. The federal government has approved New Hampshire's program with certain conditions.

Clean Water Act Section 303 (d) and its implementing regulations require states to list water segments that are impaired – defined as out of compliance with a water quality goal or designated use such as swimming or fishing, even after targeted pollution control practices have been implemented to address the problem. The 303 (d) listed waters affecting the New Hampshire estuaries are part of the Cocheco River and the Salmon Falls River downstream of Somersworth. Water bodies on the 303 (d) list are given priority for Section 319 funding to address non-point sources. In December 1999 EPA proposed to apply total maximum daily load (TMDL) reduction targets to non-point sources in 303 (d) listed water segments. This approach is already in effect for point sources in 303 (d) waters.

New Hampshire's **state** non-point source programs are coordinated by a steering committee that includes all state, federal, and local agencies with responsibilities related to non-point sources. NH Department of Environmental Services Water Division is the lead agency, with additional programs under the NH Department of Agriculture, Markets and Food and the NH Department of Resource and Economic Development's Division of Forests and Lands. The NH Office of State Planning, Regional Planning Commissions, and Conservation Districts all help municipalities plan for protection against development-related runoff problems.

New Hampshire's non-point source programs have recently been revised to focus on priority watersheds, including the coastal watershed (the NHEP's study area). New Hampshire's Coastal Non-point Pollution Control Program is coordinated with the state's Clean Water Act Non-point Source Program. NH DES provides financial and technical assistance in addressing the impacts of urban development, septic systems, agriculture, forestry, roads, marinas and boating, hydromodification, and wetlands. The *NHEP Management Plan* is closely linked with the Non-point Souce Program because both programs share objectives.

Local governments have authority to establish zoning ordinances and development regulations that can give them substantial control over non-point source pollution. Zoning, subdivision regulations, and site plan review may include requirements for stormwater and erosion control, septic design, siting,

and installation. These planning tools may address prohibited land uses, open space requirements, and more. Many towns in the estuarine area use the site plan review process to address post-construction stormwater management.

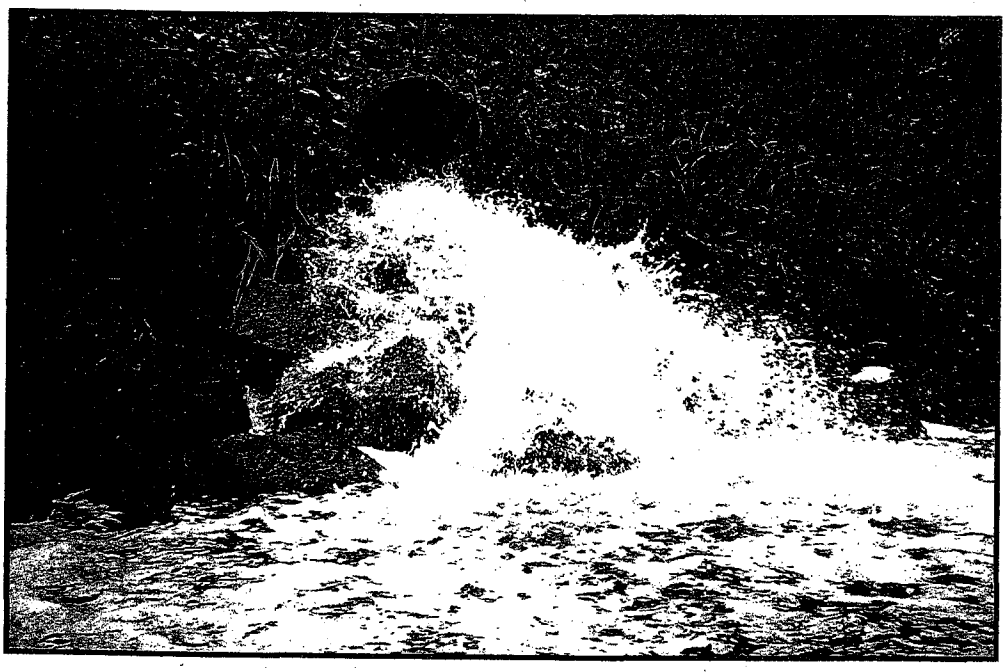
Zoning overlays may help protect shoreline habitats, wetlands, and other important natural resources from development. Municipalities can also acquire open space lands or conservation easements to protect estuaries and other surface waters or habitats.

The effectiveness of implementation and enforcement of local regulations varies from town to town in the estuarine watersheds. Alone or in combination, these municipal measures contribute to the control and abatement of non-point source pollution provided they are effectively implemented and enforced. All municipalities within NHEP Zone A have established zoning, subdivision, and site plan review processes. The NHEP *Base Program Analysis* found that local natural resource protection regulations and the implementation and enforcement of local regulations vary widely among the towns, often due to community size and staffing differences. Local land use control and its enforcement was found to be a vital link in the protection of New Hampshire's estuaries.

Point Source Pollution

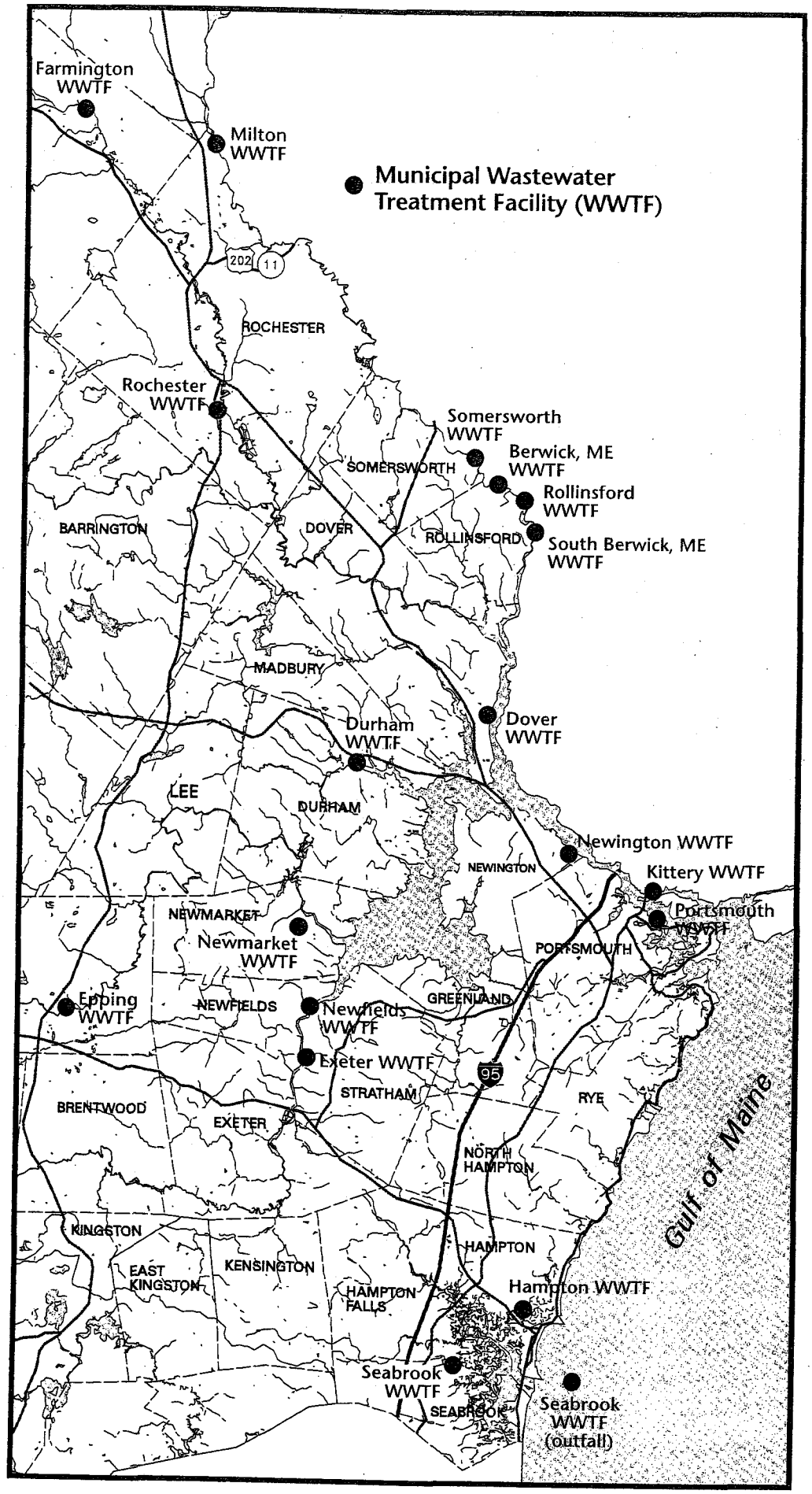
Pollution that is discharged from the end of a pipe or a single readily identifiable source is called point source pollution. This type of pollution includes discharges from industrial and municipal wastewater treatment facilities (WWTFs), and other sources such as drainage ditches. These highly visible sources were the first ones addressed by the Clean Water Act, with dramatic results. However, point source problems persist.

At the **Federal** level, the U.S. Environmental Protection Agency (EPA) regulates point source discharges through the National Pollutant Discharge Elimination System (NPDES) established under the Clean Water Act. Wastewater discharges from all sources require a NPDES permit. The NPDES permit limits the quantity and concentration of pollutants



NHEP

Rochester Wastewater Treatment Facility Discharge


Municipal Wastewater Treatment Facility (WWTF)
Farmington WWTF
Milton WWTF
202
11
ROCHESTER
Rochester WWTF
Somersworth WWTF
Berwick, ME WWTF
SOMERSWORTH
Rollinsford WWTF
South Berwick, ME WWTF
BARRINGTON
DOVER
ROLLINSFORD
MADBURY
Durham WWTF
Dover WWTF
LEE
DURHAM
Newington WWTF
NEWINGTON
Kittery WWTF
Portsmouth WWTF
PORTSMOUTH
NEWMARKET
Newmarket WWTF
Epping WWTF
NEWFIELDS
Newfields WWTF
GREENLAND
Exeter WWTF
95
STRATHAM
RYE
BRENTWOOD
EXETER
NORTH HAMPTON
Gulf of Maine
KINGSTON
HAMPTON
EAST KINGSTON
KENSINGTON
HAMPTON FALLS
Hampton WWTF
Seabrook WWTF
SEABROOK
Seabrook WWTF (outfall)

discharged. Specific requirements depend on the water receiving the effluent, the type of discharge, and may involve best available technology and economic feasibility considerations.

Certain municipal stormwater systems and industrial and construction sites currently require NPDES permits. Under Phase II of EPA's NPDES stormwater management regulations, certain additional stormwater systems that drain into, or are collected by ditches, pipes, or other conveyances before discharging into surface waters, will require NPDES permits by March 2003. Under the current Phase I regulations, construction sites that disturb five or more acres require a NPDES permit, but that threshold drops to one acre under Phase II.

In Phase I, EPA required medium and large municipal separate storm sewer system (MS4) operators – generally those serving areas with populations of 100,000 or more – to obtain permits. While no such MS4s are located in New Hampshire, dischargers of stormwater discharges associated with industrial activity were also required to apply for permits in Phase I. These industrial sources generally include heavy and light manufacturing facilities, hazardous/solid waste processing, recycling facilities including junkyards, mining, timber processing, power plants, vehicle maintenance, sewage/sludge treatment plants, and construction activities that disturb more than 5 acres.

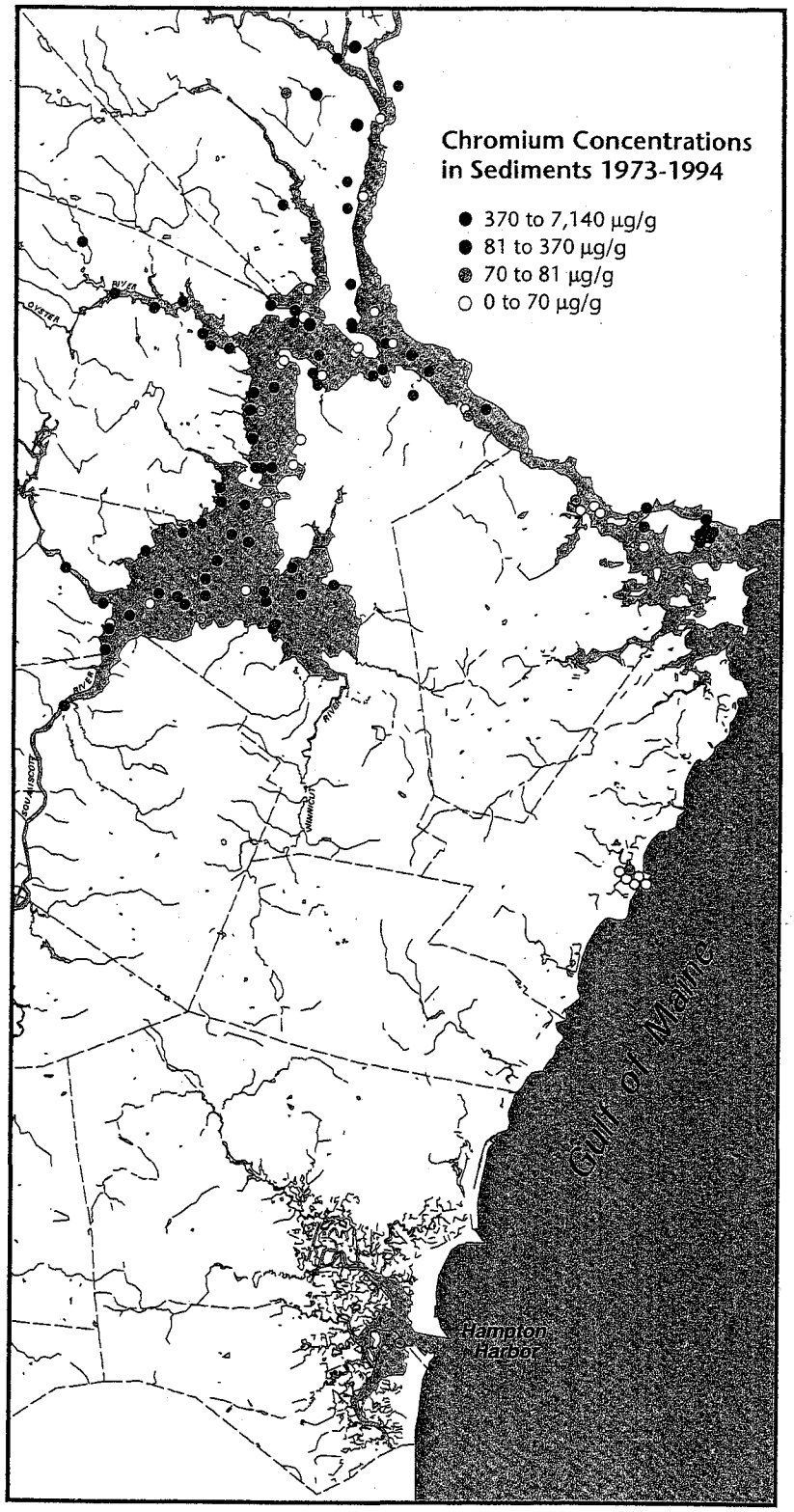
Phase II will regulate small MS4 discharges in urban areas located in 26 municipalities in New Hampshire, stormwater discharge associated with smaller-area construction activity, and the municipally owned industrial activities that were exempted from regulation during Phase I. Small municipal separate storm sewer system (Small MS4) owners and operators in the following New Hampshire Seacoast municipalities will be required to apply for NPDES permit coverage under Phase II: Dover, Durham, Madbury, New Castle, Newington, Portsmouth, Rochester, Rollinsford, Rye, and Somersworth.

As with all NPDES permits in New Hampshire, NH DES will review and certify Phase II NPDES permit applications. The NH OSP is lead agency of a working group recently formed to prepare for the technical assistance communities will need when they begin to address Phase II compliance. Participants include some of the Phase II communities, NH OSP/Coastal Program, NH DES, and NH DOT.

Each NPDES permit requires periodic monitoring and reporting of discharges to EPA and the state. Most Seacoast NPDES permit-holders are on a monthly reporting schedule. NH Department of Environmental Services inspects permitted sites in the Seacoast area at least annually. In the Seacoast, whenever sewage that has not been treated or disinfected is released the operator must notify EPA, NH DES, and all public or privately-owned water systems drawing water from the same receiving water and located within 20 miles downstream of the point of discharge. EPA can enforce NPDES requirements with a range of compliance orders and civil and criminal penalties up to $25,000 a day and imprisonment. Enforcement actions in response to significant non-compliance and certain by-pass or overflow situations are coordinated between EPA and NH DES.

Clean Water Act Section 303 (d) and its implementing regulations require states to list water segments that are impaired – defined as out of compliance

with a water quality goal or designated use such as swimming or fishing, even after targeted pollution control practices have been implemented to address the problem. The Clean Water Act requires that the list include priority ranking of segments most in need of total maximum daily load (TMDL) analysis. The TMDL defines the maximum amount of a specific pollutant that can be discharged into a body of water without violating the water quality goals for that water. NPDES permits and state wastewater discharge licenses are written in accordance with TMDL allocations for the specific water body and source. Permits for five dischargers into the Salmon Falls/Piscataqua rivers in New Hampshire and Maine are currently being developed in accordance with the TMDL for that water. TMDLs are also being developed or implemented for the Cocheco River in Rochester.



The Clean Water Act requires each **state** to establish water quality standards based on water uses and criteria for specific contaminants that are necessary to protect those uses. New Hampshire has established these standards under the state's Water Pollution and Waste Disposal Act (RSA 485-A). NPDES permits establish limits to protect these standards, and require consideration of U.S. Fish & Wildlife Service comments, in accord with the Fish and Wildlife Coordination Act. The Coastal Zone Management Act also requires that federal actions be consistent with state Coastal Zone Management Plans. Under this provision, New Hampshire requirements were incorporated into several federal projects including a hydroelectric facility in South Berwick, Maine and the new interstate gas pipeline which runs through the New Hampshire Seacoast.

Effects Range-Median (ER-M) is the concentration at which biological effects are likely to occur. ER-M = 145µg/g for chromium.

NH RSA 485-A makes it unlawful to discharge sewage, industrial, or other wastes in a way that degrades water quality below classification criteria. NH DES can require any person who causes a body of water to be degraded

below the standards of its classification to correct the problem. New Hampshire's standards for bacteria are consistent with the stringent guidelines of the US Food and Drug Administration's National Shellfish Sanitation Program for permitted discharges to tidal waters from wastewater treatment facilities.

Discharge permits must go through both state and federal review. In practice, permittees have two permits, one federal and one state, with EPA incorporating any additional New Hampshire conditions into its permits, and New Hampshire adopting the federal NPDES permits as its own.

Local governments have no direct involvement in the NPDES regulatory control for point source discharges. They may comment on NPDES permit applications as part of the public comment process. The local role in pollution discharges is primarily the management of wastewater treatment facilities and stormwater collection systems, and regulations and ordinances to reduce non-point sources that impact stormwater runoff. Municipalities also have some control over industries that discharge into municipal wastewater treatment systems, through their pretreatment programs.

GOALS FOR CLEANER WATER

To achieve cleaner water in the estuaries, the NHEP established specific goals and objectives with measurable, science-based standards. Refer to *Appendix 3* of the *Plan* for the specific standards for the water quality goals and objectives. Action Plans for water quality detail how specific sources of pollution will be identified and eliminated or reduced to meet these goals:

- Ensure that New Hampshire's estuarine waters and tributaries will meet standards for pathogenic bacteria including fecal coliform, *E. coli, Enterococci,* and total coliforms.
- Ensure that New Hampshire's estuarine waters, tributaries, sediments, and edible portions of fish, shellfish, other aquatic life, and wildlife will meet standards for metals, PCBs, oil and grease, PAHs, and other toxic contaminants.
- Ensure that New Hampshire's estuarine waters and tributaries will meet standards for organic and inorganic nutrients, specifically nitrogen, phosphorus, chlorophyll A (freshwater), dissolved oxygen, and biological oxygen demand (BOD).
- Engage the active participation of communities, government agencies, organizations, and individuals in achieving the goals for water quality.

WATER QUALITY ACTION PLANS

Wastewater Treatment Facilities

Illicit Connections in Urban Areas

Illegal Direct Discharges

Stormwater

Permitted Discharges

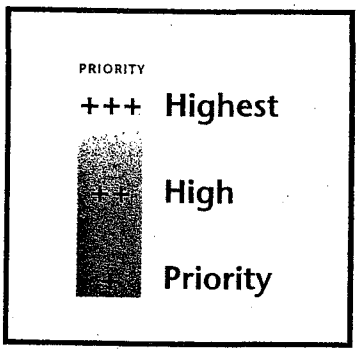
Oil Spills

Septic Systems

Air Quality

Water Quality Funding

Water Quality Outreach



ACTION WQ-1

PRIORITY

WASTEWATER TREATMENT FACILITY

Evaluate how Wastewater Treatment Facility effluent affects estuarine water quality, and seek practical options at the state level for secondary and tertiary or alternative treatment where appropriate.

BACKGROUND

Direct discharges from Wastewater Treatment Facilities (WWTFs) are in some cases contributing or major sources of suspended solids and nutrients into surface waters of the state. These pollutants can lead to aquatic nuisance plant infestation and increased incidence of reduced-oxygen concentrations, which can result in habitat degradation, aquatic fauna mortality, algae blooms and eutrophication, and changes to plant and animal communities. These environmental impacts warrant consideration and examination of advanced or alternative wastewater-treatment technologies.

Currently coastal communities evaluate wastewater treatment facilities and infrastructure through the 201 Facility Plans, as required by the EPA. Local officials and operators use these plans in long-term planning for upgrading facilities. Compliance with permit limits varies, but generally coastal wastewater plants meet most or all of their wastewater effluent limits most of the time. Hydraulic overloading is a common occurrence that results in untreated wastewater discharges. Except for Portsmouth, all Seacoast wastewater treatment facilities employ secondary treatment. The Portsmouth facility uses advanced primary treatment, a technology using sand filters to treat effluent.

Although the limited available nutrient data show that nutrients are not at critical levels in most areas of the estuarine systems, EPA, the states of Maine and New Hampshire, and local watershed groups such as the Lamprey River Watershed Association have documented evidence of eutrophication, especially from point sources, particularly at the heads of the tides in the Salmon Falls and Cocheco Rivers. Careful survey of the present effects on flora and fauna is an important part of planning for facility upgrades.

ACTIONS/ACTIVITIES

1. NH DES will hire a contractor to identify WWTF discharges that are probable or potential causes of nutrients and suspended solids impacts throughout New Hampshire's estuaries and tributary rivers. Municipal wastewater plants discharging to tidal waters include: Dover, Durham, Exeter, Hampton, Newfields, Newington, Newmarket, Portsmouth, and Seabrook. Review National Pollutant Discharge Elimination System (NPDES) permits and analyses, and the New Hampshire Estuaries Technical Characterization report.

2. The Contractor will conduct biological assessments and look for data gaps in the chemical analyses and biological assessments of surface waters in the potential impact zone. After finding data gaps, conduct follow up wet-weather and dry-weather sampling and analyses. WWTF effluent should be isolated to the extent possible from other point and non-point sources.

3 Each wastewater treatment plant determined to be negatively affecting water quality or biological communities will be evaluated by the contractor for design constraints and capacities. This will be the best point to evaluate appropriate upgrade needs for secondary, tertiary, and/or alternative treatment.

Secondary treatment should achieve removal of 85% suspended solids and 85% Biological Oxygen Demand (BOD). Secondary treatment methods may include activated sludge aeration, trickling filters, sequencing batch reactors, and rotating biological contactors.

Tertiary treatment usually aims to remove nutrients such as phosphorus and nitrogen. Phosphorus removal options are ion exchange, sorption, or coprecipitation. Nitrogen removal processes include ammonia stripping and nitrification/denitrification. A new and promising approach is biological nutrient removal.

Constructed wetlands are an alternative treatment for reducing nutrients and common contaminants; however, state regulations discourage use of constructed wetlands to treat wastewater. Commonly cited statistics indicate constructed wetlands can be expected to remove 75% of total suspended solids, 45% of total phosphorus, and 25-35% of total nitrogen.

4 NH DES will conduct cost-benefit analyses to evaluate upgrade needs for secondary, tertiary, and alternative treatment. The report of this study would include: review of wastewater treatment plant design with recommendations for changes; review of options, structural constraints, land constraints, engineering and legal planning issues, construction (depends on options), operations and maintenance, and monitoring schedules.

5 NH DES will continue to work with municipalities by evaluating the cost-benefit analyses with municipal officials and facility managers.

6 NH DES will evaluate monitoring criteria, criteria values, and monitoring frequency required in the permits for any wastewater treatment facilities that install upgrades or other adaptations as a result of this study.

RESPONSIBLE PARTIES

NH DES would hire a contractor to review available data from permit information and other sources (Step 1). The contractor would proceed with supplemental monitoring, if needed data gaps are identified (Steps 2 and 3). NH DES would use the resulting information to work with municipalities in an effort to upgrade facilities that are having impacts on water quality and biological communities (Steps 4-6).

IMPLEMENTATION LOCATION

This Action Plan will be implemented in the following communities with wastewater treatment facilities: Farmington, Milton, Rochester, Somersworth, Rollinsford, Dover, Durham, Newington, Protsmouth, Newmarket, Newfields, Epping, Exeter, Seabrook , and Hampton.

COSTS

Data and information review by contractor in Step 1	$20,000
Supplemental monitoring in Steps 2 and 3 (field work, analytical testing, and report)	$50,000
Cost/benefit analysis in Step 4	$30,000
Information transfer to municipalities in Step 5	$5,000
Evaluation of permit monitoring criteria in Step 6	$0
Research and final report in Step 4	$0
Total	**$105,000**

FUNDING

Possible funding sources would include: State and Federal Revolving Loan Fund under Clean Water Act P3 options, NHEP Implementation Funding, and the Cooperative Institute for Coastal and Estuarine Environmental Technology, or through other Federal programs identified in Tables 10.1 to 10.6 of this document.

REGULATORY NEEDS

Legislative changes may be needed to clarify the use of artificial constructed wetlands created specifically for pollutant removal, as distinct from naturally occurring wetlands. Wetlands are considered "waters of the state" and as such are entitled to strict water quality protection. Such waters may receive pollutant discharges by permit only and are subject to water quality considerations. They cannot constitute part of the treatment process. All minor permits in the Seacoast have recently been reissued.

EXPECTED BENEFITS

Upgrades of wastewater treatment plants found to be sources of suspended solids and nutrients will directly improve water quality, flora, and fauna in the zone of effluent impact. Removal of nutrients from the continuous waste stream will reduce the likelihood of internal recycling of nutrients within the estuary.

MONITORING AND ENFORCEMENT

Additional monitoring may be worked into the NPDES permits to verify the effectiveness of the upgrades.

TIMETABLE

Initiated by 2005. Opportunities to implement this High Priority action will be pursued in the next four years as funds and resources become available.

PRIORITY

High Priority. Implementation of this action is not dependent on implementation of other actions listed in the *NHEP Management Plan.*

PRIORITY

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ACTION WQ-2

Evaluate the suitability of UV alternatives to chlorine in wastewater post-treatment for Seacoast communities.

BACKGROUND

Chlorine is commonly used to disinfect wastewater before final discharge, but chlorine's general toxicity harms aquatic organisms, including shellfish larvae. Dechlorination agents are generally added after disinfection to convert the chlorine to the inert chloride. This further increases the chemical burden in the waste stream, and although less toxic than chlorine, chloride is generally undesirable. Since chemical dechlorination requires little or no infrastructure beyond the existing treatment plant, chemicals are essentially the only cost. The cost (defined as production cost - calculated on the basis of the amortized capital costs, plus the annual operation and maintenance costs, divided by the annual wastewater volume treated by the plant) of chlorination averages $0.02/1000 gallons, adding dechlorination averages $0.005/1000. A chlorine plus dechlorination facility for new plant construction averages $0.03/ 1000. The advantages of chlorine are its low cost and effectiveness on most wastewater, regardless of contents.

The only currently available and practical alternative to chlorine is UV(ultraviolet) disinfection. The waste stream is split into multiple shallow channels and exposed to modest levels of ultra-violet light for just a few seconds. For water that is clear, UV is highly effective, leaves no chemical residue, and effectively kills both bacteria and viruses. UV is also inexpensive, since it requires little space. Energy requirements are low compared to existing WWTF power usage. Long-term costs for UV disinfection are the same as for a retrofitted chlorine plus dechlorination system, $0.03/1000. Cost in new plant construction is slightly less, $0.025/1000. While a UV facility takes little space, urban plants with no expansion room may have difficulty adding a UV facility.

The principle disadvantage of UV disinfection is the process's sensitivity to turbidity, the cloudy condition of water with suspended sediments or foreign particles. Turbidity is measured differently from total suspended solids (TSS), and is not always well correlated with measures of suspended solids. There is no plant standard for turbidity, but allowable levels of total suspended solids (TSS) can easily produce turbidity that renders UV disinfection ineffective. Filtration may be required to ensure sufficient clarity. But filtration can have high operation and maintenance costs if, for example, effluent is turbid enough to cause clogging.

The Dover wastewater treatment facility constructed in 1992 has a conventional UV facility. The Environmental Research Group at UNH is studying, with NOAA-CICEET funding, an innovative UV technology called pulsed-UV. This will be piloted in Dover and Durham in 1999 and in 2000. Pulsed-UV holds promise for wastes that are more difficult to treat, e.g. CSOs (combined sewer overflows).

Table 1: Program Goals

MONITORING GOALS	MANAGEMENT GOALS
Water Quality ■ Determine the status and trends of the sanitary quality (bacteria and other disease-causing organisms) of shellfish-growing and recreational waters. ■ Determine the status and trends of eutrophic conditions in New Hampshire's coastal and estuarine waters. ■ Determine the status and trends of toxic contaminants in water, sediment, and biota of coastal New Hampshire.	**Water Quality** ■ Ensure NH's estuarine waters will meet standards for pathogenic bacteria. ■ Ensure NH's estuarine waters will meet standards for organic and inorganic nutrients ■ Ensure NH's estuarine waters, sediments and biota meet standards for toxic contaminants.
Shellfish ■ Determine the status and trends of shellfish populations in New Hampshire's coastal and estuarine waters.	**Shellfish** ■ Achieve sustainable shellfish resources by tripling the area of shellfish beds that are classified open for harvesting to 75% of all beds, and tripling the quantity of harvestable clams and oysters. ■ Assure shellfish are fit for human consumption and are support a healthy marine ecosystem ■ Provide opportunities and strategies for restoration of shellfish communities and habitat. ■ Support coordination to achieve environmentally sound shellfish aquaculture activities.
Land Use/Habitat Protection & Restoration ■ Determine the status and trends of land use, development, and habitat protection in the Seacoast region of New Hampshire. ■ Determine the status and trends of critical species and habitats in New Hampshire's coastal and estuarine watersheds.	**Land Use/Habitat Protection & Restoration** ■ NH coastal watershed has development patterns that ensure the protection of estuarine water quality and preserve the rural quality of Great Bay. ■ Maximize the acreage and health of tidal wetlands. ■ Protect freshwater and tidal shorelands to ensure estuarine water quality. ■ Protect estuarine water quality by ensuring that groundwater impacts are minimized. ■ Allow no net loss of freshwater wetland functions. ■ Maintain habitats of sufficient size and quality to support populations of naturally occurring plants, animals, and communities.

Table 2: Program Objectives

WATER QUALITY - Bacteria

Monitoring Objective	Management Objective	Action Plans
Objective A: To determine if concentrations of fecal borne microbial contaminants are increasing with time.	Minimize beach closures due to failure to meet water quality standards for tidal waters (Enterococci levels not exceeding 104 counts/100 ml. in any one sample)	WQ-3, 4A, 4B, 4C, 5, 6, 7, 8, 13, 14 SHL-2, 5
Objective B: To determine the effects of human-borne fecal microbial contaminants on surface water quality in coastal NH.	Increase water bodies in the NH coastal watershed designated 'swimmable' by achieving state water quality standards (E. coli levels not exceeding 406 counts/100 ml in any one sample. For designated beaches, E. coli should not exceed 88 counts/100 ml.)	
Objective C: To determine if the incidence and concentrations of microbial pathogens are changing with time.	Reduce the number of known illicit connections in the NH coastal watershed by 50% by 2010.	
Achieve water quality in Great Bay and Hampton Harbor that meets shellfish harvest standards (14 counts of fecal coliform/100 ml) by 2010.	Achieve 50% reduction of known illegal discharges into Great Bay, Hampton Harbor and the tributaries by 2010.	

WATER QUALITY - Toxic Contaminants

Monitoring Objective	Management Objective	Action Plans
Objective A: To determine if toxic contaminant concentrations in seafood species from NH coastal waters are increasing with time.	Develop baseline of toxic impacts on ecological and human health by tracking toxic contaminants in water, sediment, and indicator species: blue mussels (Gulfwatch); tomcod, lobsters and winter flounder (Coastal 2000).	WQ- 2, 4B, 6, 7, 11, 12A, 12B, 15
Objective B: To determine if concentrations of toxic contaminants in sediments, water, and biota are increasing with time.	Long-term: Reduce toxic contaminants levels in water, sediment and indicator species so that no levels persist or accumulate according to: ■ FDA guideline levels ■ State water standards in Ws 1700 ■ Sediment levels below ER-M levels	
Objective C: To determine if toxic contaminants are causing increasingly prevalent toxic effects in marine and estuarine biota.		

WATER QUALITY - Nutrients and Eutrophication

Monitoring Objective	Management Objective	Action Plans
Objective A: To determine whether concentrations of dissolved and particulate nutrients are increasing as seacoast region development and population increases. Objective B: To determine whether concentrations of phytoplankton, measured by chlorophyll a, in NH tidal waters change over time. Objective C: To determine whether concentrations of suspended particulates, measured by TSS and particulate organic matter, turbidity, and secchi depth, in NH tidal waters change over time. Objective D: To determine whether the concentration of dissolved oxygen and percent oxygen saturaton in NH tidal waters change over time. Objective E: To determine whether nuisance macroalgae increase in abundance and area in intertidal and shallow subtidal areas of the NH estuaries. Objective F: To determine whether eelgrass decreases in abundance, density and biomass, and area in intertidal and shallow subtidal areas of NH estuaries. Maintain inorganic nutrients, nitrogen, phosphorous and chlorophyll a in Great Bay, Hampton Harbor and their tributaries at 1998-2000 NERR baseline levels.	Maintain organic nutrients in Great Bay, Hampton Harbor and their tributaries at 1994-1996 NERR baseline levels. Maintain dissolved oxygen levels at: > 4 mg/L for tidal rivers > 6 mg/L for embayments (Great Bay and Little Bay) > 7 mg/L for oceanic areas (Hampton Harbor and Atlantic Coast) Maintain NPDES permit levels for BOD at wastewater facilities in the NH coastal watershed.	WQ-1, 5, 6, 7, 8, 9, 10, 11, 15

Illicit Connections
Sanitary sewer lines that are connected to stormwater drainage pipes, resulting in the discharge of untreated sewage to surface waters.

Impervious Surface
A surface such as asphalt, concrete pavement, or rooftops that cannot be easily penetrated by water.

Invasive Species
Especially competitive and prolific non-native, introduced species of plants or animals. Invasive species reduce the overall biodiversity of an ecosystem, and may cause complete displacement of native species.

Leach Field
A shallow sewage disposal area, often constructed of stone and pipe and covered with topsoil, designed for the final disposal of septic tank effluent in the underlying soil.

Macroalgae
Large, multicellular algae which often attach themselves to rocks or other substrates in the marine environment. Examples include kelp and rockweed.

Master Plan
A report or set of statements and land use and development proposals with accompanying maps, diagrams, charts, and descriptive matter designed to show as fully as is possible and practical a municipal planning board's recommendations for the desirable development of the territory legally and logically within its planning jurisdiction. The contents of a master plan are described in RSA 674:2.

National Estuary Program (NEP)
A state grant program within the U.S. Environmental Protection Agency established to designate estuaries of national significance and to assist local stakeholders in the preparation of a *Comprehensive Conservation and Management Plan* for the designated estuaries.

National Pollutant Discharge Elimination System (NPDES)
A requirement in the federal Clean Water Act for dischargers to obtain permits, which place limits on the levels of pollutants that may be discharged.

Natural Resources Outreach Coalition
A group of outreach and education specialists committed to helping local decision makers integrate the principles of natural resource-based planning into their planning processes. The Coalition develops a coordinated outreach effort tailored to the natural resource and growth issues and needs of each interested community, and provides access to more technical natural resource management and planning resources. Coalition members include: UNH Cooperative Extension, and Cooperative Extension/Sea Grant; New Hampshire Coastal Program; NH Fish and Game Department - Great Bay National Estuarine Research Reserve; NH Department of Environmental Services; Rockingham Planning Commission and Strafford Regional Planning Commission; Rockingham and Strafford County Conservation Districts; and the New Hampshire Estuaries Project.

Non-Point Source Pollution
Pollution that is generated over a relatively wide area and dispersed rather than discharged from a pipe. Common sources of non-point pollution include stormwater and agricultural runoff, and failed septic systems.

Nutrients

Essential chemicals needed by plants and animals for growth. Excessive amounts of nutrients – nitrogen, and phosphorus, for example – can lead to degradation of water quality and growth of excessive amounts of algae. Some nutrients can be toxic at high concentrations.

Paralytic Shellfish Poisoning (PSP)

A life-threatening syndrome caused by eating shellfish that are contaminated with toxins produced by certain kinds of microscopic algae. Symptoms include tingling, numbness, giddiness, drowsiness, fever, rash, staggering, and others. Not all cases are fatal, but the most severe cases result in respiratory arrest within 24 hours of consumption of the toxic shellfish. PSP is prevented by large-scale proactive monitoring programs to assess toxin levels in shellfish and rapid closure to harvest of suspect or demonstrated toxic areas.

Pathogen

Any organism, but particularly bacteria and viruses, that causes disease. For example, human pathogens in shellfish can cause hepatitis and intestinal disorders.

Performance Standards

Federal, state, or local codified specifications that condition development activities to limit the extent to which a structure or activity may affect the immediate environment.

Petroleum Hydrocarbons

The mixture of hydrocarbons normally found in petroleum; includes hundreds of chemical compounds.

Point Source Pollution

Pollution originating at a particular place, such as a sewage treatment plant, outfall, or other discharge pipe.

Polycyclic Aromatic Hydrocarbons (PAHs)

A class of complex organic compounds, some of which are persistent in the environment and cause cancer. PAHs are commonly formed by the combustion of petroleum products such as gasoline, and often reach waterbodies through atmospheric deposition or roadway runoff.

Polychlorinated Biphenyls (PCBs)

A series of hazardous compounds used for a number of industrial purposes. PCBs are toxic to some marine life in very low concentrations and are known to cause skin diseases and even death in humans at higher concentrations. PCBs do not decompose easily in the environment, and they can concentrate through the food chain as larger animals eat a number of smaller animals that are contaminated.

Primary Treatment

Physical processes used to substantially remove floating and separable solids in wastewater. This process can include screening, grit removal, and sedimentation.

Pumpout Facility

A fixed or mobile system or device used to remove sewage from holding tanks in boats.

Red Tide

A phenomenon where certain species of microscopic marine plants with reddish pigments grow very fast and "bloom" into dense, sometimes visible patches near the surface of water. The microscopic plants associated with red tides are often harmless to humans; however, a small number of species produce potent neurotoxins that can be harmful or fatal. A harmful red tide that often occurs off New England coastal waters causes Paralytic Shellfish Poisoning (PSP).