Buzzards Bay Comprehensive Conservation and Management Plan 2013 Update

November 26, 2013

Prepared by the Buzzards Bay National Estuary Program

Executive Office of Energy and Environmental Affairs

Massachusetts Office of Coastal Zone Management

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Acknowledgments

The 2013 update to the Buzzards Bay Comprehensive Conservation and Management Plan (CCMP) was built upon the original 1991 Buzzards Bay CCMP, which itself was the product of dozens of individuals, including Buzzards Bay NEP staff, state, and federal agency personnel, and numerous non-governmental contributors. In that regard, a special credit is needed for Bruce Rosinoff, the lead CCMP writer of the 1991 document (and later EPA project manager to the Buzzards Bay NEP until 2004), for designing a well organized and well thought out document that lasted two decades, and which became the template for the current document.

In the new Buzzards Bay CCMP, again many individuals contributed to the update and review of the document. Buzzards Bay NEP Executive Director Dr. Joe Costa was the lead writer and managing editor for the effort. Special thanks to Buzzards Bay NEP staff Tracy Warncke and Sarah Williams, who were the principal editorial reviewers. A special recognition is also needed for the members of the Buzzards Bay Steering Committee, past and present, who defined the overall approach of the 2013 document, and guiding revisions to the goals and objectives of the plan. These individuals include Bruce Carlisle (CZM), Mel Cote (EPA), Steve Halterman and Dave Delorenzo (DEP), Vandana Rao (EEA), Steve Smith and Bill Napolitano (SRPEDD), for the Buzzards Bay Coalition, Mark Rasmussen, Tom Gidwitz, John Ross, and John Bullard, and for the Buzzards Bay Action Committee Elizabeth Leidhold, Jeff Osuch, Jennifer McKay, and Dave Pichette. Other contributors of text to the new management plan include Sarah Williams and John Rockwell of the Buzzards Bay NEP, South Coastal Regional Coordinator David Janik of the Massachusetts Office of Coastal Zone Management, and Bernadette Taber of the USDA Natural Resources Conservation Service (and detailed to the Buzzards Bay NEP as our stormwater specialist). In 2006, with financial support from the Massachusetts Executive Office of Energy and Environmental Affairs, the Buzzards Bay National Estuary Program awarded a contract to the Horsley Witten Group, Inc. to update several key sections of the management plan. These updates included the overview chapter, and action plans for stormwater management, low impact development, smart growth, waterfront management, and managing water withdrawals. Throughout this document, we utilize information and graphics contained in DEP's *Buzzards Bay Watershed 2000 Water Quality Assessment* prepared by Katie O'Brien and Andrea Langhauser at DEP[1]. This report provides an excellent summary of the conditions and regulatory status of resources in the Buzzards Bay watershed, and was the foundation of Chapters 2 and 3, and several action plans.

Many others provided invaluable assistance in reviewing, revising, contributing text or data, or in preparing or updating action plans in the new Buzzards Bay CCMP. Massachusetts Coastal Zone Management staff provided invaluable support in developing and refining action plans. Key participants included CZM Director, Bruce Carlisle, and CZM staffers Jay Baker, Todd Callahan, Ann Donovan, Dennis Ducsik, Rebecca Haney, and Robin Lacey. Mark Rasmussen and Buzzards Bay Coalition staffers Korrin Petersen, Brendan Annett, and Tony Williams also provided valuable input, insight, and comments. The Buzzards Bay Action Committee provided an excellent forum to develop and discuss the new and revised action plans in the updated Buzzards Bay CCMP.

The Buzzards Bay NEP would not have been possible without the visionary development and passage of Section 320 of the Clean Water Act of which the late Senator Edward Kennedy and the late Congressman Gerry Studds were key architects and supporters, along with subsequent support by Congressmen Barney Frank, William Delahunt, and Senator John Kerry. Since the inception of the program, about $15 million of federal funds have been awarded to the Buzzards Bay NEP. These funds, together with cash and in-kind contributions from the state, Buzzards Bay Coalition, Buzzards Bay Action Committee, and municipalities have been the lifeblood for the sustained effort by municipalities and other partners, to protect and restore Buzzards Bay. All through this effort, EPA Project Officers Bruce Rosinoff, Mary Jo Feuerbach, and Ann Rodney were exceptional guides in the implementation of the program, and the update of the plan. They also helped direct millions of dollars in Section 319 and other EPA grants toward actions contained in the Buzzards Bay CCMP. This work was completed pursuant to EPA Cooperative AgreementsCE98164503 and CE96144201.

Finally, thanks to all scientists, planners, town, state, federal officials, and interested residents who, over the years, contributed many new ideas and novel approaches that have made the update of the management plan a success, and more importantly, took action to implement the original management plan.

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Cover photo credits: Naushon Island by Tony Williams; Ospreys by Robert "Grumpy" Conway.

[1] O'Brien, K., and A. Langhauser. 2003. Buzzards Bay 2000 Water Quality Assessment Report. Department of Environmental Protection Division of Watershed Management Report Number: 95-AC-2 DWM Control Number: 085.0 Massachusetts Department of Environmental Protection Division of Watershed Management. Worcester, Massachusetts. November 2003.

Foreword

Since our inception, the primary goal of the Buzzards Bay National Estuary Program (NEP) has been to “restore and maintain the chemical, physical, and biological integrity of the estuary” (Section 320[b] of the Clean Water Act, our authorizing legislation). In 1991, we completed our original Buzzards Bay Comprehensive Conservation and Management Plan (CCMP), a landmark document providing a blueprint for the forthcoming efforts to protect and restore the water quality and living resources of Buzzards Bay and its surrounding watershed. The CCMP introduced many new concepts to local planners including the need to establish watershed limits on the discharge of nitrogen from wastewater (including septic systems and other nitrogen sources), the importance of stormwater discharges to bathing beach and shellfish bed closures, and the recognition that the climate was changing.

The Buzzards Bay NEP has now updated the CCMP to reflect the progress achieved, new problems facing the bay and its surrounding watershed, and the ongoing unresolved problems that remain since the original plan was finalized. This updated Buzzards Bay CCMP includes existing, new, and revised goals that relate to 21 key issues facing the bay and watershed. In each of the 21 “Action Plans,” we identify management strategies for government, citizens groups, and the public to employ to meet the continuing challenges we face.

While the updated Buzzards Bay CCMP is not a regulatory document, it lays out a vision that we hope will continue to guide municipalities in their ongoing efforts to protect and restore the environment. It will also help state and federal agencies direct grants and technical assistance programs, and update policies and regulations, to benefit the bay and watershed for years to come.

Joseph E. Costa, PhD
Executive Director
Buzzards Bay National Estuary Program

Steering Committee Approval

Buzzards Bay
Comprehensive Conservation and Management Plan
2013 Update

The Buzzards Bay Project began in 1985 as an initiative to characterize and understand pollution threats to water quality and living resources in Buzzards Bay. Within a few years, the Buzzards Bay Project became part of the National Estuary Program (NEP). Under the guidance of a Management Committee, the program completed its Comprehensive Conservation and Management Plan (CCMP) for Buzzards Bay.

The citizens advisory committee to the project evolved into two separate non-profit organizations, the Buzzards Bay Coalition, and the Buzzards Bay Action Committee. These two organizations, together with other core agencies that participated in oversight of the program formed the Buzzards Bay National Estuary Program Steering Committee. The Steering Committee continues to provide oversight and guidance to the Buzzards Bay Program in its efforts to implement the recommendations in the CCMP document.

In the ensuing years, the Buzzards Bay NEP has had many successes and faced new challenges. Throughout this period, the original 1991 management plan proved to be accurate in assessing the problems of Buzzards Bay and had remarkable foresight in identifying solutions to those problems. Nonetheless, it was clear the management plan needed to be updated to address new information and the evolving regulatory framework of environmental management. Therefore, the Steering Committee directed the Buzzards Bay NEP staff to work with its partners to reevaluate the threats to the bay and watershed, and reexamine the potential solutions to these problems. The culmination of this effort is the *Buzzards Bay Comprehensive Conservation and Management Plan 2013 Update.*

It is our hope that this current document refocuses program activities and renews interest and enthusiasm for ongoing and future efforts to protect and restore Buzzards Bay and its surrounding watershed.

The *Buzzards Bay Comprehensive Conservation and Management Plan 2013 Update* was approved by the Steering Committee of the Buzzards Bay National Estuary Program on November 26, 2013.

Mel Cote, Manager
Ocean and Coastal Protection Unit
US Environmental Protection Agency, Region 1

Steve Smith, Director
Southeastern Regional Planning & Economic Development District

Bruce Carlisle, Director
Massachusetts Office of Coastal Zone Management

Brendan Mullaney, Chairperson
Elizabeth Leidhold, Executive. Director
Buzzards Bay Action Committee

David DeLorenzo, Deputy Director
Division of Municipal Services

Mark Rasmussen, President
The Buzzards Bay Coalition

Buzzards Bay Action Committee Resolution

***W**hereas the member municipalities of the Buzzards Bay Action Committee recognize the importance of good water quality and healthy living resources in Buzzards Bay and its surrounding watershed, and that these values are important to the residents of the Buzzards Bay watershed, and vital to the region's economic vitality,*

***W**hereas we recognize the serious threats to Buzzards Bay and its watershed from deteriorating water quality, habitat loss, declining natural resources, storms, sea level rise and future climate change, and the associated threats to public and environmental health, the local economy, and the quality of life,*

***W**hereas we further recognize that the drainage basin of Buzzards Bay crosses municipal boundaries; that the future of the Bay depends on the ability of neighboring communities to control the quality of their environment through regional communication and cooperation among municipal, state, and federal agencies responsible for managing the Bay and its watershed,*

***B**e it therefore resolved that the membership of the Buzzards Bay Action Committee unanimously agree to continue to support the voluntary, regional organization of local governments known as the Buzzards Bay Action Committee. The BBAC members agree to exchange information and ideas that will expedite the region's ability to implement sound environmental policies, regulations, and by-laws to protect and enhance our mutual resource of the Buzzards Bay and its watershed. We further agree to review and update our individual town by-laws and regulations so as to voluntarily:*

- reduce nitrogen pollution to sensitive embayments
- protect and enhance shellfish resources
- control stormwater runoff and promote low impact development
- improve land use management and promote smart growth
- manage on-site wastewater disposal systems
- manage impacts from boating, marinas and moorings
- protect and restore wetlands
- restore migratory fish passages
- protect bio-diversity and rare and endangered species habitat
- manage water withdrawals to protect wetlands, habitat, and water supplies
- manage invasive and nuisance species
- protect open space
- protect ponds and streams
- reduce beach debris, marine floatables, and litter
- manage coastal watersheets and the water front
- reduce toxic pollution
- prevent oil pollution
- plan for a shifting shoreline and coastal storms
- protect public health at swimming beaches
- monitor management actions, and the status and trends of water quality and living resources
- promote public education and participation in these activities
- encourage other organizations and agencies to take action in support of the goals and objectives of the CCMP.

These goals are contained in the Buzzards Bay Comprehensive Conservation and Management Plan 2013 Update.

Acushnet

Bourne

Dartmouth

Fairhaven

Falmouth

Gosnold

Marion

Mattapoisett

New Bedford

Rochester

Wareham

Westport

Approved by a vote of the BBAC this 21st day of November, 2013

Chapter 1. The Buzzards Bay NEP and CCMP: Then and Now

Program and Management Plan Origins

In 1985, the United States Congress appropriated funds for U.S. Environmental Protection Agency (EPA) to create programs to study and manage four nationally significant estuaries, including Buzzards Bay[2]. These programs were meant to emulate the approaches of the Chesapeake Bay Program that Congress had created in 1983. These four estuary studies would become the pilots for the National Estuary Program that would eventually be established by the Clean Water Act in 1987[3].

In 1985, the U.S. EPA and Commonwealth of Massachusetts entered into a Cooperative Agreement to create the Buzzards Bay Project. In 1987, after passage of the Clean Water Act, the Buzzards Bay Project applied for designation under the Clean Water Act, and in January 1988, the U.S. EPA formally designated the Buzzards Bay Project as a National Estuary Program. Today the Buzzards Bay NEP is one of 28 such programs in the United States.

The management structure created in 1985 for the Buzzards Bay Project included a Policy Committee composed of the state Environmental Secretary and U.S. EPA Regional Administrator who were jointly responsible for overseeing and implementing a federal cooperative agreement that supported the NEP. A Management Committee more directly oversaw the program. This committee was composed of state, federal, and local officials, citizen groups, and others. Subcommittees to the Management Committee included a Citizen Advisory Committee, a Technical Advisory Committee, and a Management Plan Advisory Committee.

Under this management structure, between 1985 and 1990, the Buzzards Bay Project funded characterizations and assessments of water quality and living resources. Based on those findings, the program identified management options to address the identified problems, and conducted financial assessments of these solutions. With feedback from the public, state, and local government, the Buzzards Bay Project drafted the Buzzards Bay Comprehensive Conservation and Management Plan (CCMP) in 1989, the first NEP to do so. Massachusetts Governor William Weld approved this Management Plan in September 1991, and in April 1992, the U.S. EPA approved it[4].

The Buzzards Bay CCMP was one of the country's first coastal watershed plans, and one of the first to focus so strongly on nonpoint source pollution and the cumulative impacts of development on water quality and living resources. Moreover, the plan did not focus exclusively on the quality or the long-term protection of Buzzards Bay waters—it also recognized that the protection of freshwater wetlands and inland habitat throughout the watershed (Figure 1) was vital and better land use decisions and improved management of development impacts were important parts of a holistic watershed protection strategy. The 1991 Buzzards Bay CCMP also included a Buzzards Bay Action Compact, signed by the member towns of the Buzzards Bay Advisory Committee (later calling itself the Buzzards Bay Action Committee), an NEP subcommittee composed of municipal officials, and letters of commitment from key federal and state agencies supporting the management plan goals.

The Buzzards Bay CCMP broke much new ground including an innovative coastal nitrogen management strategy that paved the way for the adoption of later TMDL strategies. It was also the first CCMP to address increased sea level rise from climate change. The Buzzards Bay CCMP was also innovative in its focus on support of local government. In fact, nearly three quar-

[2] In the Buzzards Bay Project's December 1985 newsletter, we wrote, "Congress also recognizes the unique value of Buzzards Bay and selected the bay as one of four estuaries in the country to be studied under a special $4 million appropriation in 1985." The original efforts to study and protect these four estuaries can be traced to a 1983 attempt to reauthorize the Federal Water Pollution Control Act (98th Congress S431, the Clean Water Act of 1983), which included funding amendments for studies of Buzzards Bay, Narragansett Bay, Puget Sound, and Long Island Sound. Although the legislation did not pass into law, the effort apparently led to appropriations for the four programs. In 1984 and 1985, additional attempts were made to formalize the designation of estuaries of national significance in various bills to reauthorize the Clean Water Act. It was not until 1987 that Congress finally passed the Clean Water Act (reauthorization of the Federal Pollution Control Act) and thus created the National Estuary Program, approving it over a presidential veto. By that time, Congress listed 10 estuaries, including Buzzards Bay, to be given priority for inclusion into the program. See additional details posted at buzzardsbay.org/bbnep-anniversary.htm.

[3] The National Estuary Program was established by Section 320 of the Clean Water Act of 1987. The 1987 Clean Water Act was an amended and reauthorized version of the Clean Water Act of 1977, which itself was an amended version of the Federal Water Pollution Control Act Amendments of 1972. The 1972 law and its subsequent revisions have become the basis of a large body of state and federal regulations to "...restore, and maintain the chemical, physical, and biological integrity" of the United States waters and bordering wetlands that are the basis of most recommendations in this CCMP. By controlling water pollution, the Clean Water Act attains and maintains a level of water quality that supports the "protection and propagation of fish, shellfish, and wildlife and for recreation in and on the United States' waters" (USC 33 Section 1251).

[4] Buzzards Bay Project. 1991. Buzzards Bay Comprehensive Conservation and Management Plan, 8/91 Final. Volume 1, EPA and EOEA (U.S. Environmental Protection Agency and Massachusetts Executive Office of Environmental Affairs). 246 pp.

Figure 1. Buzzards Bay watershed boundary (blue) adopted in the 2013 Buzzards Bay CCMP.

Watershed boundaries are somewhat changed from the 1991 Buzzards Bay CCMP (see discussion in Chapter 2).

ters of the 119 recommendations contained in the 1991 Buzzards Bay CCMP focused on local government action. This focus on local government was a reflection of Massachusetts' environmental regulatory framework, particularly the "home rule" laws, which empower municipal government, more than any other level of government, with the greatest authority to address the cumulative impacts of nonpoint source pollution and of growth.

Program Restructuring and New Focus

Well before the completion of the Buzzards Bay CCMP, a subcommittee of the Buzzards Bay Project Management Committee, called the Buzzards Bay Citizen Advisory Committee (CAC), originally formed to help identify management options to protect and restore Buzzards Bay, had separated into two new organizations. The first organization, established in 1987, called itself The Coalition for Buzzards Bay (in 2011 the group renamed itself the Buzzards Bay Coalition) and became a citizen based group dedicated to education and outreach (a 501(c)3). The second group became the Buzzards Bay Action Committee, (originally a 501(c)4 organization in 1989, then later became a 501(c)3 organization) and was composed of municipal officials. This second group became more involved with state, local, and federal legislative and regulatory issues, provided a forum for the exchange of ideas among municipal officials, and helped develop watershed wide consistent strategies among Buzzards Bay communities. Today both the Buzzards Bay Action Committee and the Buzzards Bay Coalition have adopted, as one of their major goals, the implementation of recommendations contained in the Buzzards Bay Comprehensive Conservation and Management Plan.

In the 1990s, the U.S. Congress made changes as to the focus of the NEPs. Although NEPs were originally conceived as temporary programs charged with developing management plans, Congress later recognized that these new programs could provide a valuable function in ensuring the implementation of the management plans they created. Because most of the CCMPs were non-regulatory consensus documents, during the mid-1990s Congress passed legislation authorizing NEPs to monitor and help implement their management recommendations after EPA approved their CCMPs. By the late 1990s, Congress authorized the funding of roughly $500,000 per NEP (together with an equivalent required non-federal match) to achieve these new goals.

During this period, the Buzzards Bay Project Management Committee also restructured the program's management oversight. The Policy Committee remained in place (composed of the EPA Regional Administrator and the Secretary of the Massachusetts Executive Office of Environmental Affairs), however, about 1993, with the completion of the Management Plan, the Management Committee replaced itself with a 5-member Steering Committee composed of those parties most interested in ensuring implementation of the Management Plan. These members were Massachusetts Office of Coastal Zone Management (CZM), the U.S. EPA, the Southeast Regional Planning and Economic Development District and the program's two nonprofit partners–the Buzzards Bay Action Committee and the Buzzards Bay Coalition. The Steering Committee abolished the other standing committees. In 2008, the Massachusetts Department of Environmental Protection (DEP) joined the Steering Committee.

With the completion of the Buzzards Bay CCMP, and new mandates and funding from Congress, during the 1990s the Buzzards Bay Project transformed itself into a technical assistance and implementation program dedicated to working with municipalities, non-profit organizations, and the public to implement the recommendations contained in the Buzzards Bay CCMP.

Because the Buzzards Bay watershed now had three groups with a focus on the protection and restoration of Buzzards Bay, to improve coordination among the three organizations, in 1995 the Buzzards Bay Project developed a Memorandum of Understanding with the Buzzards Bay Coalition and the Buzzards Bay Action Committee (page 313). This MOU helped clarify the interests and activities of each group to minimize duplication of effort. At this time, the Buzzards Bay Project even abandoned its public outreach program and newsletter and instead relied upon the outreach activities of the Coalition. This triad partnership among the three Buzzards Bay organizations was subsequently reflected in federal and state grants to each of the programs. The partnership has helped ensure that the program has remained one of the most successful of the NEPs.

About 2005, the Buzzards Bay Project renamed itself the Buzzards Bay National Estuary Program to minimize misidentification with other Buzzards Bay partner organizations and the recently formed Massachusetts Estuaries Project.

Update of the Management Plan

The original Buzzards Bay CCMP contained 119 recommended actions. Soon after the completion of the Buzzards Bay CCMP, seven actions were no longer relevant because of changes in law or other circumstances, and the Buzzards Bay NEP began tracking progress of the remaining 112 recommendations. By 2009, 61 of these remaining 112 Buzzards Bay CCMP recommendations were complete (Figure 2) with significant progress on many of the remaining recommendations. Some key indicators in Buzzards Bay, like reductions in shellfish bed closures, showed remarkable declines, despite new stressors to the environment. These stressors included a 20% increase in the watershed's population, together with the construction of thousands of new business and residential units, and the loss of thousands of acres of open space and natural landscapes.

Despite these successes, other indicators of water quality, particularly indicators of eutrophication, showed continued water quality declines in the embayments around Buzzards Bay with few exceptions. These changes, coupled with continued eelgrass bed loss, new shellfish bed closures, wetland declines, and failure to address persistent problems like bilge oil discharges from commercial vessels suggests a reevaluation of recommendations and strategies in the Buzzards Bay CCMP. New problems have also arisen, some never considered in the original Buzzards Bay CCMP.

Besides these new environmental issues and challenges, other changes in state and federal programs have refocused the priorities of the Buzzards Bay NEP. The most important of these new programs has been the promulgation of new federal rules requiring the treatment of stormwater from industrial and construction sites, and municipal stormwater networks under the Phase II NPDES stormwater program. In addition, in the early 2000s, the U.S. EPA also promulgated rules requiring the issuance of nitrogen and bacteria total maximum daily load (TMDL) limits for coastal watersheds. These programs are incorporating certain nonpoint sources of pollution, once considered beyond the control of state and federal regulators, into permit programs that increasingly require action by local government. These programs will have a profound effect on state and local government in the decades to come and are now the foundations of several action plans in this document.

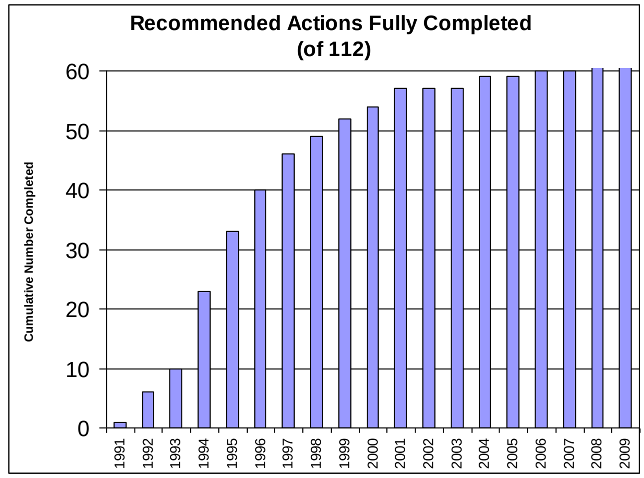


Figure 2. Numbers of recommendations completed in the 1991 Buzzards Bay CCMP.

Other changes occurred within state government in their effort to bring together diverse programs and prioritize actions, in a more holistic way, to address watershed scale problems. In the early 1990s, the Massachusetts Executive Office of Environmental Affairs along with community partners initiated the Massachusetts Watershed Initiative - an innovative, results-oriented program that protected and restored natural resources and ecosystems based upon a watershed perspective. The Massachusetts Watershed Initiative was a movement to a more inclusive, collaborative agenda-setting and decision-making process, making it possible for all parties to use their specialized knowledge or expertise to help influence local and regional policy making management decisions, and funding allocations. This watershed initiative established watershed teams composed of state and federal agencies, conservation organizations, businesses, municipal officials, and interested residents.

One of the goals of these watershed teams was to create 5-year Watershed Action Plans (WAPs). The purpose of these WAPs was to guide state and local environmental actions and funding over five-year periods to implement the goals of the Massachusetts Watershed Initiative and the recommendations in the WAPs. While there were strong parallels between NEP CCMPs and Watershed Action Plans, WAPs included goals and actions that were not included in the original CCMPs such as restoring natural flows to rivers, improving public access, balanced resource use, and protecting drinking water supplies. Thus, in some respects, the WAPs took a more holistic approach to watershed environmental management by focusing actions on public and private utilization of natural resources like water withdrawals, which have profound effects on terrestrial and aquatic resources within coastal watersheds.

The Watershed Initiative faced a special challenge in Buzzards Bay in that a watershed plan already existed (the Buzzards Bay CCMP), but this management plan did not contain all the elements of a Watershed Action Plan, and it was outdated. This lead to a consensus within the agency and CZM that a newly updated Buzzards Bay CCMP should also address many Watershed Initiative goals and objectives contained in other Watershed Action Plans around the state. Although the state Watershed Initiative is no longer a functioning program, state managers agree that guidelines for the development of WAPs remain relevant to the update of the Buzzards Bay CCMP, particularly because many state grant programs still prioritize funding to Watershed Action Plan recommendations.

In 2007, the governor and state legislature merged the Massachusetts Executive Office of Environmental Affairs with two energy cabinet secretariats to create a new Executive Office of Energy and Environmental Affairs. This action explicitly recognized the interrelationships between energy, environment, and climate issues, and the Commonwealth of Massachusetts was the first state to combine such divisions of government. With subsequent proposals to build wind farms in Buzzards Bay and elsewhere, this linkage of programs has become all the more relevant.

Finally, the Massachusetts legislature passed the Oceans Act, which was signed by Governor Patrick in 2008. The Oceans Act both modified the existing Massachusetts Ocean Sanctuary Act, and also required the Secretary of Energy and Environmental Affairs to develop a comprehensive plan to manage development in state waters that balances natural resource preservation with traditional and new uses, including renewable energy. The plan, based on scientific information and stakeholder input, was promulgated by December 31, 2009. Future activities in these ocean areas must be consistent with the Ocean Management Plan. The plan will be updated in 2014.

Most of Buzzards Bay is included in this new plan (Figure 3). However, where the Buzzards Bay CCMP recommendations are principally focused on actions in the watershed and nearshore areas, the Ocean Management Plan principally focuses on areas greater than a third of a mile from shore.

For all these reasons, it became clear that it was vital to reevaluate and renew the Buzzards Bay CCMP, and bring it into the 21st century. The updated management plan, it was agreed, needed to address previously unaddressed issues like managing water withdrawals, invasive and nuisance species, regional open space protection, and it needed to better integrate regional recreational and public access needs to ensure consistency with other Watershed Action Plans in Massachusetts.

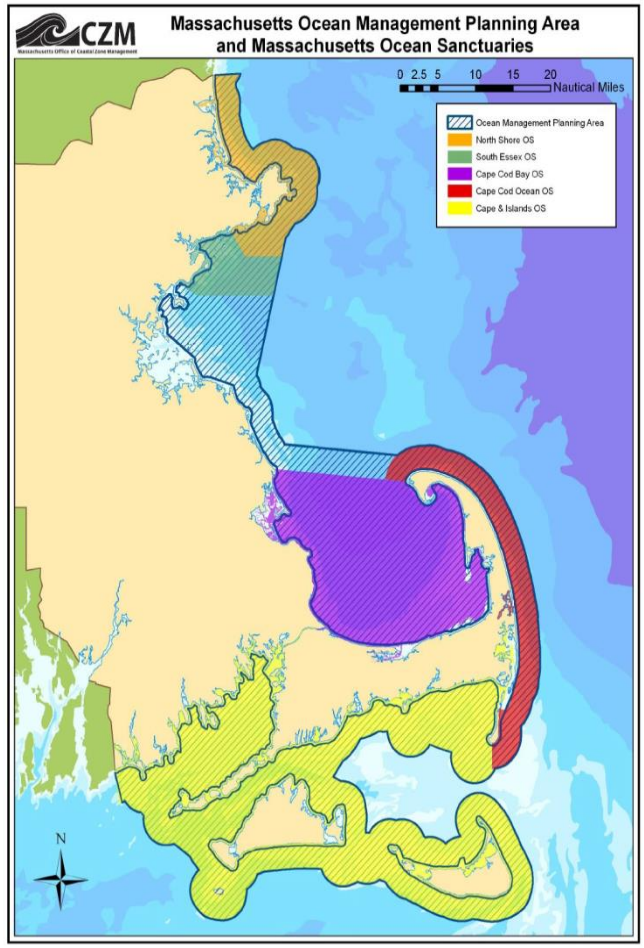


Figure 3. Massachusetts Ocean Management Planning Area and Massachusetts Ocean Sanctuaries.

Differences between the New and Old Plan

In most ways, the new Buzzards Bay CCMP is very much like the old Buzzards Bay CCMP, with a few exceptions. The most important change is the elimination of specific recommendations and an increased focus on goals, objectives, and the general processes for achieving those goals. This change was initiated by the NEP's experiences in that there is not a one-size-fits-all approach to environmental management. Each community must define the approaches and financial solutions that make the most sense to them. Thus, the new Buzzards Bay CCMP embraces goals to meet nitrogen TMDLs, but leaves the solution as to whether sewering, nitrogen removal septic systems, or some other set of combined approaches make the most sense. For programmatically tracking and goal setting, the Buzzards Bay NEP will instead rely on progress on annual workplans and possibly future 5-year watershed action plans.

Other ways that the new Buzzards Bay CCMP was changed was that new areas of concern were added (e.g. freshwater pollution, and litter in the environment), and certain other management actions were further parsed out. For example, low impact development, which deals principally with stormwater management, was treated separately from smart growth, which deals with policies and patterns of development. Similarly, the old Buzzards Bay CCMP chapters on land use management, implementing the Buzzards Bay CCMP, and the separate monitoring plan volume have all been converted to or incorporated into other action plans.

In contrast to these additions, the chapter titled Pollution Remediation Projects in New Bedford has been eliminated as a stand-alone chapter and pollution issues specific to New Bedford are interspersed among the background chapters and specific action plans. Thus, recommendations about combined sewer overflows are included in Action Plan 1 Managing Nitrogen Sensitive Embayments and Action Plan 3 Managing Stormwater Runoff and Promoting LID, and recommendations about the New Bedford PCB superfund cleanup are included in Action Plan 16 Reducing Toxic Pollution.

The original Buzzards Bay CCMP also had a separate financial plan volume. In the new Buzzards Bay CCMP, financial costs are interspersed in action plans, and the overall financial plan strategy is included in Chapter 5 Implementing the Buzzards Bay CCMP. The net result is that the new Buzzards Bay CCMP has 21 action plans as compared to 14 equivalent action plans in the original document.

Management Plan Principles

In the development of the Buzzards Bay Comprehensive Conservation and Management Plan 2013 Update, the Buzzards Bay NEP adopted two principles. First, like the 1991 Buzzards Bay CCMP, we developed a plan based on sound science and an excellent understanding of the regulatory framework with which environmental protection decisions are made. Upon this framework, diverse ideas were incorporated though collaborative efforts and outreach with state, federal, and local government, citizen groups, businesses, and the public of the Buzzards Bay watershed. The Buzzards Bay NEP long ago recognized that effective progress in plan implementation requires stakeholder involvement and partnerships.

Second, in each action plan we identified how implementation toward the goals and objectives could be tracked objectively. With the passage of government performance reporting laws, and the need to better track successes and failures, this new Buzzards Bay CCMP now includes many more recommended performance-tracking measures. These performance-monitoring measures can be found under the measuring success headings both in the action plan summary pages, and in the action plan discussions sections. Many of these measures will be incorporated into an online tracking system on the Buzzards Bay NEP's website. This tracking system includes data on environmental conditions and implementation activities, as well as management actions by government agencies and cumulative individual actions.

The Buzzards Bay Comprehensive Conservation and Management Plan 2013 Update lays out a variety of approaches for achieving the ultimate goal of a clean and healthy bay and surrounding watershed system of streams, ponds, wetlands, and groundwater. We wrote the plan for the benefit of the public, the people who live in the Buzzards Bay watershed, those who visit the region, and anyone who uses or benefits from the bay and its surrounding watershed.

At its core, this new Buzzards Bay CCMP remains a document based on the best available scientific and technical information and a rational analysis of the present and potential regulatory and non-regulatory actions that can protect and restore an entire bay and coastal watershed of a National Estuary. We hope that this 2013 update of the Buzzards Bay CCMP will form a blueprint for action throughout this decade.

Chapter 2. Buzzards Bay: Its Watershed, Living Resources, and Governance

Buzzards Bay Setting

Buzzards Bay is a moderately large estuary located between the western most part of Cape Cod, Southeastern Massachusetts, and the Elizabeth Islands (Figure 4). The bay is 28 miles long (45 kilometers), averages about 8 miles (13 kilometers) in width, and has a mean depth of 36 feet (11 meters). The Buzzards Bay NEP jurisdictional area of Buzzards Bay is approximately 250 square miles or 650 square kilometers in size[5]. The coastline stretches over 350 miles (563 kilometers)[6] and includes over 13 miles (21 kilometers) of public beaches that lure thousands of residents and tourists.

The Buzzards Bay watershed or drainage basin (defined also in this document as the NEP study area[7], Figure 4) covers 435 square miles (1209 square kilometers) and includes portions of 21 municipalities in two states, although 5 towns, including the two in Rhode Island, have relatively small areas (<14%) within the Buzzards Bay watershed. A complete list of all the communities and their area and population within the watershed are shown in Table 1.

The ratio of watershed land area to water surface is 1.9:1. This ratio is low compared to other National Estuary Program watersheds, and low compared to large east coast estuaries such as Chesapeake Bay and Delaware Bay, which have land-to-water ratios of 14.5:1 and 17.3:1 respectively. Approximately 250,000 people reside in the drainage basin at an average concentration of 572 per square mile, or 0.9 people per acre.

The bay itself is part of an interconnected hydrologic system that includes some rivers, but mostly a large network of small perennial streams totaling nearly 700 linear miles. Groundwater seepage accounts for a large part of the freshwater inflow to Buzzards Bay, particularly in Wareham, Bourne, and Falmouth that have large sandy soiled glacial outwash plains and till areas. Along its western shore (west of the Cape Cod Canal), the drainage basin is formed by seven major river basins and numerous smaller ones. The largest river basins include the Agawam, Wankinco, Weweantic, Mattapoisett, Acushnet, Paskamanset, and Westport. These rivers, including their tributaries, total roughly 100 miles[8].

As noted above, the eastern shore of Buzzards Bay (Cape Cod Canal to Woods Hole) is drained mostly by groundwater, but there are several small groundwater-fed streams. The most prominent of these freshwater streams along the eastern shore are the Back, Pocasset, Wild Harbor Rivers, and Herring Brook.

In general, rivers within the Buzzards Bay drainage basin are relatively slow-moving, meandering streams near their headwaters and for most of their freshwater length. Nearing the coast, particularly on the western shore, past glacial erosion of the bedrock created wide river valleys that are today submerged, creating a network of broad, elongated, fringing tidal estuaries. On average, Buzzards Bay rivers are considerably shorter, (only a few exceed 20 miles or 34 kilometers) and have smaller drainage areas than other rivers within the state.

Physical Features of the Bay

Geologic Formation

For millions of years, the shore and continental shelf of southern New England was periodically submerged and exposed by the ocean as the climate repeatedly warmed then cooled, and glaciers advanced and retreated across the northern hemisphere, causing sea levels to rise and fall. The foundation for the modern configuration of Buzzards Bay was formed by the last ice age.

During the last ice age, over many tens of thousands of years, great masses of glacial drift, chiefly boulders, gravel, sand, and clay were deposited at the leading edge of the Laurentide ice sheet. When the ice cap began receding 19,000 years ago[9], these moraines of unstratified glacial drift formed large hills on the eastern and south-

[5] Other agencies and publications define different boundaries for Buzzards Bay. The Buzzards Bay NEP jurisdictional area and the EPA approved No Discharge Area is a straight line drawn from the Rhode Island Border to Cuttyhunk Island. The boundary based on nautical chart and US Coast Guard definitions (a line drawn from Gooseberry Point to Cuttyhunk Island, and which excludes the Cape Cod Canal), is approximately 233 square miles. If all state waters to the south of the Buzzards Bay NEP line are included (as employed by the Division of Marine Fisheries), the area is roughly 280 sq. miles. See the municipal boundaries in Figure 4.

[6] This total is includes 310 miles of coast, including embayment coastlines, for the mainland portion and Cape Cod coast of Buzzards Bay, and 40 miles of coastline on the bay facing side of the Elizabeth Islands. This total does not include the 9 miles of coastline along the Cape Cod Canal within the NEP study area.

[7] The NEP study area, land watershed area, and bay boundary adopted in this Management Plan are quite similar to the original NEP study area used throughout the 1990s and early 2000s, and the Buzzards Bay boat waste No-Discharge Area adopted by the U.S. EPA in 2000. The watershed area changed mostly in the Cape Cod and Plymouth/Carver portions of the basin based on new groundwater models. An explanation of these changes can be found at: buzzardsbay.org/buzzards-bay-boundary.htm.

[8] Based on MassGIS "major stream" coverage, which includes key tributaries and small pond connections.

[9] The most rapid melting began about 15,000 years ago.

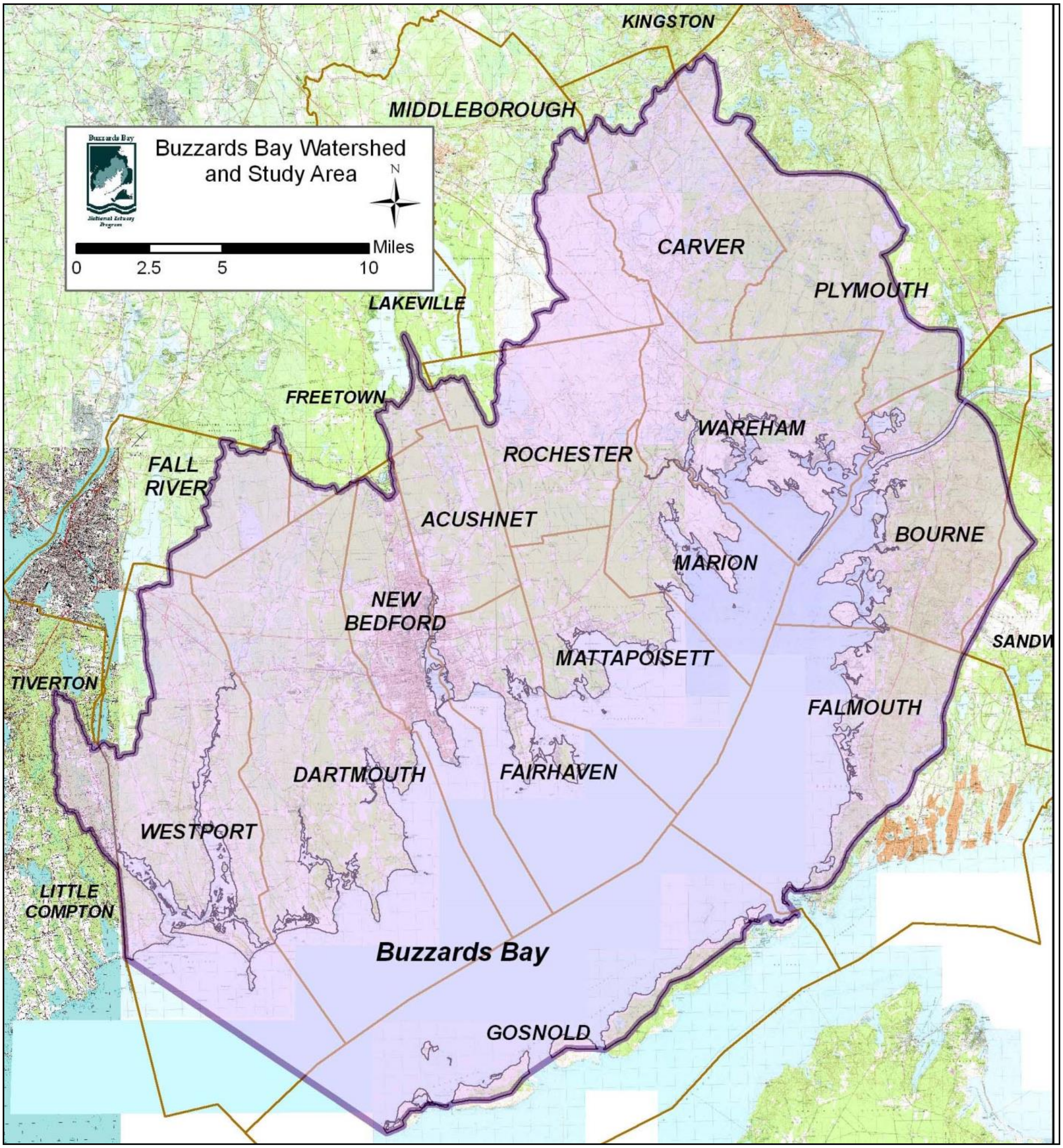


Figure 4. Buzzards Bay topographic map showing watershed (purple line) and municipal boundaries.

ern sides of a large valley, and formed what are Bourne, Falmouth, and the Elizabeth Islands today.

As the ice cap continued to recede across Canada, sea level rose hundreds of feet with the greatest increases occurring during the first 10,000 years of ice cap melting. Still, as late as 8,000-9,000 years ago, Buzzards Bay remained an upland valley (Shaw, 2006), with rivers flowing into the sea along the western side of the bay in various configurations that would later form the irregular coastline of the bay as the rising sea drowned these ancient river valleys.

Five thousand years ago, sea level was likely at least 21 feet lower in southern New England than today[10]

[10] Donnelly (1998) concluded (based on radiocarbon dating of buried salt marsh sediments) that 5,000 years ago, sea level was

Table 1. Summary of town areas and year-round population (U.S. 2010 Census) within the Buzzards Bay watershed.

Town	Total municipal area including coastal waters sq. mi (1)	Coastal Waters (sq. miles)	"Land" sq. miles (2)	Total municipal "Land" acres	% in the watershed	sq miles in watershed	US Census 2010 population	2010 population estimate in watershed (3)	% of 2010 population in the watershed
Acushnet	18.9	0.1	18.9	12,082	100.0%	18.88	10,303	10,303	100%
Bourne	57.3	16.2	41.1	26,293	83.2%	34.17	19,754	14,850	75%
Carver	39.8	0.0	39.7	25,422	84.3%	33.50	11,509	9,211	80%
Dartmouth	96.2	34.3	62.0	39,653	100.0%	61.95	34,032	34,030	100%
Fairhaven	40.9	28.5	12.4	7,942	100.0%	12.41	15,873	15,873	100%
Fall River	40.0	1.5	38.5	24,668	27.6%	10.65	88,857	506	1%
Falmouth	103.2	57.7	45.5	29,135	41.8%	19.05	31,531	9,700	31%
Freetown	36.4	0.9	35.5	22,699	13.7%	4.88	8,870	1,619	18%
Gosnold	135.0	121.6	13.4	8,604	52.3%	7.04	75	30	39%
Lakeville	36.1	0.0	36.1	23,116	0.6%	0.21	10,602	48	0%
Marion	28.0	13.9	14.1	9,036	100.0%	14.12	4,907	4,907	100%
Mattapoisett	42.3	24.8	17.5	11,196	100.0%	17.49	6,045	6,045	100%
Middleborough	72.2	0.0	72.2	46,209	23.5%	16.99	23,116	2,091	9%
New Bedford	33.4	13.1	20.3	12,979	96.1%	19.48	95,072	92,964	98%
Plymouth	176.7	74.1	102.6	65,683	43.6%	44.73	56,468	7,190	13%
Rochester	36.1	0.1	36.0	23,062	91.5%	32.96	5,232	4,709	90%
Sandwich	67.7	23.8	43.9	28,108	4.3%	1.88	20,675	0	0%
Wareham	46.4	9.2	37.1	23,772	100.0%	37.14	21,822	21,822	100%
Westport	89.8	37.7	52.1	33,351	85.3%	44.46	15,532	11,969	77%
Little Compton RI	NA	NA	22.6	14,469	1.2%	0.28	3,492	279	8%
Tiverton, RI	NA	NA	30.4	19,448	8.2%	2.49	15,780	1,855	12%
Watershed Totals			**811.1**	**519,086**	**53.7%**	**435.24**	499,547	249,999	50%

Notes: (1) data source = bondyp1.shp from MassGIS, (2) Includes ponds and fresh surface waters, (3) U.S. 2010 Census tiger files census blocks (391 of 8,950 total blocks in the watershed) were clipped to Buzzards Bay watershed and population and housing units were presumed proportional to clipped area in the watershed. This analysis was based on the Buzzards Bay study area in Figure 4. Similarly, within the watershed boundary there are 116,204 housing units (both year round and seasonal/vacant).

(Donnelly, 1998; Engelhart et al., 2011), and the northern end of Buzzards Bay would have defined by a shoreline extending from Sippican Neck in Marion, to Scraggy Neck in Bourne.

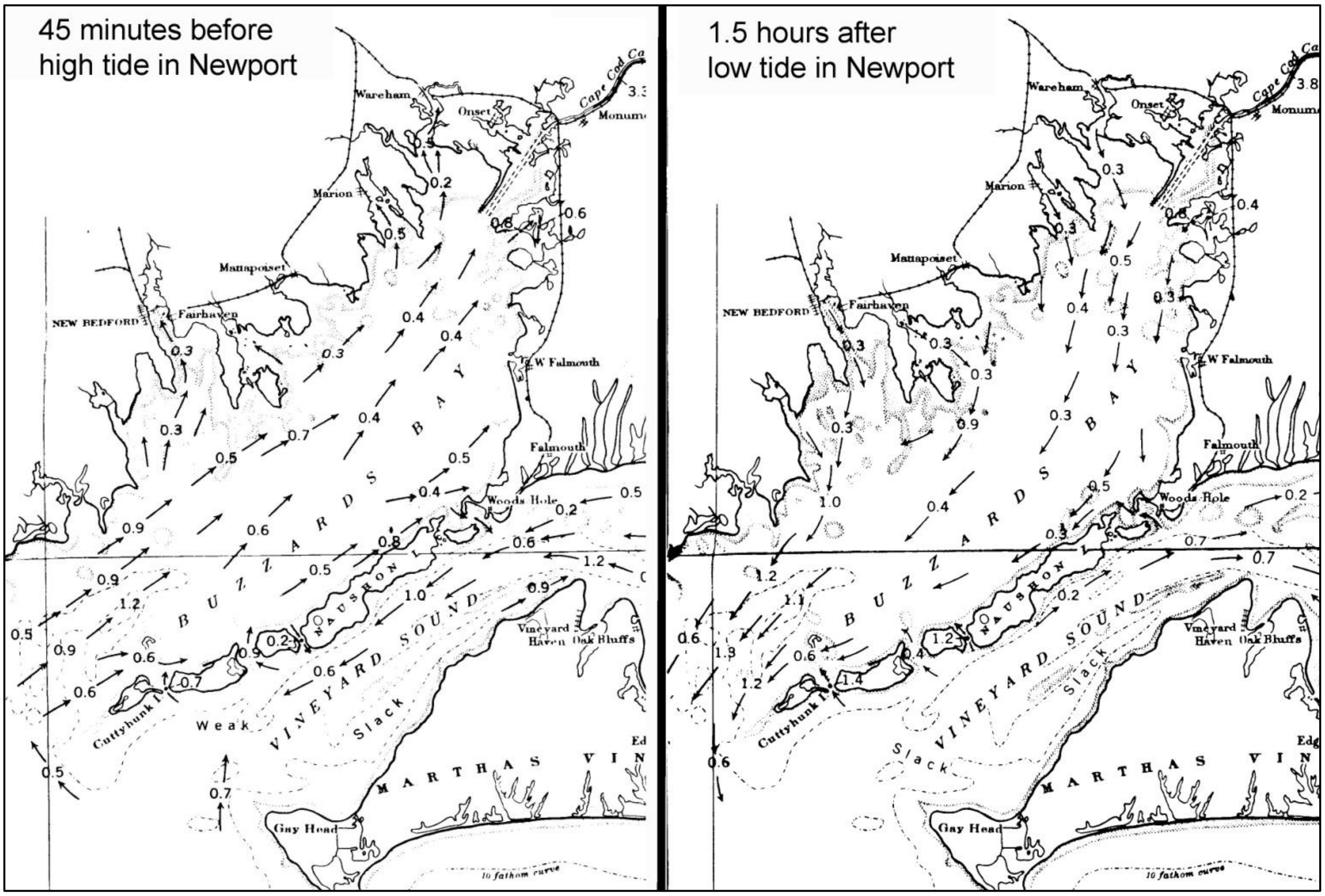
The rate of sea level rise subsequently slowed appreciably. Engelhart et al. (2011) estimated an average rate a bit over 5 inches per century during the last 4,000 years. During the past 3,300 years, sea level rose in a Revere, MA marsh 8.5 feet, or an average of 3 inches per century (Donnelly, 2006), with a higher rate in southern New England[11]. All during this period, sea level rose, and bluffs were eroded by waves and storms, many of the bays and inlets that formed became sheltered from the ocean through the formation of barrier spits and islands.

Salinity, Temperature, and Hydrology

The hydrology of Buzzards Bay and its embayments is driven by winds, tidal circulation, freshwater flow, salinity stratification, and temperature. Tidal currents and wind are the dominant circulation forces in Buzzards Bay because the Elizabeth Islands protect the bay from large, long period, open-ocean waves. Tidal exchange

about 39 feet lower in southern New England (=9.4 inches per century increase for the entire period), and 13 feet lower around Boston (=3.1 inches per century average). However, Engelhart et al. (2011) estimated a rate of only 5 inches per century during the last 4,000 years in the area New York. Extrapolating this rate for 5,000 years suggests that sea level was at least 21 feet lower.

[11] The sea level rise around Boston is slower than southern New England (Donelly, 1998; Engelhart et al., 2011). In addition, the rate was variable even during brief periods. For example, during the cold period known as the Little Ice Age (1300-1850), sea level rise in southern New England was less than 3 inches per century and higher in the preceding period (Donnelly et al., 2004).



Modified from Eldridge Tide and Pilot Book 1985. Robert Eldridge White, Publisher, and derived from a NOAA tidal currents chart.

Figure 5. Tidal currents in Buzzards Bay.

and currents flow back and forth between the southern entrance of the bay and Rhode Island Sound, through "holes" in the Elizabeth Island chain and Vineyard Sound, and to and from Massachusetts Bay through the Cape Cod Canal (Figure 5). Complete tidal mixing of bay water with ocean water is estimated to occur every 10 days (Signell, 1987).

Water temperatures in the bay, are on average, typically warmest from mid-July to mid-August (72º F or 22º C in Woods Hole), and coldest in January (34º F or 1º C)[12]. Temperatures nearshore and within embayments heat up more in the summer (Figure 6), and cool more in the winter, and thus exhibit more extreme ranges and fluctuations.

Like most of southern New England, Buzzards Bay shows dramatic differences between summer and winter water temperatures. During colder winters, embayments and large portions of the outer bay can freeze, usually with ice banking for a mile or more on the eastern and

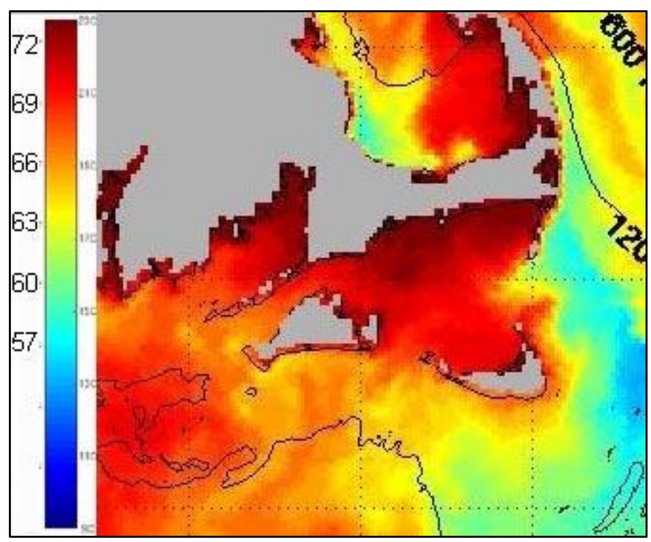


Figure 6. Satellite image showing estimated water temperatures in Buzzards Bay and around Cape Cod, June 2013.

NOAA-18 satellite, July 05, 2013, 4 AM local time, modified from marine.rutgers.edu/cool/sat_data/.

[12] Long-term averages as reported by NOAA at www.nodc.noaa.gov/dsdt/cwtg/all_meanT.html, last accessed October 1, 2013. For comparison, the average August maximum water temperature for the WHOI temperature data set from 1898-2006, is 73.2º, or 22.9º C (calculated by the BBNEP).

Photo by Joe Costa.

Figure 7. Ice on Buzzards Bay.

Photo taken January 1985 at Stony Beach in Woods Hole, looking southwest to Dartmouth.

northern shores (Figure 7). During the spring and summer, solar warming keeps surface waters warmer than the deeper waters. Temperatures in embayments can become quite warm, and in the daytime commonly exceeding 75º F (24º C) during heat waves in July and August. During the summer, Buzzards Bay is somewhat stratified, mostly due to changes in water density from temperature differences. In the central bay, water temperature gradually decreases with depth until a point where the temperature drops more abruptly. Below that point, known as the thermocline, the temperature resumes a gradual drop until the coldest depths are reached at the bottom.

Salinity within central Buzzards Bay has a small annual range, and is typically between 30.5 and 31.5 ppt (PSU values are approximately equivalent). It is lowest at the north end of the bay (it can drop to 28 ppt in northern Buzzards Bay in the spring during the period of greatest river flow[13]). Because of the relatively small watershed land area in relation to water area (few large streams bringing fresh water into the bay) and good tidal flushing, salinity in the south and central bay is nearly the same as that of the adjoining Rhode Island and Vineyard Sounds. In the semi-enclosed embayments alongshore, salinity can be more variable and is typically lower at the heads of the bays and during periods of greatest stream and groundwater discharge (winter and spring). Salinity is generally highest in late summer because of reduced freshwater inputs.

The thermocline and salinity stratification can act as a barrier to vertical mixing within deeper estuaries and the bay as a whole. Under certain weather conditions, when winds are calm and freshwater inputs are high, stratification can lead to brief hypoxic or anoxic conditions at night in some estuaries, resulting in fish kills. However, in general, wind-caused water turbulence, surface wave mixing, and turbulent tidal flow prevent strong stratification. A more thorough discussion of salinity, temperature, and tidal circulation in Buzzards Bay can be found in Howes and Goehringer (1996).

Land Use within the Bay

Much of Buzzards Bay remains undeveloped, with nearly 58% of the land classified as forest (Figure 8 and Table 3, from 2005 MassGIS data). A large portion of

[13] This is the result of freshwater discharges from the Weweantic, Wankinco, and Agawam rivers and the lesser flushing in the upper bay.

this undeveloped land is wetlands (Table 4), including notable forested wetlands like the Haskell Swamp of Mattapoisett and Rochester and Deerfield Swamp of Dartmouth. Strictly speaking, estimates of undeveloped lands from the MassGIS forest categories represent an overestimate of undeveloped land for several reasons. First, the MassGIS land use aerial surveys were conducted during a "leaf on" period, hence the low-density development areas with dense tree cover may be underestimated somewhat, and the forest overestimated. Second, some portions of the watershed have 1 to 3 acre zoning, and where homes are located close to roads, the back portions of these developed lots would be lumped into the forest category. Finally, since the 2005 survey, hundreds of acres of land have been developed.

Despite these caveats, most buildout studies of Buzzards Bay communities suggest there are large amounts of undeveloped land with development potential. This fact highlights the importance of wise land-use planning, and the need for protection of sensitive open space areas to protect Buzzards Bay.

Figure 8 shows that the greatest density development is found in the greater New Bedford area (New Bedford, Dartmouth, Fairhaven, and Acushnet) where nearly half the watershed population lives. Dense development is also found in Wareham, Buzzards Bay village in Bourne, and other areas around the bay.

Within specific embayment drainage basins, there is considerable variation in land use. In the Buttermilk Bay drainage basin, 70% of the land is forested and 16% is developed, whereas in the Apponagansett Bay drainage basin, 37% is forested and over 31% is developed.

Cranberry bogs are widespread in the northern portion of the Buzzards Bay watershed, particularly in Wareham, Carver, Rochester, and Middleborough. Other agricultural land, particular dairy farms, and crops like corn are found in Westport and Dartmouth.

Much of the forested land is away from the coast, and most of the residential land is near the coast. When land use within a half mile of the coast is examined, only 36% is forested, and more than 34% is in the residential/industrial/commercial categories. The concentration of development nearshore is also evident in U.S. Census statistics. In Buzzards Bay coastal towns, 22% to 81% of the population lives within 1/2 mile of shore, and for the entire watershed, 41% of the population lives within a half mile of the bay (Table 2).

Table 2. Percent of Buzzards Bay watershed municipal population living within 1/2 mile of Buzzards Bay.

Town	population within 1/2 mile of Buzzards Bay	% of population 1/2 mile of Buzzards Bay
Acushnet	2,326	22%
Bourne	9,569	66%
Carver	0	0%
Dartmouth	6,970	22%
Fairhaven	12,552	77%
Falmouth	5,613	62%
Freetown	0	0%
Gosnold	66	77%
Lakeville	0	0%
Marion	4,295	81%
Mattapoisett	4,007	62%
Middleborough	0	0%
New Bedford	40,001	44%
Plymouth	937	8%
Rochester	0	0%
Wareham	14,715	69%
Westport	2,826	24%

Analysis by Buzzards Bay NEP based on 2000 U.S. Census statistics and MassGIS files. The Falmouth, Bourne, and Plymouth statistics are shown only for those areas of the town within the Buzzards Bay watershed.

Habitats of the Bay

Buzzards Bay is a special coastal region in the Commonwealth. The jagged border of Buzzards Bay bound by the glacial deposits that form the Elizabeth Islands creates many diverse environments around the bay. The coastal zone of Buzzards Bay is characterized by a variety of important habitats including salt marshes, tidal streams, eelgrass beds, tidal flats, barrier beaches, rocky shores, and a number of subtidal habitats. Buzzards Bay is within the Virginian Biological Province, which means that the species in Buzzards Bay are typical of those found along the east coast between Chesapeake Bay and Cape Cod. The Cape Cod Canal, however, forms a direct tie to the cold-water species found north of Cape Cod. For these reasons, a unique mix of semi-tropical and Arcadian species can be found in Buzzards Bay during different times of year. Giblin and Foreman (1990/2013) provide a good summary of the different habitat types found in Buzzards Bay.

Salt Marshes and Tidal Streams

Salt marshes are among the most productive ecosystems in the world even exceeding most types of agricultural land. For a long time salt marshes and tidal areas were considered unproductive land to be filled. Today they are among the most highly protected wetland types in Massachusetts and enjoy stringent protections. They are recognized as an important resource that provides wildlife habitat, produces large quantities of plant and animal biomass, exports food to nearby coastal food webs, protects the coastal zone from floods, and absorbs some water-borne contaminants. Salt marshes add great-

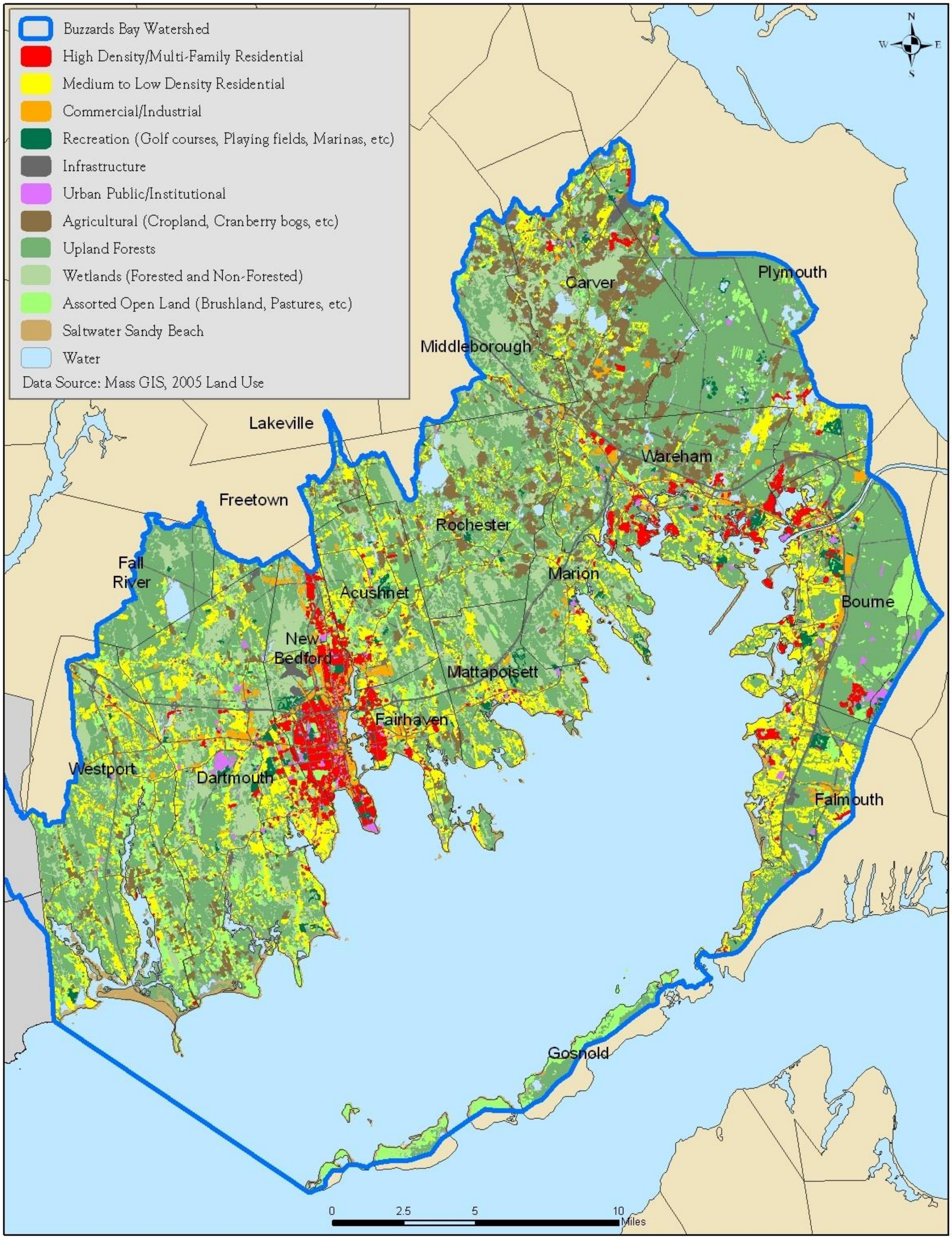


Figure 8. Land use in the Buzzards Bay watershed based on 2005 interpretation by MassGIS.
Comparable land use for the watershed area in Rhode Island is not available.

Table 3. Summary of land use in the Buzzards Bay watershed, summarized by municipality.

Land use description / Acres	Acushnet	Bourne	Carver	Dartmouth	Fairhaven	Fall River	Falmouth	Freetown	Gosnold	Marion	Mattapoisett	Middlebor-ough	New Bedford	Plymouth	Rochester	Wareham	Westport	Grand Total
Brush land/Successional	30	68	36	494	72	2	58	12	1,749	6	19	10	86	23	31	60	285	3,078
Cemetery	25	117	15	67	32		2	3		16	14	5	260		10	41	30	635
Commercial	70	349	75	603	256	1	62	29		55	83	20	738	24	67	343	226	3,000
Cranberry bog LU category area	236	198	5,358	156			48	256		258	92	1,398	16	1,136	2,107	2,571		13,829
Cranberry bog production area	68	147	3,323	57			24	130		164	67	861	13	623	1,212	1,701		8,290
Cropland	237	11	50	918	381	4	11	31	2	35	114	19	8	0	576	9	1,153	3,558
Forest	5,644	13,608	8,093	17,863	2,266	5,089	7,470	1,604	1,480	4,239	5,812	5,155	2,191	17,729	9,681	11,318	14,198	134,447
Forested Wetland	1,532	116	1,946	6,072	671	894	113	450	88	1,610	2,083	2,759	1,701	165	3,698	762	3,241	27,917
Golf Course	125	170	14	359			96			120	193		108	152	56	114	47	1,574
High Density Residential	170	439	231	697	583		317			43	44		2,081	285		1,221	57	6,167
Industrial	54	90	90	154	134		77	8		42	44	32	818	14	22	248	52	1,879
Junkyard	17	7	25	40			7			4		4	14		12	32	39	201
Low Density Residential	1,153	1,146	1,000	2,842	244	103	1,205	267	17	478	729	319	84	411	830	1,059	2,405	14,298
Marina		17		7	20		7		1	4	4		14			12	3	89
Medium Density Residential	528	1,082	403	1,717	1,127	14	1,227	34	19	528	581		296	423	0	1,007	574	9,561
Mining	158	190	74	36			151			31	10		8		13	21	19	711
Multi-Family Residential	116	368	44	313	204	1	73			29	70	24	1,701	4	24	200	11	3,187
Non-Forested Wetland	384	193	1,487	559	196	22	175	111	115	229	130	548	260	331	899	797	321	6,757
Nursery	177			115	41		28	3		1	5	1	10		32	11	40	463
Open Land	187	1,215	127	963	103	15	116	66	221	69	119	84	202	539	157	256	642	5,525
Orchard	8			99										2		2	151	262
Participation Recreation	43	205	63	199	95	7	55	2		58	40	8	232	123	58	100	50	1,356
Pasture	499	69	54	1,409	252	27	30	51	124	103	85	83	7	44	589	92	1,510	5,026
Power line/Utility	115	365	157	144	20	41	147	17		30	43	80	23	406	144	175	16	1,958
Saltwater Sandy Beach	3	418		535	281		378		465	179	213		89	0		347	1,149	4,057
Saltwater Wetland	29	359		1,145	608		246		26	419	257		4	1		892	987	4,971
Spectator Recreation			1															1
Transitional	26	158	193	216	28		116	10	1	2	7	54	62	41	102	53	83	1,153
Transportation		311	115	159	141		161			85	126	118	648	318	22	456	155	2,828
Urban Public/Institutional	49	277	65	505	104		125	3	5	84	52	4	557	49	54	135	68	2,292
Very Low Density Residential	277	204	273	791	121	6	413	116	20	281	230	172	19	144	695	343	971	5,082
Waste Disposal		8		99	9		76	0					87		37	25	35	376
Water-Based Recreation	3	14	1	6	2		4	1			9		7	3		23	5	77
Sub-Total (land only)	11,892	21,772	19,989	39,279	7,990	6,225	12,992	3,072	4,332	9,037	11,207	10,897	12,328	22,367	19,915	22,722	28,521	266,314
Water (fresh and some marine)	222	803	1,261	1,524	352	578	770	29	277	136	129	129	712	1,689	1,213	2,154	3,169	15,145
OFFSHORE WATERS		6,630		20,755	17,820		22,498		36,876	8,736	15,714		7,811			4,789	10,650	152,279
Grand Total	12,114	29,204	21,250	61,559	26,163	6,803	36,260	3,101	41,485	17,909	27,049	11,025	20,851	24,056	21,128	29,665	42,340	433,737

Based on Mass GIS 2005 land use data, and only within the Buzzards Bay NEP 2010 watershed boundary. Analysis does not include land use analysis for Rhode Island. Not shown, but included in column totals, are lands in Lakeville (135 acres), and Sandwich (1,641 acres). Cranberry bog note (a): top acreage is the land use category and includes berms, farm roads, sand storage, etc.; bottom is the bog production acreage (from a DEP GIS coverage, updated by the Buzzards Bay NEP).

Table 4. Summary of types of wetland resource areas within the watershed summarized by municipality

Wetland Resource Area Description	**Acushnet**	**Bourne**	**Carver**	**Dartmouth**	**Fairhaven**	**Fall River**	**Falmouth**	**Freetown**	**Lakeville**	**Marion**	**Mattapoisett**	**Middleborough**	**New Bedford**	**Plymouth**	**Rochester**	**Wareham**	**Westport**	**Grand Total**
Barrier Beach System		49		65	94		28			47	86					36	455	860
Barrier Beach-Coastal Beach		20		81	8		53									9	121	292
Barrier Beach-Coastal Dune		9		94	12		77									9	200	401
Barrier Beach-Deep Marsh																	2	2
Barrier Beach-Marsh		2					2										12	15
Barrier Beach-Salt Marsh																	0	0
Barrier Beach-Shrub Swamp							2										5	7
Barrier Beach-Wooded Swamp Deciduous																	2	2
Bog		10	129	4			1	0				44	26	37	1	21		274
Coastal Bank Bluff Or Sea Cliff	0	73		20	7		16			10	7		25	0		44	14	217
Coastal Beach	2	123		100	64		94			71	56		36			148	43	739
Coastal Dune		88		37	30		35			6	18		5			90	19	327
Cranberry Bog	66	134	2,954	57			24	131		163	66	750	13	561	1,080	1,591		7,592
Deep Marsh	139	42	415	70	5	9	20	44		34	3	211	8	141	218	296	7	1,661
Rocky Intertidal Shore		21		45	31		36			21	29		14			9	47	254
Salt Marsh	29	360		1,144	607		246			419	402		4	1		886	987	5,084
Shallow Marsh Meadow Or Fen	134	29	252	243	140	3	58	16		77	32	36	144	54	209	186	212	1,824
Shrub Swamp	111	109	676	242	51	10	92	49		119	95	269	82	95	469	294	83	2,845
Tidal Flat	1	39		93	34		43			26	20		1			2	249	508
Wooded Swamp Coniferous	17	6	342	211	1	83	19	17		31	131	67	265	54	264	65	15	1,589
Wooded Swamp Deciduous	1,060	86	692	4,385	570	335	81	227		1,029	1,189	1,080	773	39	2,147	435	3,052	17,180
Wooded Swamp Mixed Trees	637	18	897	1,478	100	475	13	205	16	551	729	1,602	662	71	1,311	261	171	9,197
Grand Total	2,195	1,217	6,356	8,371	1,755	914	938	691	16	2,604	2,863	4,060	2,058	1,053	5,700	4,383	5,697	50,871

Table is based on Mass GIS 2007 wetlands conservancy program data. Includes only the Buzzards Bay watershed portions of the town, and excludes open water types (salt and fresh). Cranberry bog acreage in the wetland conservancy maps may include berms, and is somewhat older than the data set used in Table 3 for the production area.

Photo by Joe Costa.

Figure 9. Spartina salt marshes are an important habitat and nursery around Buzzards Bay.

ly to the aesthetic diversity of the coastal landscape, providing a source of recreational enjoyment through fishing, shellfishing, water fowling, and nature appreciation in all seasons.

Salt marshes typically are located in intertidal areas behind barrier beaches, bordering quiet water, or along the banks of tidal rivers (a typical Buzzards Bay marsh is shown in Figure 9). Significant salt marsh areas are located in Dartmouth, Wareham, Westport, and Fairhaven (see Figure 8).

Salt marshes have been well protected in Massachusetts under state and local laws for decades, and the acreage of salt marsh in Buzzards Bay has been relatively constant. The MassGIS land use analyses, where the methodology has been relative consistent, show that between 1971 and 2005, there has been negligible change in marsh area (1971: 4,950 acres; 1985: 4,945 acres, 1999: 4,941 acres; 2005: 4,971 acres). Hankin et al. (1985), using somewhat simpler methods, estimated that in 1984 there were 5,000 acres of salt marshes in Buzzards Bay. Using DEP's 2007 wetland conservancy program data, which uses a somewhat different methodology and larger scale mapping than the land use studies, there are 5,084 acres of salt marsh in Buzzards Bay (Table 4)[14].

"High marshes" are the areas of salt marshes inundated only during spring tides and characterized by the presence of the grass *Spartina patens*. "Low marshes" are the areas submerged by tides daily and characterized by the grass *Spartina alterniflora*. The high marsh is dominated by salt-tolerant plants and terrestrial species of animals. Many shorebirds nest in the high marsh. Estuarine and marine invertebrates and fish are often abundant in low marshes and associated tidal creeks.

Water draining from marshes enters coastal waters via streams or groundwater. Because dense layers of peat under marshes impede groundwater flow, groundwater transported from uplands may break out at the surface in springs or travel under the marsh's peat. The specific pathway of transport of waterborne contaminants such as coliforms and nitrogen through and around marshes has management implications because of potential human health risks and rates of attenuation differ depending on whether land drainage passes over or under a marsh.

Ditching of salt marshes has been a common practice since the 1930s as a method of mosquito control. The objective of ditching is to drain pools of water ("pans") in salt marshes as well as to provide fish access to these pools to feed on mosquito larvae. Today, new ditches are not commonly dug but old ditches continue to be maintained. The practice has come under increased scrutiny, and some scientists feel that valuable feeding habitat for shore birds and waterfowl may be lost by ditching efforts. Some open-marsh management programs are developing better ditching patterns to allow enhanced access by fish. The only alternative to ditching for mosquito control is limited pesticide use.

Eelgrass

Beds of subtidal eelgrass (*Zostera marina*), like salt marshes, are important food production and nursery areas. This perennial plant is found in waters of varying salinity, growing in sand or mud (typical shallow bed shown in Figure 10), in depths ranging from just under low-tide level to 20 feet below sea level in places where sunlight penetrates to the ocean floor and current or wave action is not too severe. Eelgrass flourishes in salt ponds, bays, and at the mouths of estuaries and tidal creeks.

Eelgrass beds are important because they serve as a substrate for other plant and animal life, are consumed directly as food by grazing animals, offer protection and

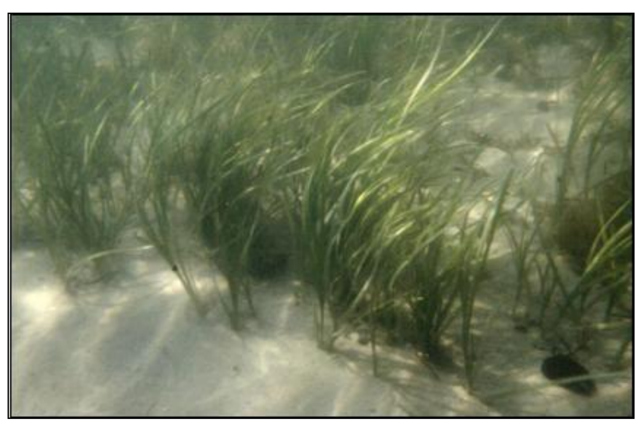


Photo by Joe Costa.

Figure 10. Photograph of a healthy eelgrass bed in a shallow sandy habitat in the Elizabeth Islands.

[14] The 2005 data includes many small and fringing marsh areas that were likely omitted from the 1984 estimate, hence the apparent small increase in marsh area 20 years later.

security to other marine animals, cycle nutrients in subtidal coastal waters, and provide a habitat for marine animals such as winter flounder. Eelgrass provides a critical nursery area for bay scallops, which often survive their first month of life by attaching themselves to eelgrass stems.

Based on sediment cores, historical records, anecdotal information, and observations in pristine areas in the Elizabeth Islands, Costa (1988) speculated that in predevelopment times, eelgrass likely colonized most shallow areas with salinities above 10 ppt in Buzzards Bay (Figure 11). During the early 1930s, most eelgrass disappeared in Buzzards Bay (and elsewhere in the Atlantic) because of a "wasting disease." Scientists do not fully understand the causes and timing of this event, but eelgrass subsequently recovered throughout most of the bay. Some initially recovering beds were likely to have been destroyed during the hurricane of 1938. Between the 1960s and 1980s, eelgrass appeared to have recovered in most parts of the bay, but between the 1980s and 2000s, new declines were occurring. These new declines, and the apparent lack of recovery after the wasting diseases in some parts of the bay, appeared to be the result of human disturbance and pollution.

The new losses in particular appeared to be related to the addition of nitrogen to coastal waters. (These eutrophication-related losses are described further in Action Plan 1 Managing Nitrogen Sensitive Embayments). These new losses are a serious management concern because, unlike areas affected by natural disasters, these areas will never recover until nitrogen inputs and other disturbances are reduced. Eelgrass has been lost in many parts of Buzzards Bay, with some of the more prominent historical losses occurring in and around New Bedford, Apponagansett Bay, the Wareham River estuary, Weweantic River, upper West Falmouth Harbor, Sippican Harbor, the Westport Rivers, Buttermilk Bay, and Onset Bay, among others.

Because eelgrass beds are ecologically important and are increasingly threatened by human activity and development, there is interest in resource management initiatives to protect the beds. In addition, the now widespread distribution of eelgrass and its sensitivity to pollution qualifies its use as an indicator species to identify water quality degradation and declining health of coastal ecosystems.

Tidal Flats

Tidal flats are found in estuaries and quiet bays, behind barrier beaches, in salt ponds, and, depending on slope, below the depth of wave disturbance along the open shores of Buzzards Bay. These shallow, sloping flats exist in a range of salinities from the coastal areas to the upper reaches of the estuary. The substrate is composed of materials ranging from very fine silt and clay to

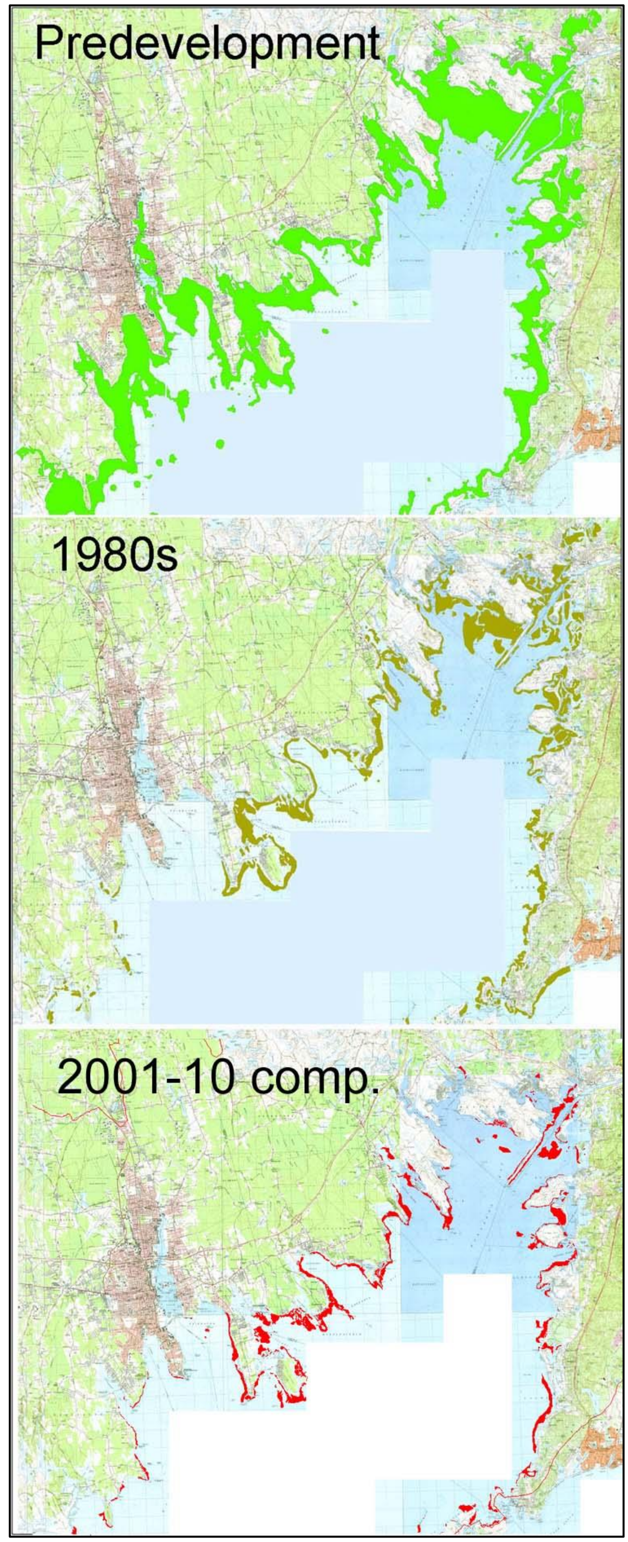


Figure 11. Conjectural estimate of eelgrass in predeveloped Buzzards Bay based on bathymetry and presumed water quality as compared to mapped 1980s and 2001-2010 composite view of eelgrass distribution.

(Note: the last complete baywide eelgrass map was 2001, but this composite map includes the most up-to-date mapping from various sources including DEP 2006 and 2010 coverages. Additional maps and explanations can be found at buzzardsbay.org/eelgrass-historical.htm.)

coarse sands. It is the combination of salinity, substrate quality, and character of water movement over the flat that determines the species composition of plants and animals.

Because of the lack of suitable substrate and the nature of the sand-mud environment, large plants do not take hold on these tidal flats. Instead, microscopic algae are prevalent. In general, tidal-flat animals are those that live in sediments, or bury themselves there with the outgoing tide. These include bivalves and various species of marine worms and crustaceans.

There are over 5,000 acres of tidal flats within the Buzzards Bay drainage basin. The largest amounts are found in Westport, Falmouth, Fairhaven, Mattapoisett, and Wareham.

Barrier Beaches

Barrier beaches are formed from sand and gravel transported by waves from a sediment source. Typically, they begin as sand spits that grow out from and parallel to the shore. Barrier beaches are usually long and narrow; they may be barely elevated above the level of high tide, or they may contain high dunes. Barrier beaches can become islands when storms breach their connection to the uplands.

Barrier beaches have moderately strong protection under the state Wetlands Protection Act (WPA) and Title 5 sanitary wastewater regulations[15]. CZM has mapped and designated 233 barrier beaches in Buzzards Bay covering 1,431 acres[16] (Figure 12). Building on or stripping of vegetation on barrier beaches is discouraged or prohibited because these beaches protect the lands behind them from storm damage and because they tend to move over geological time. The exact application of the law depends upon the particulars of the site. For example, construction in barrier beach primary dunes within a FEMA mapped velocity zone is prohibited by Massachusetts Executive Order 181. Signed in 1981, this executive order also discourages development on barrier beaches by limiting state and federal funding for sewer and water lines, buildings, and coastal engineering structures; and encourages public acquisition of barrier beaches for recreational purposes.

Barrier beaches are offered much less protection under federal law because they are not considered wetlands. The exception to this rule of thumb is that many of the larger barrier beach systems in Buzzards Bay are protected under the Coastal Barrier Resources Act (CBRA) of 1982. The law encourages the conservation of these sensitive areas and restricts federal expenditures that encourage development, and limits federal flood insurance through the National Flood Insurance Program[17].

Fisheries of the Bay

Lobster

Buzzards Bay lies in the central portion of the North American coastal range of the American lobster, *Homarus americanus*. In the United States, coastal Maine waters produce the greatest annual landings, with Massachusetts ranking second. In the 1991 Buzzards Bay CCMP, lobster landings in 1988 for Buzzards Bay were estimated to be $2.3 million. In 2002, 13,745,537 pounds of lobster were reported landed by commercial lobstermen in Massachusetts (Dean et al., 2002[18]). Based on an average price of $3.72 per pound, the commercial catch was valued at $51,133,397. In that year, Buzzards Bay accounted for only 1.6% of the state total, but this still represented an annual retail value close to $817,000. Although the lobster fishery is important to the local economy, Buzzards Bay is one of the less productive areas in terms of statewide commercial landings. Overall, lobster catches in Buzzards Bay increased somewhat in the 1980s and 1990s, but have declined appreciably after 1999 (Figure 14).

Licensed lobstermen take lobsters by pots or traps that are set for several days or longer. Massachusetts law prohibits the taking of lobsters by spearing, dipping, or dragging. In addition to the commercial fishery in Buzzards Bay, there are noncommercial lobstermen who purchase the 10-trap limit or 10 hand takings by scuba diving recreational permit. There is no estimate of how many of the more than 10,000 noncommercial lobstermen in the state fish Buzzards Bay.

In 1988, approximately 200 to 250 commercial lobstermen fished Buzzards Bay (Grice, 1990b/2013). In 2004, 149 fishermen reported landing 788,247 pounds of lobster from 224,926 trap hauls in the Massachusetts portion of Southern New England (MASNE) stock (Glen et al., 2007; Figure 14). As noted by Massachusetts

[15] Barrier beaches are considered a wetland resource area under the state WPA, and Title 5 prohibits mounded septic systems in barrier beaches within FEMA designated velocity zones.

[16] Buzzards Bay NEP calculation from MassGIS shapefile coverage State Designated Barrier Beaches dated April 1997. This CZM designation has no statutory implication under the state WPA which has its own definition of barrier beaches, and smaller unmapped areas may meet the regulatory definition for this wetland resource area.

[17] According to the U.S. Fish and Wildlife Service that oversees the program, "CBRA is a free-market approach to conservation. These areas can be developed, but Federal taxpayers do not underwrite the investments. CBRA saves taxpayer dollars and encourages conservation at the same time. CBRA has saved over $1 billion and will save millions more in the future." (from: www.fws.gov/coastal/docs/785.pdf. Last accessed October 11, 2013.

[18] Retrieved from www.mass.gov/eea/docs/dfg/dmf/publications/lobster-report-2002-tr20.pdf. Last accessed October 11, 2013.

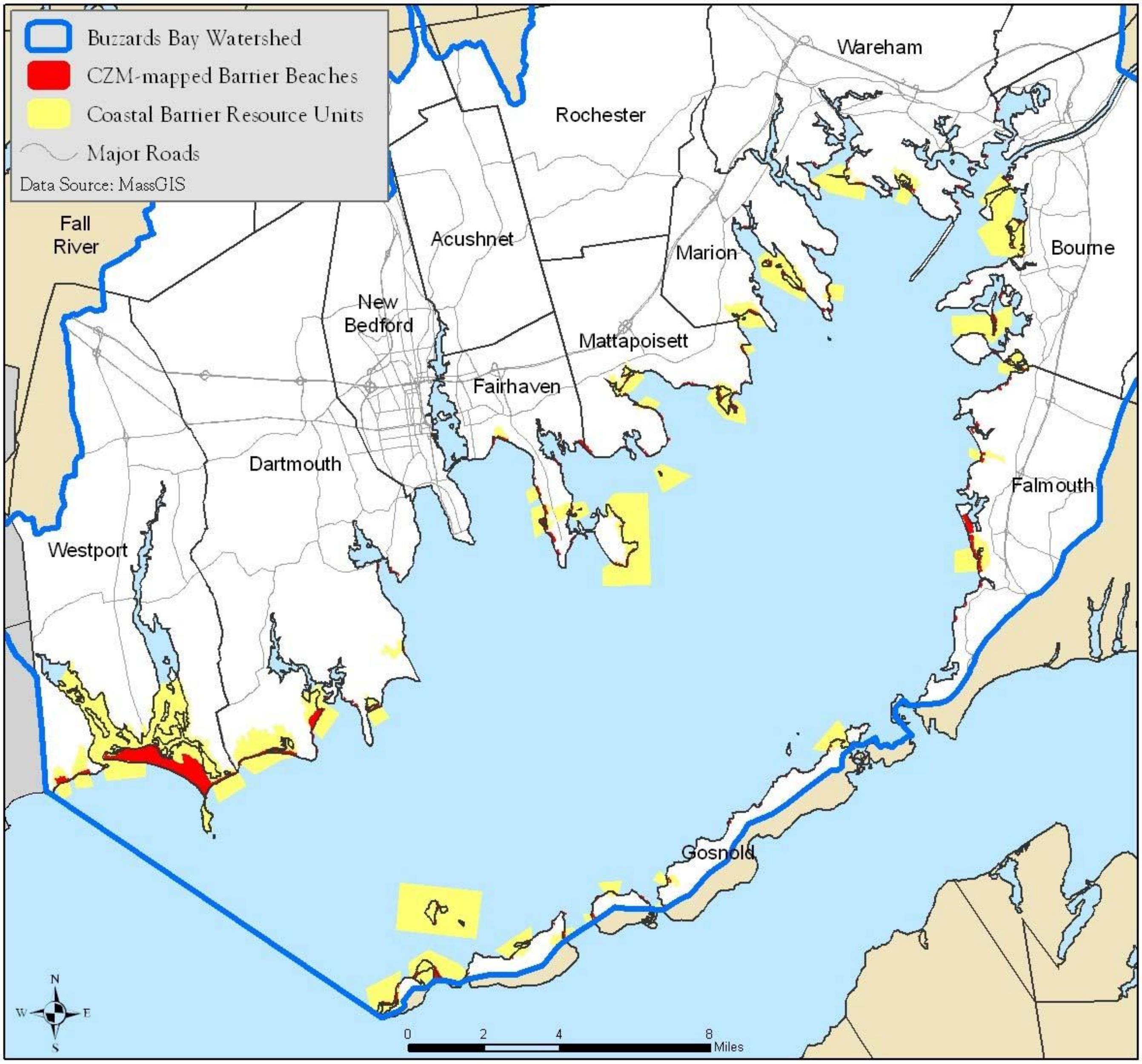


Figure 12. Massachusetts CZM designated barrier beaches and federal CBRA designated areas in Buzzards Bay.

DMF, these were the lowest recorded landings, trap hauls, since 1981.

The lobster resource of Buzzards Bay, although not as economically productive as other coastal areas in Massachusetts, is extremely important for its production of lobster larvae. Female lobsters in Buzzards Bay mature earlier and at a smaller size than in more northerly coastal areas. This means that the existing legal size limit tends to protect some small mature females, allowing a higher percentage of them to bear eggs. This smaller size at sexual maturity may help account for an abnormally high incidence of egg-bearing lobsters in Buzzards Bay. In 1988, 28% of the female lobsters sampled by state biologists in the commercial fishery of Buzzards Bay were egg bearing compared to only 5% in other samples from coastal areas in the Gulf of Maine. Some researchers have attributed this earlier maturity to physical characteristics of the habitat, for example, relatively high water temperatures in the summer and restricted water circulation and exchange, in combination with a high population density of lobsters.

In June and July of each year, very large numbers of lobster larvae hatch in the waters of Buzzards Bay. Researchers have estimated larval concentrations to be 8 times higher in Buzzards Bay than in Block Island Sound during these months. A significant number of these larvae end up in the Cape Cod Canal and further east in Cape Cod Bay, contributing to its lobster population.

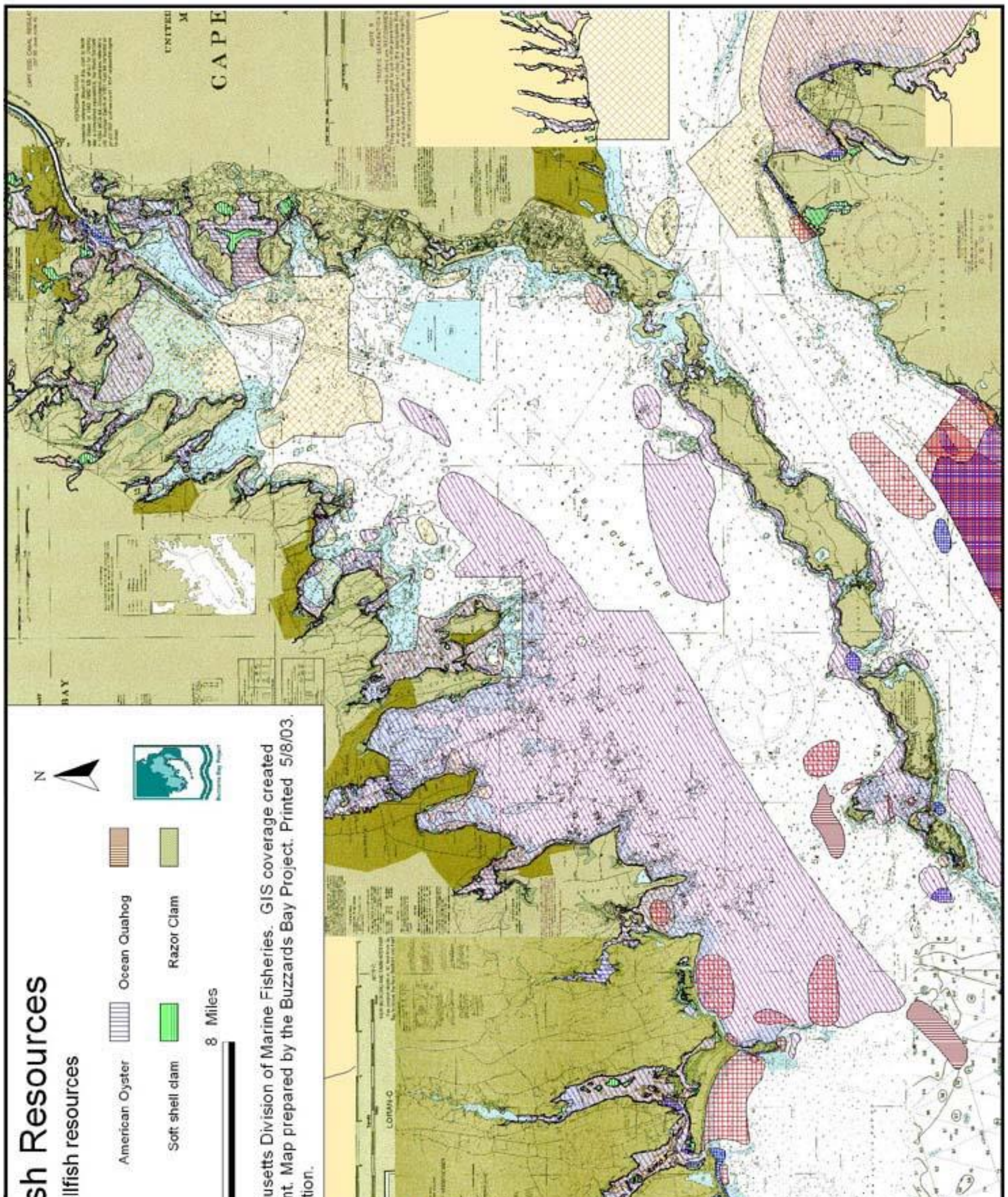


Figure 13. Buzzards Bay shellfish resources.

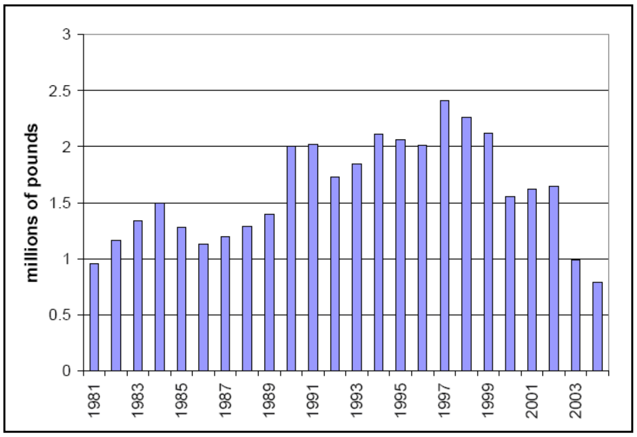


Figure 14. Lobster catch in the Massachusetts portion of the Southern New England lobster stock area.

Data shown is principally for Buzzards Bay and Vineyard Sound. Data only available to 2006.

The lobster is a bottom-dwelling animal that is affected by, and succumbs to, disease caused by environmental pollution. In their investigations of 12 coastal sites in the state, the Massachusetts Division of Marine Fisheries found that two conditions, black gill disease and shell disease, were more common in lobsters from Buzzards Bay than in animals from other coastal sites. Lobsters sampled from the New Bedford Inner Harbor had the greatest incidence of the two diseases.

In 1979, PCB contamination prompted the Massachusetts Department of Public Health to close approximately 18,000 acres of fishing grounds surrounding New Bedford to lobstering. Subsequent investigations by the Division of Marine Fisheries found PCB levels in lobster averaged 0.96 parts per million (ppm). Concentrations in hepatopancreas (tomalley) probably exceed the 2-ppm action level established by the U.S. Food and Drug Administration. These areas remain closed today.

Shellfish

The commercial and recreational shellfisheries of Buzzards Bay include quahog (*Mercenaria mercenaria*), bay scallop (*Argopecten irradians*), soft-shell clam (*Mya arenaria*), and oyster (*Crassostrea virginica*; see Figure 13).

In 2003, Mass DMF estimated[19] the annual value of shellfish harvested from Buzzards Bay was $4 million. Using an economic multiplier effect of 4.5, this catch contributed $18 million to the local economy. Historically, landings of quahog and bay scallop constitute the majority of the commercial shellfishery in Buzzards Bay, although in recent years, bay scallop populations have collapsed in most areas.

Soft-shell clams and oysters are harvested primarily in the recreational fishery, and together constitute a small portion of the total reported landings. Like the bay scallop, productive soft-shelled clam beds have disappeared from most parts of Buzzards Bay.

The shellfisheries in Buzzards Bay are managed in accordance with Massachusetts General Laws, Chapter 130, which authorize local control. Methods used by local officials to collect catch data from both the commercial and recreational fisheries vary by community. This makes the catch estimates of recreationally harvested shellfish problematic, particularly for use in implementing new management practices.

Like the rest of Massachusetts, in the 1970s and 1980s, Buzzards Bay experienced a dramatic increase in the number of acres of shellfish beds closed due to fecal coliform contamination. Although there have been appreciable improvements since that time, as of 2013, roughly 5,700 acres remain permanently closed, with an additional 2,700 acres of mostly seasonal closures. While this represents only 5% of the area of Buzzards Bay, it represents a significant percentage of the bay's productive nearshore shellfishing areas frequented by recreational and commercial shellfishermen.

The Division of Marine Fisheries authorizes the relay, or transplant, of quahogs from closed areas to clean areas. After relocation, the quahogs are allowed to depurate for at least three months, and through a spawning period, before the area is opened for shellfishing. Most relayed shellfish are taken out of areas closed because of coliform levels. Relaying of shellfish from toxically contaminated areas is less common but does occur, even out of severely impacted areas like New Bedford Inner Harbor. There is a lack of information on depuration rates of some toxic contaminants such as PAHs. Contaminated shellfish have been relayed to all Buzzards Bay towns in order to increase the utilization of the resource.

Finfish

Buzzards Bay is recognized as a highly valuable resource area for the many species of finfish that inhabit the bay, and is a habitat for those species that migrate north during the spring and summer. Its numerous inlets, coves, and freshwater streams are rich with small fish (minnows, sand eels, silversides, and alewives) that attract the larger recreational species. Salt marshes and eelgrass beds offer protection to many species of young fish, some of which are commercially important.

Buzzards Bay is a spawning and nursery ground for many important commercial and recreational species. Species such as scup, sea bass, tautog, butterfish, winter

[19] Reported in DMF NEWS Third Quarter 2003, "Update on Buzzards Bay Oil Spill" newsletter at www.mass.gov/eea/docs/dfg/dmf/publications/dmfnq303.pdf. These values are less than the 1988 estimate for the 1991 CCMP. The CCMP estimate for 1988 was $4.5 and $18.8 million respectively, which when adjusted for inflation, equals $6.9 and 28.9 million in 2003 dollars (using inflation calculator at data.bls.gov/cgi-bin/cpicalc.pl).

Table 5. Fisheries species where Buzzards Bay is designated as Essential Fish Habitat and their applicable life stages.

Species [1]	Eggs	Larvae	Juveniles	Adults
American plaice *(Hippoglossoides platessoides)*			X	X
Atlantic butterfish *(Peprilus triacanthus)*	X	X	X	X
Atlantic cod (*Gadus morhua*)	X	X	X	X
Atlantic herring *(Clupea harengus)*			X	X
Atlantic mackerel *(Scomber scombrus)*	X	X	X	X
Atlantic wolffish* (*Anarhichas lupus*),	X	X	X	X
black sea bass *(Centropristis striata)*	n/a	X	X	X
bluefin tuna *(Thunnus thynnus)*			X	
bluefish *(Pomatomus saltatrix)*			X	X
cobia *(Rachycentron canadum)*	X	X	X	X
haddock *(Melanogrammus aeglefinus)*	X	X		
king mackerel *(Scomberomorus cavalla)*	X	X	X	X
little skate (*Leucoraja erinacea*)			X	X
red hake *(Urophycis chuss)*		X	X	X
sandbar shark *(Carcharhinus plumbeus)*				X
scup *(Stenotomus chrysops)*	X	X	X	X
Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X
summer flounder *(Paralichthys dentatus)*	X	X	X	X
windowpane flounder *(Scophthalmus aquosus)*	X	X	X	X
winter flounder *(Pseudopleuronectes americanus)*	X	X	X	X
winter skate (*Leucoraja ocellata*)	X	X	X	X
Molluscs				
long-finned squid *(Loligo pealei)*			X	X
short-finned squid (*Illex illecebrosus*)			X	X
surf clam *(Spisula solidissima)*	n/a	n/a	X	X

[1] Modified from ARCADIS (2012) and with additions (*) from www.habitat.noaa.gov/protection/efh/efhmapper/index.html. Last accessed October 30, 2013. List may not be complete for unmapped species; NOAA EFH mapper inconsistencies with fact sheets ignored.

flounder, shad, and alewife are the primary species that depend on the bay for spawning and nursery grounds. During the spring and summer, bluefish, striped bass, and weakfish migrate north. Buzzards Bay is also designated as essential fish habitat (EFH) pursuant to the Magnuson-Stevens Act[20]. A list of EFH designated species and their relevant life stages are found in Table 5.

Because of its recreational fishing and nursery values, Buzzards Bay was closed to commercial fishing by nets, seines, and fish traps by Chapter 192 of the Massachusetts Acts of 1886[21]. A detailed summary of The Finfish Resources of Buzzards Bay is also provided by Grice (1990c/2013).

Other Living Resources

Marine Mammals

The harbor seal (*Phoca vitulina*) is the most abundant marine mammal throughout New England and the only marine mammal species commonly found in Buzzards Bay. Harbor seals are present in the bay between mid-October and early May. Although a few seals are observed throughout the year, most move north to coastal Maine and eastern Canada prior to the pupping season, which occurs from mid-May through early July. Harbor seals occur throughout the Elizabeth Island chain. In Buzzards Bay, the largest single concentration of seals

[20] In 1996, Congress passed the Sustainable Fisheries Act (Public Law 104-297) which amended the habitat provisions of the renamed Magnuson-Stevens Act. The amendments called for direct action to stop or reverse the continued loss of fish habitats. It also required identification of those habitats to protect, conserve, and enhance "essential fish habitat." Congress defined essential fish habitat for federally managed fish species as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."

[21] The constitutionality of this law was affirmed by the U.S. Supreme Court in the case Commonwealth of Massachusetts v. Arthur Manchester, 1890.

Photo by Bill Byrne, Massachusetts FWS NHESP

Figure 15. The diamondback terrapin (*Malaclemys terrapin*).

generally occurs at Gull Island[22]. In 1988, about 280 seals were recorded at this location and approximately 300-400 seals were found throughout the Elizabeth Islands and the remainder of Buzzards Bay throughout the winter. Since the late 1980s, in New England as a whole, harbor seal populations have nearly doubled.

In addition to the harbor seal, gray seals (*Halichoerus grypus*) are occasionally seen on rock ledges in the bay, but generally in small numbers. Harp seals (*Pagophilus groenlandicus*) and hooded seals (*Cystophora cristata*) are rarer, but have been reported on the south side of Cape Cod (Waring and Wood, 2008), and in Buzzards Bay[23] in recent years.

Buzzards Bay is not considered a high-use habitat for whales, dolphins, or porpoises. However, these species are occasionally observed passing through the bay. Species observed include the Atlantic bottlenose dolphin (*Tursiops truncatus*), harbor porpoise (*Phocoena phocoena*), long-finned pilot whale (*Globicephala melas*), humpback whale (*Megaptera novaeangliae*), and the finback whale (*Balaenoptera physalus*).Their presence is partly due to the proximity of their habitat in the southwest Gulf of Maine and Cape Cod Bay and areas south, and sometimes cetaceans enter the Cape Cod Canal. For example in January 2012, the Army Corps of Engineers closed the Cape Cod Canal because of the passage of two North Atlantic right whales apparently travelling from Buzzards Bay to Cape Cod Bay[24]. Later that year, a pilot whale became stranded in New Bedford Harbor[25].

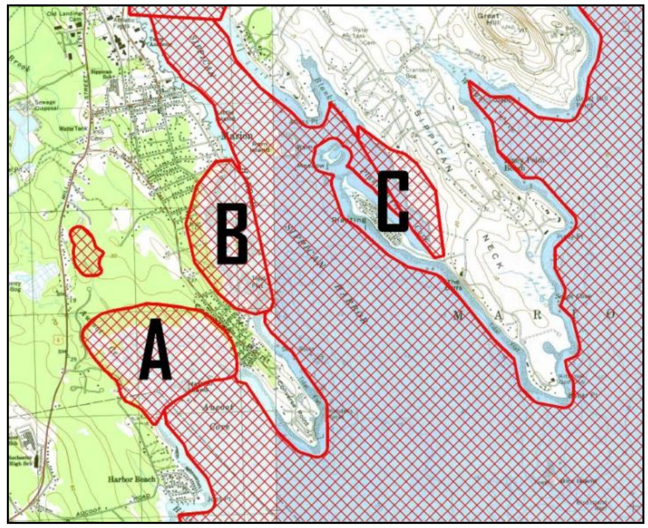


Figure 16. Map of terrapin turtle egg laying habitat in outer Sippican Harbor, Marion.

Large areas of Buzzards Bay, principally areas of salt marsh, are defined as terrapin turtle nursery areas. The areas, marked A, B, and C, are known to be egg laying habitat for this species. MassGIS NHESP coverage.

Other unusual mammal visitors include lone manatees appearing in Buzzards Bay and on Cape Cod in both 2006 and in 2008[26]. A detailed historical summary of marine mammals found in Buzzards Bay is provided by Payne et al. (1990/2013), and more recent information is contained in Leeney et al. (2010). Action Plan 9 Protecting Bio-Diversity and Rare and Endangered Species Habitat contains a species list of rare and threatened marine mammals and other species.

Marine Turtles

Five species of sea turtles can be found in Buzzards Bay waters: the loggerhead, Kemp's ridley, leatherback, green turtle, and hawksbill. The leatherback is the marine turtle species most frequently reported in Buzzards Bay due to its immense size. In August 2008, more than 100 sightings were reported in southeastern Massachusetts. The turtles purportedly were attracted by high standing stocks of jellyfish, their main food source. Generally present from July through November, this endangered turtle is sometimes found dead on beaches because of entanglement (and subsequent drowning), collisions with boats, or occasionally due to intestinal blockage after eating floating plastics.

The Kemp's ridley turtle, the rarest sea turtle in the world, is known to frequent Buzzards Bay and the south shores of Cape Cod, although it is most likely to be

[22] The site attracts seal watch charters out of New Bedford Harbor.
[23] See nmlc.org/2011/01/hooded-seal-in-buzzards-bay/. Last accessed October 18, 2013.
[24] Bragg, M. A. 2012. Right whale sighting closes Cape Cod Canal. Cape Cod Times, January 3, 2012. Retrieved from www.capecodonline.com/apps/pbcs.dll/article?AID=/20120103/NEWS/201030307/-1/NEWS01. Last accessed October 1, 2013.
[25] Urbon, S. 2012. Pilot whale stranded in New Bedford Harbor. The Standard Times. Retrieved from www.southcoasttoday.com/apps/pbcs.dll/article?AID=/20120412/NEWS/120419961. Last accessed October 1, 2013.
[26] These visits and their relation to water temperature are described at buzzardsbay.org/buzzards-bay-manatees.htm.

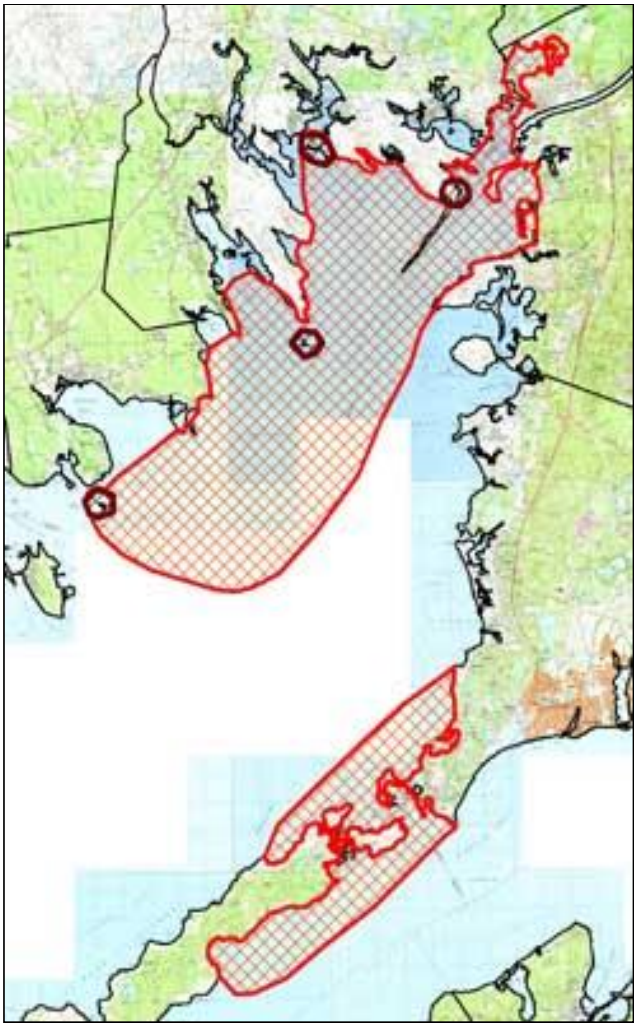
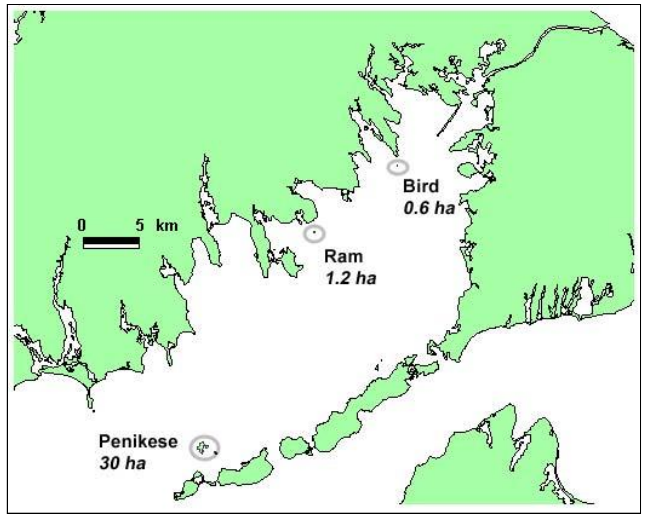


Figure 17. Buzzards Bay colonial bird (Roseate Tern) nesting and feeding areas.

Summary map created from a 1991 USF&WS report titled [Northeast Coastal Areas Study Significant Coastal Habitats].

found in Cape Cod Bay. In fact, despite its rarity, it is one of the most common marine turtles reported (caught in fishing nets or stranded) within Cape Cod Bay. Sightings within Buzzards Bay are rare, possibly in part because commercial fishing by nets and seines is prohibited in the bay's waters. Given the distribution of the species, Buzzards Bay may be a potentially important foraging area during late summer and early fall, for juvenile and subadult individuals.

Besides sea turtles, a coastal marine turtle, the diamondback terrapin (*Malaclemys terrapin*, Figure 15) makes its home in Buzzards Bay. The species is a threatened reptile in Massachusetts, and for that reason, the presence of the species has important regulatory implications, particularly because it feeds and lays eggs in salt marshes (Figure 16). Diamondback terrapins have a medium-sized wedge-shaped carapace (top shell) variably colored gray, light browns, greens and blacks. It has concentric ring patterns on the carapace and a pronounced ridged or bumpy mid-line keel. Both sexes have grayish to black skin, spotted with dark green flecks and light colored upper and lower jaw. This turtle has very large, paddle like hind feet with thick webbing.



Graphic from the MA Natural Heritage & Endangered Species Program.

Figure 18. Locations and sizes of the major tern nesting islands in Buzzards Bay, MA.

1 hectare [ha] = 2.5 acres

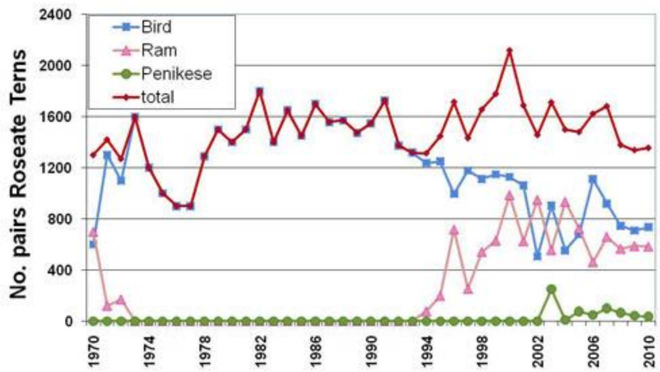
The species is threatened by salt marsh habitat loss and changes in marsh hydrology including tidal restrictions. Human activity and off road vehicles may disturb egg laying activities, or injure or kill nesting females, nests, and hatchlings. Diamondback terrapins may be trapped and drown in improperly discarded "ghost" netting, and can be a by-catch in estuarine crab traps. Nesting females sometimes get injured crossing roads to reach appropriate nesting habitat.

A detailed historical summary of marine turtles found in Buzzards Bay is provided by Payne et al. (1990/2013) and more recent observations and information is contained in Leeney et al. (2010).

Waterbirds

Although greatly reduced in number and diversity from colonial times, birds remain an important component of the Buzzards Bay ecosystem. Because birds congregate and are often sensitive to habitat loss and certain toxic chemicals, their health and breeding success can reflect the fates and persistence of environmental contaminants and the quality of nesting habitat within Buzzards Bay.

Three species of terns breed along Buzzards Bay shores in significant numbers: the Common Tern, Roseate Tern, and Least Tern. Two large areas of Buzzards Bay have been identified as important feeding areas for these tern species (Figure 17). The Roseate Tern, a worldwide species that is listed as a U.S. federally endangered species, breeds exclusively in only two areas worldwide: the northeast coast of the United States (New



Graphic courtesy of the MA Natural Heritage & Endangered Species Program.

Figure 19. Peak Roseate Tern breeding pairs in Buzzards Bay, MA, 1970-2007.

Data from the [Buzzards Bay Tern Restoration Project](#).

Photo and graphic from Mass Wildlife staff.

Figure 20. A Piping Plover.

York to the Canadian Maritimes) and in the Caribbean Islands. In the northeast U.S., Bird Island and Ram Island in Buzzards Bay (Figure 18) serve as the nesting areas for about 50% of the North American breeding population of Roseate Terns[27].

Buzzards Bay terns have experienced declines largely due to competition with gulls, although human disturbance is also a major factor influencing breeding numbers and distribution (Poole, 1990/2013). The arrival of Herring Gulls in the mid-1930s displaced nearly all the terns from several nesting colonies in just a few years. Because Herring and (especially) Black-back Gulls eat tern eggs and chicks, the terns tend to move their colonies in response to influxes of gulls. The increased population of these gulls devastated the Roseate Tern population in Massachusetts in particular, resulting in a 70% decline between the 1940s and 1960s (Blodget and Melvin, 1996; Mostello, 2007). These threats and additional impairments led to protection and restoration efforts, including a gull control program on Ram Island in 1990-1991. This effort led to the successful recolonization of Roseate Terns there after a 20-year hiatus (Figure 19).

In 1988 and 1989, several dead Roseate Terns and Common Terns were found that also had high levels of PCBs in their body tissue. Because these species sometimes feed in the vicinity of New Bedford Harbor, this raised concerns among managers and led to the use of some superfund restoration dollars dedicated to the design and restoration and protection of Bird and Ram Islands (only in the design phase as of 2010).

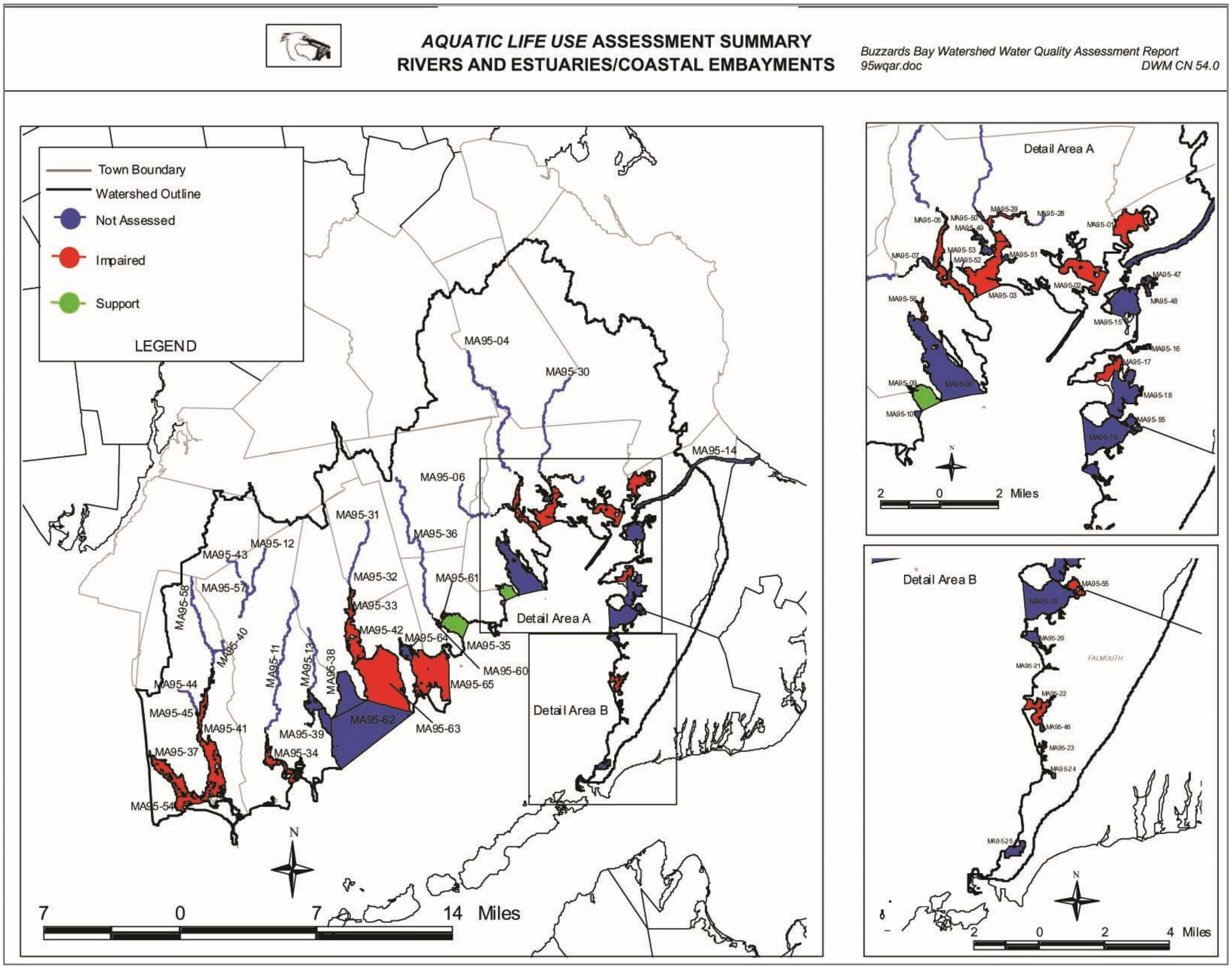
Similarly in 2003, oil from the Bouchard oil spill landed on Ram and Bird Islands, exposing some terns (three were found dead with oil on them), and also disrupting nesting because of cleanup activities. These impacts will be address by the oil spill trustees sometime in 2014 as part of the Natural Resource Damage Assessment for the spill.

The Piping Plover (Figure 20) is listed as a “threatened species” in Massachusetts, and another bird that is the focus of management action in Buzzards Bay. Fencing around Piping Plover habitat to exclude predators has been highly successful, boosting reproductive success significantly. Islands and other isolated areas make ideal nesting habitat for plovers and terns. Poole (1990/2013) reported an average of 30 nesting pairs in Buzzards Bay for the period 1984-89. In the 2009 Massachusetts Piping Plover census, Melvin (2010) reported 47 pairs in Buzzards Bay.

Only one species of cormorant breeds in Buzzards Bay: the Double-crested Cormorant. After being nearly eliminated in the 19th century, this species recolonized the Weepecket Islands in 1946. Since about 1970, this colony has been growing rapidly, increasing from 150 breeding pairs in 1971 to 1135 in 1984. In 1986, another colony began on Ram Island, perhaps due to spillover from the Weepeckets. Currently cormorants have become so abundant in states the federal government has allowed for their depredation (destruction) because of impacts on fisheries.

During the 18th and 19th centuries, ospreys undoubtedly were abundant along the shores of Buzzards Bay. It is often stated that the early explorers in Buzzards Bay named this body of water after the osprey ("buzzards"). During the 1950s and 1960s, ospreys decreased by more than 50% due to DDT-related reproduction failure. Local use of DDT ceased after the mid-1960s and osprey reproduction revived about a decade later. By 1979, the Westport population had grown to 20 active nests (all but

[27] See Massachusetts Fish and Wildlife fact sheet at: www.mass.gov/eea/docs/dfg/nhesp/species-and-conservation/nhfacts/roseate-tern.pdf and www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/species-information-and-conservation/rare-birds/buzzards-bay-tern-restoration-project.html. Last accessed October 11, 2013.



Data from DEP (2003) Buzzards Bay Watershed 2000 Water Quality Assessment.

Figure 21. Aquatic life assessment for coastal embayments and rivers in the Buzzards Bay watershed.

one on artificial platforms). A decade later, Westport had 69 active nests, and in 2006, Westport had 88 nests[28]. The availability of safe, sturdy nest sites is a key limiting factor for this species, and throughout Buzzards Bay, osprey populations returned dramatically during the past two decades, mostly because local residents built nesting platforms.

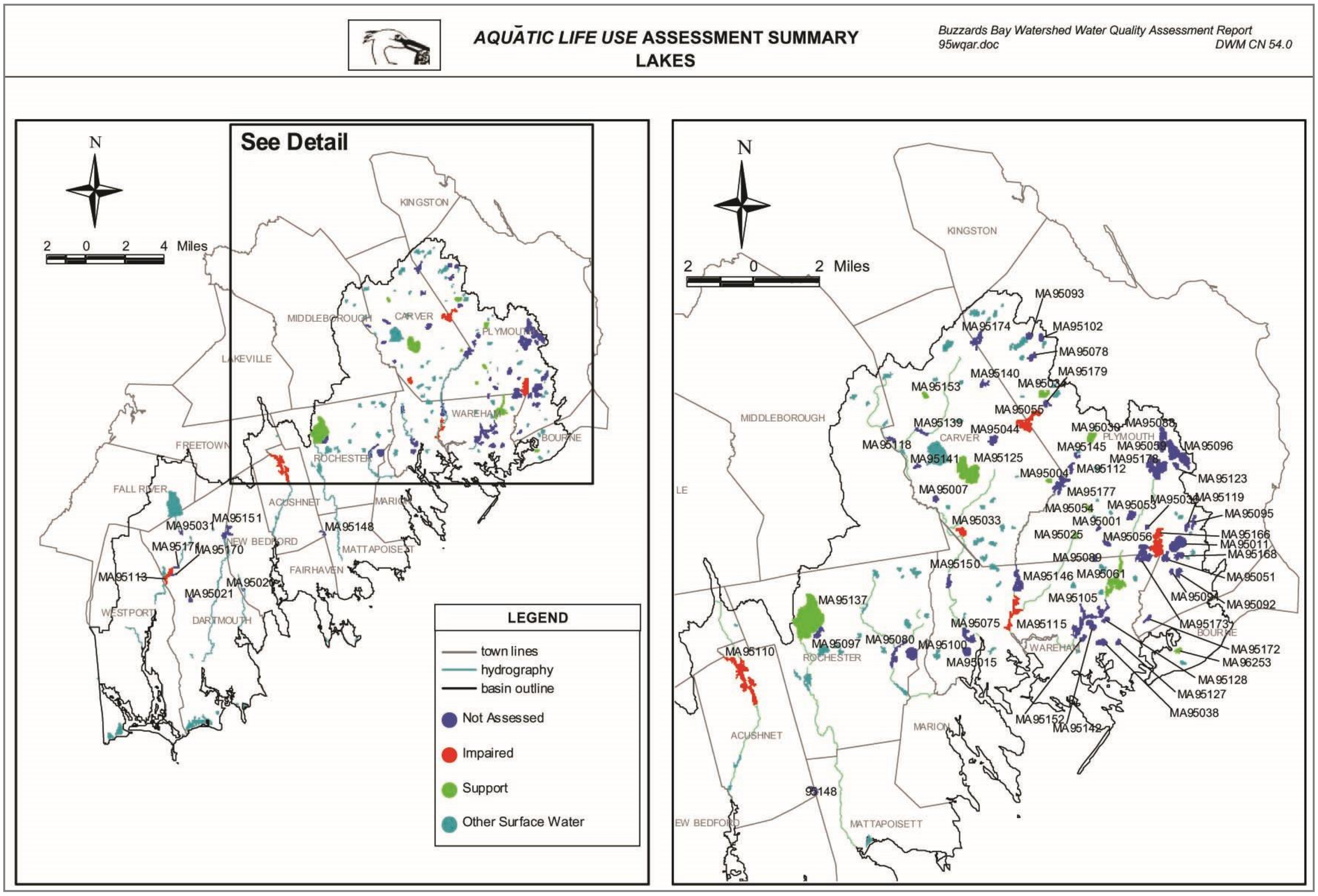
Two species of wading birds are known to nest along Buzzards Bay shores: Black-crowned Night Herons and Snowy Egrets. Several other waders roost and feed here, but none has been confirmed as breeders. At least 20 species of waterfowl (swans, ducks, and geese) are found on Buzzards Bay waters. Two broad categories of these waterfowl are sea ducks, such as Common Eiders, Old-squaw, and White-winged Scooter, and estuarine species such as Canada Goose, Canvasback, and Black Duck.

Assessment of Impairments

The most recent and robust regulatory assessment of living resource impairments in Buzzards Bay and its surrounding watershed are contained in DEP's Buzzards Bay Watershed 2000 Water Quality Assessment.[29] The document was completed in 2003 by the Massachusetts Department of Environmental Protection (DEP) which is responsible for the assessment of current water quality conditions pursuant to reporting requirements under the Federal Clean Water Act (section 305(b)) and the Massachusetts Surface Water Quality Standards. Every two years DEP creates a new integrated list of impaired waters. Although a new watershed assessment has not been completed for Buzzards Bay since 2003, DEP considers new data collected and evaluated since the 2003 assess-

[28] Westport Shorelines article published November 30, 2006.

[29] See the DEP Buzzards Bay water quality assessment report (O'Brien and Langhauser, 2003)



Data from DEP (2003) Buzzards Bay Watershed 2000 Water Quality Assessment.

Figure 22. Aquatic life use assessment for fresh water ponds in the Buzzards Bay watershed.

ment report. For example, the draft 2008 proposed integrated list includes new sites based on the Buzzards Bay Coalition monitoring program.

The DEP watershed assessment reports designate the most sensitive uses for which surface waters in the Commonwealth shall be protected, forms the basis of watershed management programs at DEP, and are the foundation of many goals in the Buzzards Bay CCMP. They identify to what degree water quality supports (support status) the "designated uses" of each water body. The assessment reports classify water bodies in the categories (support, impaired, or not assessed) for meeting those goals. The reports also provide basic information and action needed to focus resource protection and remediation activities in watershed management and planning efforts.

The Buzzards Bay assessment report presents a summary of water quality data and information as of November 2003. The status of designated uses as defined in the Massachusetts Surface Water Quality Standards: aquatic life, fish consumption, drinking water, shellfish harvesting, primary and secondary contact recreation, and aesthetics. Each use, within a given segment of the Buzzards Bay watershed, was individually assessed as support or impaired. When too little current data/information exists or no reliable data are available the use is not assessed. However, if there is some indication of water quality impairment, which is not "naturally occurring," the use is identified with an "alert status."

It is important to recognize neither the DEP Buzzards Bay water quality assessment report, nor the Buzzards Bay CCMP, characterize conditions of all rivers, streams, ponds, and coastal embayments in the Buzzards Bay watershed (Figure 21). In fact, most of the smaller freshwater streams and ponds have never been assessed (Figure 22).

For example, as noted in the report, DEP considers "aquatic life use" supported when suitable habitat and water quality are available for sustaining a native, naturally diverse, community of aquatic flora and fauna. Impairment of the aquatic life use may result from anthropogenic stressors that include point and/or nonpoint source(s) of pollution and hydrologic modification. Due to the lack of current quality-assured chemical and biological data, none of the rivers in the Buzzards Bay watershed have been assessed for the aquatic life use (Figure 21). However, the 2003 report does identify specific conditions that may affect aquatic life such as flow manipulation, which may adversely affect fish passage in the Agawam, Wankinco, Weweantic, and Sippican Rivers and water withdrawals that may adversely affect the Mattapoisett, Paskamanset, Copicut, and the Shingle Island Rivers. The report also noted "the Acushnet River is designated an "Alert Status" due to the potential negative effects of elevated nutrients and oxygen depletion as evidenced in the Buzzards Bay Coalition's poor health index score. Since then, more embayments have been added because of the results of the Buzzards Bay Coalition efforts.

Watershed Demographics

Based on the 2010 Census, there are approximately 250,000 people living in the Buzzards Bay watershed, and of these, nearly 50% live in the greater New Bedford area. Although most residents within the region have been born in the United States, Portuguese was reported as the most dominant ancestry, with Irish a close second. The majority of people in the area who are foreign-born are descended from Europeans. English is the dominant language spoken in households. In the 2000 Census, approximately 30% of the residents within the area are employed as management professionals. Other predominant occupations include sales (26%), service (16%), transportation (17%), construction (10%) farming, and fishing (0.4%).

According to the 2010 U.S. Census, Bristol County, which accounts for 69% of the watershed population[30], has a median age of 40, a 2.54 person average household size, and a median household income of $55,813 (Table 6). This is a similar demographic makeup as the rest of Massachusetts and the U.S., except for the average age, which is somewhat higher than the U.S. average. There are, however, more significant differences in population, age, and race among cities and towns in the watershed. In particular, the greater New Bedford area, one of the largest urban centers in the region, maintains the highest population of the region at 95,072 persons, and has a high proportion of environmental justice populations[31].

These demographics contrast with most other communities, and many of the surrounding towns have much smaller populations (Marion is the smallest at 4907 persons). There are some sharp contrasts among household income among Buzzards Bay watershed communities. New Bedford, with the highest Portuguese, Hispanic, and other minority populations, also has the lowest median household income in the region ($37,493), while Rochester, which has one of the lowest minority populations also, has one the highest median household income ($99,129). These factors present some considerations for regional planning efforts when forecasting growth, planning for transportation improvements, accommodating businesses, as well as protecting natural resources.

Maintaining a balance between a healthy environment and changing land uses caused by population increases is always a challenge. Increases in population also prompts cities and towns to provide more services, causing strains in municipal budgets that often exceed new tax revenues. From 1980 to 1990, the population among principal watershed municipalities grew by 10.3%, appreciably higher than the statewide average (4.3%). The population growth was accompanied by a considerable conversion of forested land to residential development (see statistics in Action Plan 4 Improving Land Use Management and Promoting Smart Growth). During this time, the majority of new jobs that appeared in the region were service-sector jobs that included professional services, small businesses, repair, food, entertainment, recreation, health, and education, while many manufacturing jobs disappeared.

In subsequent decades, population growth slowed, with declines even occurring in the City of New Bedford. Between 2000 and 2010, the cumulative rate of population increase among the same principal Buzzards Bay watershed municipalities was only 4.7%. Like most of Massachusetts, changes in population growth rates may have been affected by the recession of 2009. Variations exist among communities. For example, Rochester and Dartmouth had double-digit population rate increases in all three decades.

Besides population, other trends are evident in the U.S. Census data. For example, Boston Metropolitan Planning Organization's household forecasts predicted that: "*the number of households in the region will continue to grow faster than the population through 2025 as lifestyle changes toward a smaller average household size persist*." This prediction appears to be borne out by the 2010 census, which saw average household size decline in every Buzzards Bay municipality.

It should be noted that the seasonal influx of tourists to some communities and seaside villages within the Buzzards Bay watershed could raise their populations by almost three-fold during the summer, increasing pressures to environmental systems (Howes and Goehringer, 1996).

[30] Value calculated from 2010 U.S. Census block data of blocks within the watershed, where census blocks bisected by the watershed divide are assigned a population proportional to the area of the block within the watershed. Based on this methodology, there are 250,003 persons in the Buzzards Bay watershed, with 167,263 within Bristol County.

[31] Principally, minority, low income, and "household English isolation" in the 2010 U.S. Census.

Table 6. Census 2010 demographic composition: Bristol County, Massachusetts, and U.S.

Parameter	Bristol County	MA	United States
Average Age	40	39	37
Average Household Size	2.54	2.49	2.58
Average Household income	$55,813	$65,981	$51,144

Economic Setting

The Buzzards Bay watershed includes a diverse assemblage of businesses and industries, and the cities and towns within the region are leaders in a number of Massachusetts industries such as tourism, biotechnology, and fishing and shellfishing. The approximate economic value of the largest of these are shown in Table 7 and described in the sections below.

Tourism

Tourism remains the most important industry for southeastern Massachusetts (Table 7). Table 8 shows 2004 travel expenditures (the last date Bristol County data) in southeastern Massachusetts counties, including travel-generated payroll and employment, and state and local tax revenues. One of the top five counties in the state for tourism expenditures was Barnstable County (Bourne and Falmouth), which posted $746 million in domestic expenditures to rank third in the state. These expenditures generated nearly $208 million in payroll as well as approximately 9,300 jobs within the county. Bristol and Plymouth counties made their marks with approximately $300-400 million in expenditures, generating close to $20 million in payroll and 3,000 jobs per county.

The beaches and historic seaside communities of southeastern Massachusetts are central to tourism and are advantageous to attracting and retaining qualified employees. Employment in the two major tourist sectors--lodging and restaurants--has roughly doubled in the Buzzards Bay region since 1970, and the growth in tourism numbers has been sharply increasing (Howes and Goehringer, 1996).

Access to open water, beaches, and parklands varies from town to town and by ownership (see Figure 8 and Table 3 showing different types of public land uses per community). There are approximately 13.4 miles of public beaches (municipal and state owned) in the Buzzards Bay watershed, with an additional 32 miles of "semi-public" beaches. Semi-public beaches include some large tracts of public coastal lands (state, municipal, and private conservation owned), beach association, community beaches, private pay-to-use beaches, club and resort beaches, and other stretches of coastline where more than a single owner is allowed use. Generally, boat ramps and launches that are owned by the state or municipal government are open for use to anyone.

There are approximately 19,311 acres of public parks, forests, trails, paths, campgrounds, and play-

Table 7. Annual value of some marine-related and other industries in Massachusetts.

Category	Millions[1]	Date of info
All Rec. Angler Trip Expend. [2]	$1,164	2011
Tourism, direct spending [3]	$16,900	2011
Coastal Tourism & Recreation[8]	$2,300	2004
All Agriculture [4]	$471	2011
Cranberries (21% of total)[5]	$99	2012
Aquaculture [4,5]	$18.5	2007
Commercial Fishing Landings [6]	$565	2011
Mining (sand, gravel, stone) [7]	$214	2009
Marine Constr. & Infrast. Jobs [8]	$949	2004
Marine Science & Technology [8]	$419	2004
Marine Transportation [8]	$93	2004
Bio-pharma Industries payroll[9]	$6,036	2011

1 Figures represent most current data available and do not reflect associated economic multipliers.

2 NOAA (2012) Fisheries Economics of the United States, 2011. Economics and Social Analysis Division Office of Science and Technology National Marine Fisheries Service. New England Statistics supplement. From table "Angler Trip & Durable Expenditures."If just direct sales generated are considered, the total is $726 million.

3 Massachusetts Office of Travel and Tourism (2012) The Economic Impact Of Travel on Massachusetts Counties 2011. U.S. Travel Association Washington, D.C. September 2012.

4 Includes farm animals. Statistics from 2011 State Agricultural Overview, U.S. Department of Agriculture, National Agriculture Statistics Service. Aquaculture separated from state totals. Cranberry production from NASS New England Agricultural Statistics, 2011, and Massachusetts Cranberries February 8, 2013. USDA, NASS New England Field Office.

5 From (4), but note that MA DMF estimates 2006 aquaculture as only $6.2 million as reported at www.mass.gov/eea/agencies/agr/about/divisions/aquaculture-industry-generic.html.

6 National Marine Fisheries Service, Annual Commercial Landings Statistics (2011), the port of New Bedford accounts for $369M.

7 USGS (2013) The 2009 Minerals Yearbook Massachusetts [advance release].

8 Fact Sheet: The Massachusetts Ocean Act: Sustaining the Commonwealth's Marine Economy Through Fact Based Coordination. Retrieved from www.massoceanaction.org/docs/MOAfactsheet.pdf. See also University of Massachusetts Donahue Institute (2000).

9 Biopharma Industry Snapshot 2012 - Massachusetts Biotechnology Council. Retrieved from www.massbio.org. Last accessed August 27, 2013.

Table 8. 2004 Domestic travel impact on southeastern Massachusetts.

County	Expenditures ($ Mil)	Payroll ($ Mil)	Employment (Thousands)	State Tax Receipts ($ Mil)	Local Tax Receipts ($ Mil)
Barnstable	$745.61	$207.92	9.28	$32.45	$43.12
Bristol	$311/64	$71.93	3.00	$17.24	$5.88
Plymouth	$384.19	$87.60	3.65	$19.44	$17.05
Subtotal	$1,441.44	$367.45	15.93	$69.22	$66.05
State Totals	$10,975.45	$2845.83	110.47	$451.59	$268.50

Data from Massachusetts Office of Travel and Tourism, www.massvacation.com/wp-content/uploads/2013/09/econ-impact-12.pdf.

grounds within the Buzzards Bay watershed. Providing public access to natural resource areas and protecting open spaces in the region are key requirements for maintaining tourism. Open spaces provide critical habitat and corridors for wildlife and plants, protect important water supplies, provide areas for recreational activities, protect historically significant places, and preserve the charm and character of the area in which we live. Open space protection contributes to the regional economy by making the region attractive to businesses, farmers, and tourism. It stabilizes differences between tax revenues and government expenditures because it is generally true that government expenditures for services supporting residential development exceed tax revenues generated by new residential development. Undeveloped protected land costs the towns little, since community services, such as schools, police, and road services, are not required.

Unfortunately, land preservation efforts are uneven around the Buzzards Bay watershed. Some communities such as Acushnet and Wareham have only 10% and 12% respectively of their town's land-base protected from development. Many others have more than twice that amount.

Agriculture

Many people associate southeastern Massachusetts with cranberry bogs, their ripening red berries, and harvest in the fall. Most of the state's 13,000-plus acres (2012 estimate) of cranberry bogs are located within the Buzzards Bay watershed and the region still hosts the North American headquarters of Ocean Spray Cranberries. In 2012, Massachusetts was second in the nation in cranberry production, which exceeded $99 million in product value[32]. Based on 1996 estimates, there were in 5,500 jobs and two million dollars in payroll to Commonwealth residents in the cranberry industry. Cranberry growing is also intricately tied to several wetland and water quality issues discussed in the CCMP. It is thus essential that growers manage their land to minimize environmental degradation.

According to a 2002 USDA Agricultural Census of Buzzards Bay, there are approximately 474 farms in the Buzzards Bay region, accounting for approximately 8% of the total number of farms in Massachusetts (6,075 total farms) and 27% of the total farms in the region's counties: Bristol, Plymouth and Barnstable (1,703 total farms). The crops typically grown within the region include vegetables, fruits, and berries (including cranberries, as described above), as well as nursery and greenhouse plants. (Aside from the Towns of Carver, Wareham, and Middleborough, most farms in other cities and towns generate less than $50,000 in revenue from their crops). In addition, Westport is the only town that has farms that generate a wide variety of crops, ranging from nursery to livestock. Dairy farming was once a more prominent agricultural activity within the watershed, and has been identified as a major water pollution source to some systems. However, the number of dairy farms has greatly diminished during the past twenty years, especially in the Dartmouth/Westport area.

The southeastern Massachusetts Agricultural Partnership's (SEMAP) "Buy Local" campaign works to raise consumer awareness about the benefits and importance of buying fresh, locally grown farm products and to increase and identify opportunities for purchasing these products. In 2003, SEMAP conducted a regional survey to assess the effectiveness of the campaign, and to understand the food buying habits of the region's consumers. The results of this survey indicated that local residents prefer to buy locally grown or raised foods (approximately 68% reported that they are more likely to buy local and 88% buy at farmers markets). Furthermore, the survey concluded that residents are more likely to buy locally grown or raised products at roadside stands than at large supermarkets because they taste better. This indicates a clear interest by regional residents to preserve and protect local agriculture. According to the Woods Hole Research Center, there has been approximately a 40% loss of agricultural lands in the region and more than a 60% increase in residential, industrial, and commercial properties since that time. Growth management, comprehensive planning, and agricultural land

[32] USDA NASS. 2013. New England Agricultural Statistics, 2012.

preservation are essential tools that government needs to employ to help protect agriculture in the region.

Biotechnology/Marine Sciences

Southeastern Massachusetts is currently the center of marine science and marine science-related industries, including marine instrumentation, fishing, and aquaculture. The University of Massachusetts at Dartmouth, Woods Hole Oceanographic Institute, Marine Biological Laboratory, and the Massachusetts Maritime Academy are all located within the region and promote education and research in marine science, technology, and environmental technology. These educational institutions, through programs like UMass Dartmouth's Advanced Technology & Manufacturing Center, School for Marine Science and Technology, and the federally designated Northeastern Regional Aquaculture Center, provide specialized training to help marine industries expand and modernize. Fall River's South Coast Research and Technology Park is located in the region's only research and development overlay district. This zoning district portrays an interesting example of the use of zoning to attract a particular type of industry.

The entire southeastern portion of Massachusetts benefits from its proximity to two major metropolitan areas--Boston, Massachusetts and Providence, Rhode Island. The region's extensive highway network provides excellent access to the deep-water ports in southeastern Massachusetts, particularly in Fall River and New Bedford. These ports, which offer access to world markets, currently compete with major metropolitan areas such as Boston and New York. According to the Massachusetts Alliance for Economic Development, New Bedford has been designated as a Foreign Trade Zone, as it serves as a direct port of entry to Europe and Latin America.

Fishing and Shellfishing Economies

Commercial and recreational shellfishing in Buzzards Bay is important to the economy of the Buzzards Bay watershed. A large number of commercial and recreational permits are sold by Buzzards Bay municipalities, but the number has been declining in recent years (Figure 23) because of depleted shellfish populations and to a lesser degrees, increasing shellfish bed closures. Still, in recent years, Buzzards Bay has accounted for 20-40% of the entire state catch of commercial shellfish (Figure 24).

In Buzzards Bay, five major species of shellfish are harvested: quahogs (or hard-shelled clams), oysters, soft-shelled clams ("steamers"), surf clams, and bay scallops. Quahogs represent the largest portion of the shellfishery in terms of poundage (Figure 25), yet significant numbers of the other major species are harvested each year, many of which have a higher market value per pound.

Nearly every harbor in Buzzards Bay has shellfish beds; however, many shellfishing areas within the region

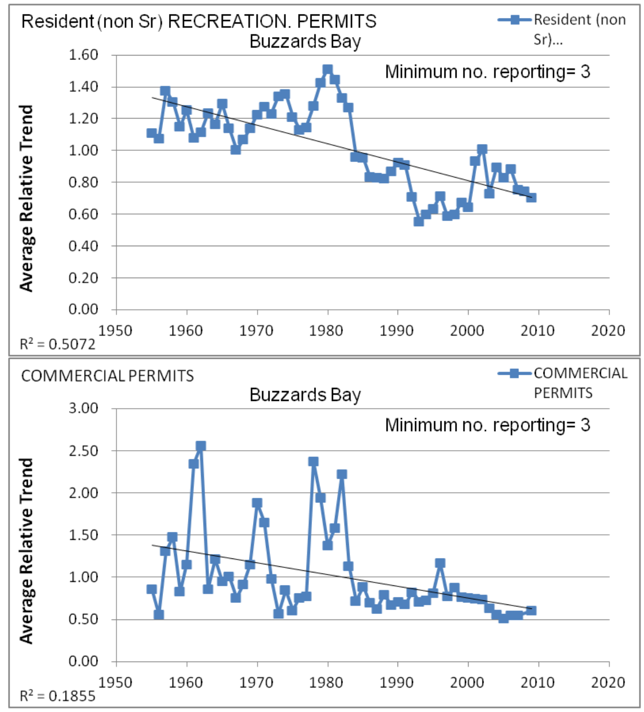


Figure 23. Relative trends of commercial and recreation permits issued in Buzzards Bay.

Includes data from Westport, Dartmouth, Fairhaven, Mattapoisett, Marion, Wareham, Bourne, and Falmouth (including non-Buzzards Bay waters). New Bedford excluded because shellfish beds were not reopened until the 1980s. Data courtesy of MA DMF with additional analysis by Buzzards Bay NEP, data and information at: buzzardsbay.org/shellfish_catch_trends_bb_ma.htm.

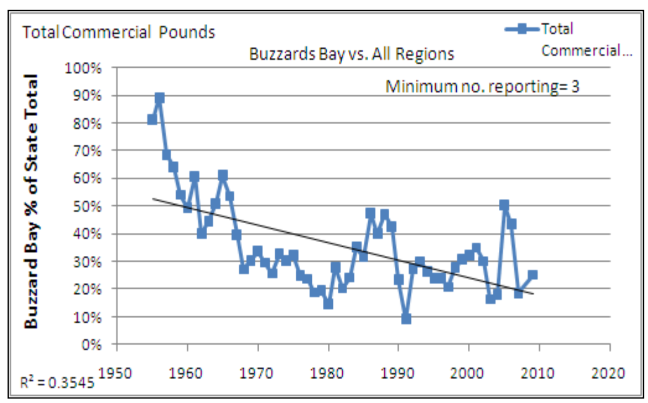


Figure 24. Commercial catch in Buzzards Bay as a percentage of state catch over time.

Based on pounds caught for the period 2000-2005, for all species. Data and findings posted at: buzzardsbay.org/shellfish_catch_trends_bb_ma.htm.

are restricted due to bacterial closures. Some of these closures are permanent (year-round), seasonal (summertime), or rainfall conditioned. For example, the closures at the end of Clarks Point in New Bedford and east of Mishaum Point in Dartmouth are permanent closures because of municipal sewage treatment facility discharges in those areas. Other areas like those in Sippican Harbor in Marion, and West Falmouth Harbor in Falmouth, are closed because of elevated bacteria levels or high densities of boats moored during the summer. Most closures around Buzzards Bay are the result of "nonpoint" land-based pollution sources, often conveyed by stormwater runoff. Therefore, it is vital to control nonpoint sources of pollution (contaminants, nutrients from fertilizers and sewage, and chemicals from pesticide use and other sources) in the Buzzards Bay watershed in order to preserve this important industry. A high priority of this Comprehensive Conservation Management Plan is to provide abatement and long-term management solutions for nonpoint source pollution.

Although commercial finfishing is prohibited within central Buzzards Bay waters, finfishing outside of this prohibited area accounts for a large portion of the region's marine economy as well as shellfishing. Recreational fishermen, shore-based recreational anglers, vessel-based anglers, and participants in charter vessel excursions, tend to conduct their activities in the warmer months of the year. Local residents have always considered the area around the Elizabeth Islands as a prime sport fishing area, particularly for the fishing of striped bass, bluefish, and black sea bass. These waters are frequented often during the summer months. Most anglers agree that the presence of a variety of habitats, and the strong currents flowing into and out of the Canal, create ideal conditions for fishing for the following species: scup, striped bass, bluefish, tautog, weakfish, black sea bass, and fluke (Colburn et al., 2002).

Watershed Municipalities

Community Profiles

Seventeen municipalities are located either totally or partially within the Buzzards Bay watershed, ten of which front directly on the bay. These municipalities are briefly described below, with town-specific demographic data presented in Table 9.[33]

Acushnet

At the headwaters of the Acushnet River, the Town of Acushnet has a business and commercial area near its borders with the Town of Fairhaven and City of New Bedford, but much of the town has retained a centuries old rural atmosphere of country roads, farms, and apple orchards. It covers 18.9 square miles, but has one of the smaller populations in the watershed, with 10,303 persons counted in the 2010 U.S. Census.

In the 19th century the town was the site of water powered factories and boat yards; and today construction and manufacturing remain important industries. Notably, the town is the home of the Acushnet Company, makers of Titleist brand golf balls, clubs and accessories.

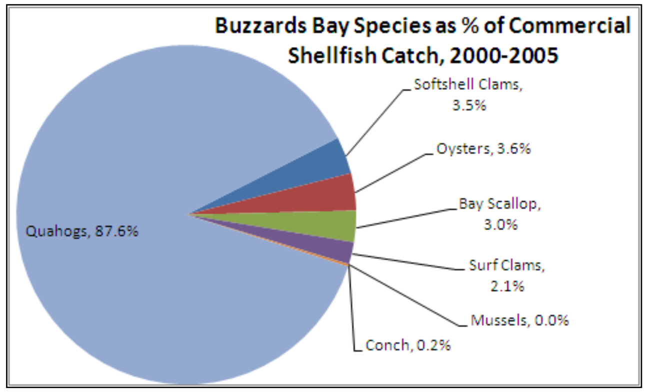


Figure 25. Relative commercial catch by species in Buzzards Bay.

Based on pounds caught for the period 2000-2005. Data and findings posted at: buzzardsbay.org/shellfish_catch_trends_bb_ma.htm.

Bourne

The Town of Bourne is a medium-sized residential and rural community at the gateway to Cape Cod, with most of the town in the Buzzards Bay watershed. The Cape Cod Canal bisects the community, with both the Bourne and the Sagamore bridges and the lift railroad bridge all located in Bourne. The town's development and character are defined by its village centers, which include the town's main business and government center in the village of Buzzards Bay on the west side of the canal, and the villages of Gray Gables, Monument Beach, Pocasset, and Cataumet on the Cape Cod side of the canal. The Bourne Scenic Park campground is located beneath the Bourne Bridge and is a perfect location for fishing and scenic bike rides. Bourne has numerous harbors and inlets for boating and swimming, and shellfishing has always been an important commercial and recreational activity in the town. The National Marine Life Center, which provides hospital and care facilities for stranded or injured marine animals, has undergone an expansion and will help drive ecotourism to the Buzzards Bay village, which has been economically depressed. A large area of the western part of the town is within the Massachusetts Military Reservation, and is undeveloped open space.

Carver

The Town of Carver today is largely a suburban commuter community. In colonial times, the discovery of bog iron ore in the region stimulated the development of iron foundries, which supported the town's economy. Later cranberry bog production dominated the local economy. Today, the town is one of the few in the state where most of the land is still in agricultural production, in this case, and cranberry growing is the single most important industry in the community.

[33] Elements of these community profiles were excerpted from or modified from the community profiles prepared by the Massachusetts Department of Housing and Community Development at Mass.gov. Last accessed March 16, 2011.

Table 9. Buzzards Bay watershed municipal demographics from 2000 and 2010 U.S. Census fact sheets.

Municipality	2000 census population	2010 census population*	2010 median age	2010 average household size	2010 median household income	2010 Total Housing Units	2010 % vacant	2010 % owner occupied
Acushnet	10,161	10,303	43.6	2.62	$64,695	4,118	4.5%	84.5%
Bourne	18,721	19,754	44.1	2.30	$62,531	10,805	27.2%	75.7%
Carver	11,163	15,059	42.3	2.68	$70,608	4,600	6.6%	91.4%
Dartmouth	30,666	34,032	39.6	2.54	$73,007	12,435	9.6%	78.5%
Fairhaven	16,159	15,873	45.3	2.33	$60,179	7,475	10.7%	71.9%
Fall River	91,938	88,857	38.0	2.27	$34,789	42,750	10.0%	35.7%
Falmouth	32,660	31,531	50.5	2.21	$61,244	21,970	36.0%	76.1%
Freetown	8,472	8,870	42.4	2.78	$61,244	3,317	4.7%	88.8%
Gosnold	86	75	48.5	1.92	$52,813	215	81.9%	41.0%
Marion	5,123	4,907	46.8	2.45	$87,793	2,445	22.5%	82.4%
Mattapoisett	6,268	6,045	47.7	2.41	$82,065	3,262	23.2%	78.6%
Middleborough	19,941	23,116	41.2	2.67	$73,490	9,023	6.2%	77.7%
New Bedford	93,768	95,072	36.6	2.40	$37,493	42,933	9.7%	42.1%
Plymouth	51,701	56,468	41.4	2.55	$76,631	24,800	14.2%	78.0%
Rochester	4,581	5,232	43.3	2.88	$98,728	1,885	3.8%	92.8%
Wareham	20,335	21,822	44.4	2.38	$52,556	12,256	25.8%	77.0%
Westport	14,183	15,532	45.6	2.52	$73,736	7,193	14.4%	81.2%

*Data taken from 2000 and 2010 fact sheets at http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml. Last accessed October 11, 2013.

Both the iron foundries and later cranberry bogs drew immigrant workers from the Cape Verde Islands and Finland, who settled in the community. In the 1940s, the town produced more cranberries than any town in the world, and today this agricultural industry remains as important to the town's economy as it had in the past, with bog acreage actually increasing in recent decades. Because so much of the land is owned by cranberry growers, the town retains its rural flavor.

Dartmouth

The Town of Dartmouth covers 62.0 square miles, and had a population of 34,032 in the 2010 U.S. Census. The town has a scenic coastline that borders Buzzards Bay with three large estuaries (the Slocum River, Little River, and Apponagansett Bay), and a large cove it shares with New Bedford (Clarks Cove). The town has appreciable farmlands, particular in the southern half of the town. The town has undertaken significant efforts to preserve the rural and agricultural character of the community through land protection. The northern portion of the town contains the Town Forest and other significant land holdings that serve as both passive and active recreational uses in order to meet the needs of the growing community. Dartmouth has multiple industrial parks with considerable areas of land available for development. The more densely developed parts of town are serviced by municipal water, sewer and gas, all at a tax rate that is one of the lowest in Massachusetts. The community is home to the University of Massachusetts at Dartmouth, a four-year higher educational institution. The town also has a number of malls and large retail stores that are patronized by residents of neighboring areas.

Falmouth

In the early 1800s Falmouth was a fishing and farming community, as well as a homeport for a significant fleet of whalers. Ships were built at Woods Hole, Quissett, and West Falmouth. From about 1870 onwards, the population increased, largely because of the growing number of summer homes, summer resort hotels, and the opening of the railroad through to Woods Hole in 1872. The increasing size and worldwide renown of the scientific institutions at Woods Hole have contributed to the growth and importance of the town. Expanding amenities have also made Falmouth attractive as a retirement community.

Falmouth is a large town geographically (approximately 49 square miles), and has one of the longest coastlines in the state (approximately 57 miles). Large tracts of land, amounting to over 1,000 acres, have been set aside for public conservation areas, not exclusively waterfront, but some woodland and back land areas that contain natural habitat for wildlife, that enhance the attractiveness of the community. Private conservation land also exists, owned by several land trusts, the largest of which is The 300 Committee.

Fall River

The City of Fall River straddles the Buzzards Bay watershed, with the developed portion of the city in the Taunton River watershed, and the mostly undeveloped portion of the city, including a protected forest inside the Buzzards Bay watershed. The city covers 38.5 square miles and had a population of 88,857 in the 2010 U.S. Census, just somewhat less than the City of New Bedford. It is located approximately 50 miles from Boston and 15 miles from Providence, Rhode Island. It is an industrial community on the banks of the Taunton River in Bristol County, formerly an important textile mill town, like New Bedford. In fact, from the 1870s until the 1920s, Fall River was the largest center in the U.S. for the manufacture of cotton textiles. The city's geography and port facilities make it both a transfer point for passenger and freight traffic to New York and the site of intense industrial development. Its diverse residential population is made up of immigrants from Portugal and Great Britain, drawn to the mill jobs in the city. While most of the textile mills closed by the 1970s, the modern city maintains a highly diversified industrial profile with chemical operations, electrical and food product manufacture, along with the remaining garment and textile industries. The city also attracts tourists with the largest factory outlet district in New England.

Fairhaven

The Town of Fairhaven is a seaside community on the shore of Buzzards Bay with 15,873 persons (2010 U.S. Census) in a 12.4 square mile area. Through the middle of the 18th century the town's economy was agricultural until a shift toward maritime activities such as shipbuilding, whaling and foreign trade occurred. By 1838, Fairhaven-New Bedford Harbor was the second busiest whaling port in the country. To date, the town's most notable features are the European-style public buildings built between 1885 and 1906 by Standard Oil Company millionaire Henry Huttleston Rogers, a native of the town. The community began taking on the character of a suburban town in the late 1870s when the street railway connected Fairhaven to New Bedford. During this time, Fairhaven began to develop as a summer resort area with significant rural areas and working farms. During the 20th century, the economy of Fairhaven was affected by the expansion then decline of manufacturing in the City of New Bedford. Today the town is known to be a suburban/fishing/resort community.

Marion

The Town of Marion covers 14.1 square miles with a population of only 4,907 (2010 U.S. Census). The town was first settled as a village known as Sippican, a part of Rochester. Rochester, Mattapoisett, and Sippican, widely separated villages under the domain of Rochester, gradually developed different interests and economies. Marion is a town that captures the essence of a classic New England village. The streets in the village section are tree lined with historic homes and white picket fences. There is a General Store in the center of the village and the Post Office is directly across the street. Marion is also home to Tabor Academy, a well-known preparatory school. Marion's Sippican Harbor, hosts a variety of waterfront programs, including swimming at the town beaches, pleasure boating and fishing. Forested swamps and wetlands that drain into the Sippican and Weweantic Rivers dominate the northern portions of the town. Today the town has a stable year-round population with a moderate summertime increase.

Mattapoisett

The 17.5 square mile Town of Mattapoisett has a population of 6,045 (2010 U.S. Census). The town was part of Rochester until 1857, when it was incorporated into a separate town. In addition to settlement by European explorers, archeologists have also found Native American burial sites in town indicating co-habitation. Forested swamps and wetlands that drain into the Mattapoisett River dominate the northern portions of the town. Shipbuilding was established around 1740, and approximately four shipyards were in operation by 1800. Mattapoisett was one of the most important shipbuilding towns on the East Coast, building some 400 ships over a period of 100 years. Prior to the Civil War, the principal business in the town was whaling. Following the decline of the whaling and shipbuilding industries, an influx of wealthy summer residents built summer homes on large estates in town. Mattapoisett became a summering place for residents of New York and Boston.

Middleborough

The Town of Middleborough is the second largest town by land area in Massachusetts. It is a 70-square mile historic industrial town on the Nemasket River, with a population 23,116 in the 2010 U.S. Census. The town is one of only a handful of southeastern Massachusetts communities that retained a sizeable Native American population throughout the colonial period. Although the iron industry dominated the federal period, Middleborough also made shovels and textiles. After the Civil War, the town became a rail center attracting industrial development, lumbering, box mills, brick making, and the Maxim Motor Company, which has been producing fire trucks since 1914. Today, cranberry agriculture is the most important single industry, with other important industries being silviculture, and the manufacture of calendars and brass goods. The town has zoned land as an industrial park to encourage additional development in the community. Tourism is driven by historic museums and antique shops.

New Bedford

The City of New Bedford is the most populous Buzzards Bay watershed municipality, with a population of 95,072 in the 2010 U.S. Census in an area covering only 20.3 square miles. The city was the whaling capital of the world in the 18th century, and has evolved to become the home of many major industries, which manufacture products used throughout the United States and abroad. The city continues to rank as the nation's number one commercial fishing port in terms of value of landed catch, and has long held title as the nation's leading supplier of sea scallops. The working waterfront is home to several national seafood-processing plants, which produce a wide array of products shipped around the world. The New Bedford Business Park, located in the far north end of the city, employs over 2500 people and accounts for approximately $650 million in sales revenue. Tourism is also a fast-growing segment of the local economy. New Bedford's rich history, its national park status and its authentic working waterfront draws increasing numbers of tourists annually. In addition, a continued increase in the number of galleries, museums, and cultural events is earning New Bedford recognition as "a city of art, "attracting professional artists, art patrons and visitors of all interests drawn to the city's growing artistic vibrancy.

Rochester

The Town of Rochester had a thriving coastal trade from its harbors on Buzzards Bay. Its coastline was lost when Marion and Mattapoisett, originally within the borders of Rochester, were made separate towns in 1852 and 1857, respectively. Parts of Rochester were also given to Fairhaven and Wareham. Rural Rochester retains many of the farms that began in the town over 300 years ago. Rochester's agricultural character, winding roads, and open space are evident as one travels throughout the town, and the landscape reflects the fact that it has one of the largest areas of any town (36.4 sq. mi.) in the watershed, but it also has one of the smallest populations (5,232 in the 2010 U.S. Census) of the mainland communities. Historic Rochester Center is still a busy central location that includes the Town Hall, First Congregational Church, Town Library, Post Office, a bakery, and the Plumb Corner Mall. Currently, there are several riding stables in town, the Rochester Golf Club, and a park in the town center that serves as the home for several sports teams. Rochester is one of only two communities in the watershed with neither municipal water nor sewer services.

Wareham

The Town of Wareham, once termed the: "Gateway to the Cape", is situated at the head of Buzzards Bay and offers easy traveling distance to the Boston and Providence metropolitan areas. The town covers 46.3 square miles, and had a population of 21,822 in the 2010 U.S. Census. The town has over 54 miles of coastline enhanced by diverse assemblage of beaches, estuaries, rivers, and ponds. These features, together with large areas of undeveloped land around a large network of cranberry bogs, create visually distinct vistas throughout the town. From its early beginnings of farming and shipbuilding in the 1700s, Wareham has evolved a diversified industrial and commercial economy, with cranberry cultivation remaining an important economic driver in the community. The town has a number of seaside villages that are mostly occupied only during the summer, but like most towns in the region, many of these seasonal residences are being converted to year-round dwellings.

Westport

The Town of Westport had long been considered a rural and largely residential community known for its beaches, cornfields, and dairy farms, but the character of the town is rapidly changing and only four dairy farms remain. Covering 52.1 square miles, the town's population was 15,532 in the 2010 U.S. Census. Westport's landscape features diverse estuarine and freshwater habitats, many of which are identified as important habitat supporting rare and endangered species. While fishing and agriculture were once important livelihoods in town, today many residents engage in service trades, and many are retirees. In the summer months, thousands of tourists visit Horseneck Beach, a state beach that contains approximately 600 acres of barrier beach and salt marsh. Nearby Gooseberry Island, accessible by a causeway, is a popular place to fish. Several Westport businesses have made national names for themselves in the past few years, such as the Westport Rivers Vineyard and Winery and the Buzzards Bay Brewing company.

Seasonality and Occupancy

There are a number of interesting trends that can be illustrated by the demographic data in Table 9, such as the relationship between owner occupancy (the inverse of rental occupancy) and vacancy rates (Figure 26). For example, the Cities of Fall River and New Bedford have relatively low vacancy rates and high rental occupancy rates. Some communities, like Falmouth, Wareham, and Bourne have high vacancy rates because a large fraction of the homes are seasonal summer use only, so these homes were either vacant during the time of the census taking (March), or they may have winter renters. At the other end of the spectrum are towns such as Carver and Rochester, whose residents tend to be year-round, and nearly all these residents own their own home. There is also a very strong correlation between median income and the percentage of renters in a community (not shown).

Municipal Governance

Of the municipalities within the Buzzards Bay watershed, only the cities of New Bedford and Fall River have mayors forming the executive branch and city councils forming the legislative branch, passing ordinances. All other municipalities have the town form of government, with boards of selectmen forming the executive branch, and town meeting forming the legislative branch, passing bylaws. Within this town form of government, there is further variation as to how many selectmen serve, whether town meeting is open to the public, or only elected representatives, and which boards have elected members or political appointments (Table 10). These variations in governance can have a profound effect on how rapid or easily a municipality can adopt environmental laws and regulations.

From an environmental management point of view, the capacity of municipal government to address environmental issues, whether through internal staffing, hiring of contractors, or its political capacity to fund programs through taxes, bonds, and fees, depends, to a very large degree, on existing tax rates, bond commitments, and the affluence of the community. The ability of a town to adopt certain measures also depends whether certain financial accounts are established, such sewer enterprise accounts, or if the town has adopted the Community Preservation Act. These specific financial strategies are touched upon, where applicable, in each action plan, and in Chapter 6 Resources for Financing the Buzzards Bay CCMP.

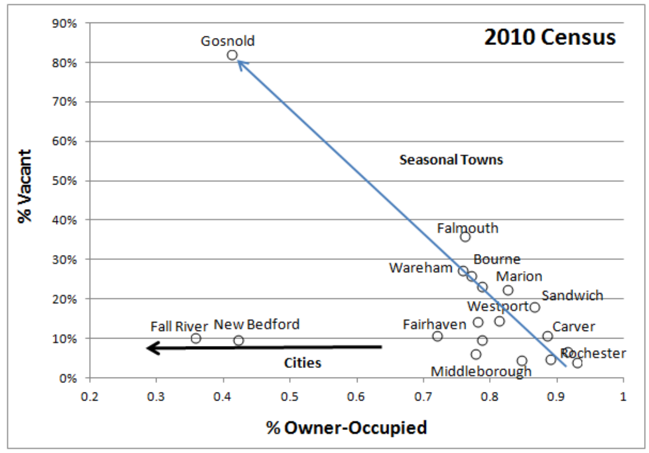


Figure 26. Census 2010 vacancy versus owner occupancy for Buzzards Bay municipalities.

Table 10. Buzzards Bay watershed municipal governance.

Municipality	Executive Branch	Legislative Branch	Administration	Health	Planning	Conservation
Acushnet	3 Selectmen	Open Town Meeting	Town Administrator	3 elected	5 elected	7 appointed
Bourne	5 Selectmen	Open Town Meeting	Town Administrator	5 elected	9 elected, 2 alts	7 appointed
Carver	5 Selectmen	Open Town Meeting	Town Administrator	3 elected	5 elected	7 appointed, 3 alts
Dartmouth	5 Selectmen	Elected Town Meeting	Executive Administrator	3 elected	5 elected, 1 alt	7 appointed
Fairhaven	3 Selectmen	Open Town Meeting	Executive Secretary	3 elected	8 Elected	7 appointed, 2 alts
Fall River	Mayor	City Council	Mayor	3 appointed	5 appointed	3-7 appointed
Falmouth	5 Selectmen	Elected Town Meeting	Town Manager	5 appointed	7 Elected	7 appointed, 3 alts
Gosnold	3 Selectmen	Open Town Meeting	Executive Secretary	3-selectmen serve as the Board of Health and Planning Board		5 appointed
Marion	3 Selectmen	Open Town Meeting	Town Administrator	3 elected	7 elected	5 appointed, 2 alts
Mattapoisett	3 Selectmen	Open Town Meeting	Town Administrator	3 elected	6 elected	5 appointed
Middleborough	5 Selectmen	Open Town Meeting	Town Manager	5 elected	5 elected	7 appointed
New Bedford	Mayor	City Council	Mayor	3 appointed	5 appointed	3-7 appointed
Plymouth	5 Selectmen	Elected Town Meeting	Town Manager	5 elected	5 elected, 1 alt	7 appointed
Rochester	3 Selectmen	Open Town Meeting	Town Administrator	3 elected	7 elected	7 appointed
Wareham	5 Selectmen	Open Town Meeting	Town Administrator	3 appointed	5 appointed 1 alt	7 appointed, 2 alts
Westport	5 Selectmen	Open Town Meeting	Executive Secretary	3 elected	5 elected	7 appointed

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Chapter 3. Characterization of Pollution Sources

Overview

Buzzards Bay remains an estuary in transition. The stresses faced by Buzzards Bay are typical of the stresses placed on many estuaries of the northeastern United States from past dumping of wastes, new development, and conflicting uses of natural resources. Along the eastern and northern shores of Buzzards Bay, dramatic coastal development occurred in the 1980s and 1990s. Owners converted small summer vacation homes into year-round residences. Property owners built an even larger number of new homes in some of these summer cottage areas. In the late 1990s and early 2000s, communities on the western shores like Westport, Dartmouth, and Mattapoisett had their own similar growth booms. In contrast, areas like the City of New Bedford, an old industrial and fishing center has had both a severe and continued population and economic decline, in part contributing to the suburban growth patterns in the surrounding communities.

Like many old industrial centers, the greater New Bedford area suffered from decades of pollution. While areas of New Bedford inner and outer harbor and Clarks Cove have seen some dramatic improvements in water quality, this area of Buzzards Bay still faces decades of prescribed cleanup and restoration.

In contrast to the success stories around New Bedford, most growth areas for development around the bay have largely experienced only continued water quality declines during the past two decades. Most of this degradation has been the result of nonpoint source pollution, and regulators have not imposed solutions, nor have towns adopted solutions voluntarily, especially for coastal eutrophication problems.

In the early 2000s, the ability of managers and government to address these problems expanded as DEP began issuing nitrogen TMDLs for some Buzzards Bay embayments, and issued a bacterial TMDL in 2009. Both these actions will have profound environmental, economic, and political impacts in the region for decades to come. Any improvements to water quality, however, will largely depend on the schedule that federal and state government mandates for compliance with these TMDLs. These issues are discussed in other chapters of the Buzzards Bay CCMP.

Management solutions for restoring and protecting Buzzards Bay require an increasingly sophisticated knowledge and understanding of pollution sources, estuarine processes, and the effect of land use on water quality. This chapter is meant to provide a cursory overview of the main pollutant issues facing Buzzards Bay and is not meant to be exhaustive. In each section, we provide footnotes to articles with more thorough discussions, or that contain data that are more specific.

Classification of Pollution Types

To simplify characterizing pollution sources, since the introduction of the Clean Water Act, managers tend to classify pollution sources into point and nonpoint sources. Point sources occur at discrete and identifiable points, usually through pipeline discharges or direct dumping. Obvious point-source discharges into estuarine and coastal waters include sewage treatment plants, industrial discharges, and combined sewer overflows (CSOs). Nonpoint sources are considered diffuse, often intermittent, and sometimes ill-defined inputs to an estuary. These sources include surface runoff, direct atmospheric deposition, underground transport from wastewater and disposal sites, and other pathways that contribute pollutants from agriculture and development to surface waters.

This classification of pollution sources largely reflected the type of discharge permit required from a state or federal agency. However, by 2000, state, and federal discharge permit programs began to treat certain nonpoint sources as permittable pollutant sources. Certain agricultural practices, such as concentrated agricultural feedlots, and water pumped from cranberry bogs also became regulated as point sources of pollution if they caused environmental degradation. In particular, the aggregating of previously considered nonpoint municipal stormwater networks under a regulatory discharge permit program (NPDES) began having profound effects on stormwater is characterized and managed. Someday septic systems could be managed under a programmatic discharge permit, depending upon the outcome of certain legal challenges to nitrogen TMDLs in Massachusetts.

Despite this shift in the regulatory classification of some nonpoint sources, throughout this Buzzards Bay CCMP, we still refer to stormwater discharges and nitrogen discharges from septic systems as nonpoint source pollution.

Wastewater Facilities

Based on 2010 U.S. Census statistics, and estimated sewer coverage in Buzzards Bay, 64,335 units or 55% of the total residential units in the Buzzards Bay watershed are sewered.[34]. Most of these units are tied to one of the six-wastewater treatment facilities shown in Table 11. All sewage treatment facilities cause, or have the

[34] Buzzards Bay NEP analysis; see the detailed explanation of this calculation in Action Plan 1 Managing Nitrogen Sensitive Embayments.

potential to cause, local decline in water quality. Because these facilities collect and treat such a large fraction of residential and commercial wastewater flow and other discharges, and will increasingly do so in the future, they warrant special attention in this chapter. In many instances, sewage treatment facilities have caused regional declines in the health of coastal ecosystems. The type of treatment provided, the location of the discharge, and the types of wastes collected by sewers are critically important to the impacts caused by these systems.

As the population in the Buzzards Bay drainage basin continues to grow, or as sewer systems continue to expand and tie in homes on onsite wastewater facilities, there will be a need to expand the capacity of existing wastewater facilities or to create new ones. Most of these systems are publicly owned wastewater treatment facilities (also called publicly owned treatment works, or POTWs); hence, the operation of these facilities and the siting of future sewage treatment facilities are critically important to the local and regional water quality in Buzzards Bay. Increasingly, with the construction of large new mixed use development projects in the northern Buzzards Bay watershed, and the consolidation of wastewater treatment for some types of commercial development, more privately operated wastewater facilities will also be built. The biggest challenge facing all these wastewater facilities, whatever their scale, is that they must be built or upgraded to comply with new nitrogen TMDLs. When permits for these facilities expire, or are updated to accommodate new flows, state and federal agencies must ensure that they meet nitrogen TMDLs, and that permits are renewed expeditiously.

Facilities discharging to surface waters are issued a National Pollutant Discharge Elimination System (NPDES) permit by the U.S. Environmental Protection Agency (EPA) in consultation with the Massachusetts Department of Environmental Protection (DEP). Massachusetts is the only state that did not delegate this responsibility. Wastewater discharges to groundwater (with system designs over 10,000 gallons per day) are issued a groundwater discharge permit by the DEP.

Table 11. Buzzards Bay major municipal publicly operated treatment facilities (1).

Permit/Municipality	**New Bedford**	**Fairhaven**	**Dartmouth**	**Wareham**	**Marion**	**Falmouth**
Permit Number	MA0100781	MA0100765	MA0101605	MA0101893	MA0100030	SE#3-168
Permit Type	surface	surface	surface	surface	surface	groundwater
Permitted Volume	30.0 MGD	5.0 MGD	4.2 MGD	1.56 MGD	0.5 MGD	1.0 MGD
Percent Sewered(2)	96%	79%	61%	50%	39%	3%
Others served	Acushnet	Mattapoisett	-	Bourne	-	-
Discharge Location	Off Clarks Point in Buzzards Bay	New Bedford Harbor (Acushnet River)	Off Mishaum Point in Buzzards Bay	Agawam River to Wareham River Estuary	Benson Brook to Aucoot Cove	Groundwater to West Falmouth Harbor
Issue date	26-Sep-08	4-Mar-03	18-Jun-09	28-Apr-08	22-May-07	15-Feb-02
Expiration date	26-Sep-13	4-Apr-05	18-Jun-14	27-Apr-13	02-Feb-12	15-Feb-03
Treatment(3)	advanced secondary	secondary	secondary	tertiary	tertiary	tertiary
Pre-treatment Program	yes	no	no	no	no	no
N limit?	no, report only	no, report only	no, report only	yes, 4.0-ppm TN seasonal	no, but seasonal ammonia limit	yes, 3.0-ppm TN seasonal

(1) There are other municipal groundwater discharge systems (Fairhaven West Island facility and Falmouth New Silver Beach facility), and some school (e.g. Mass Maritime Academy) and smaller private discharges not included here. See additional facilities in Table 12.

(2) Data as follows: Falmouth: from town reports (whole town by percent of water accounts), Wareham: Buzzards Bay NEP estimate from built parcels (residential and non residential) coded to sewer and septic (for comparison, 45% from census residential units calculation), Marion, New Bedford Fairhaven and Dartmouth: estimated from analysis of residential units in U.S. Census blocks intersected with estimated sewer maps as outlined in Action Plan 1 Managing Nitrogen Sensitive Embayments. Not shown is Bourne (9% of residential units to Wareham), Acushnet (20% to New Bedford), and Mattapoisett (39% to Fairhaven).

(3) Primary treatment: Wastewater treatment process where solids are removed from raw sewage primarily by physical settling. The process typically removes about 25-35% of solids and related organic matter (BOD). Secondary treatment: Waste treatment process where oxygen-demanding organic materials (BOD) are removed by bacterial oxidation of the waste to carbon dioxide and water. Bacterial synthesis of wastewater is enhanced by injection of oxygen. Tertiary treatment: Waste treatment processes designed to remove or alter the forms of nitrogen or phosphorus compounds contained in domestic sewage.

Figure 27. Town of Falmouth wastewater facility.

There are six major publicly owned municipal treatment works (sewage treatment facilities) in the Buzzards Bay drainage basin (Table 11, Figure 27). All of these discharge to surface waters under a NPDES permit, except the Falmouth wastewater facility, which has a groundwater discharge permit. While the Dartmouth, Marion, and main Falmouth wastewater facilities only serve their communities, the New Bedford facility also serves portions of Acushnet, the Wareham facility also serves part of Bourne (near Buttermilk Bay and the village of Buzzards Bay), and Fairhaven also serves the Town of Mattapoisett (Rt. 6 and Village Center). This sewer service is provided to the respective neighboring towns for a fee.

There are also two smaller municipal community scale facilities operated by Buzzards Bay municipalities, both of which discharge to groundwater. The Town of Fairhaven has a wastewater facility serving approximately 250 residents on West Island (permitted maximum flow of 100,000 gpd), and the Town of Falmouth has a wastewater facility serving 150 residences in the New Silver Beach area of North Falmouth (permitted maximum flow of 60,000 gpd).

The Massachusetts Maritime Academy, a state school, has a wastewater discharge NPDES permit to discharge to Buzzards Bay. The school, which has more than 1,100 students, has a wastewater discharge limit of 77,000 gpd.

A portion of the Mass. Military reservation is sewered, and its wastewater is treated at a facility outside the watershed, in the Town of Sandwich. The treated wastewater (30,000 gpd design limits, permit WE648), is then pumped 8 miles to leaching beds along the Cape Cod Canal, which are inside the Buzzards Bay watershed, so some groundwater borne contaminants from this discharge enter into Buzzards Bay via tidal flows from the Cape Cod Canal. Other groundwater wastewater discharges in the Buzzards Bay watershed over 10,000 gpd are shown in Table 12.

Table 12. Groundwater wastewater discharge groundwater permits in the Buzzards Bay watershed over 10,000 gpd not included in Table 11.

Permit	Town	Facility Name	Design Flow
SE415	Bourne	Brookside Golf Association	60,000
SE670	Bourne	Bourne Middle School	35,400
SE778	Bourne	Pocasset Assisted Living	16,350
SE515	Carver	Mass. Environ. Services	75,000
SE620	Fairhaven	West Island WWTF	100,000
SE49	Falmouth	Seacrest Condo Assoc	85,000
SE720	Plymouth	Plymouth Airport	25,000
SE711	Westport	Edgewater Apartments, LLC	11,000

The NPDES program originated with the federal Water Pollution Control Act of 1972, which required that by 1983 (later adjusted to 1988), sewage treatment facilities that discharge to surface waters must provide a minimum of secondary treatment (biological processes that remove a minimum of 85% of the organic matter). All facilities, except New Bedford, complied with the Act by 1988, and New Bedford finally completed its facility in 1994. There remain special problems faced by New Bedford with respect to their combined sewer overflow systems, and these issues are discussed below.

For the most part, detrimental effects from the discharges of sewage treatment facilities are localized near the sites of discharge, although the New Bedford discharge is of such a magnitude that it has appreciable effects over a broad area. These effects are most acute when the discharge occurs in poorly flushed areas. Both the New Bedford and the Dartmouth plants discharge to well-mixed portions of Buzzards Bay, but the other facilities discharge to coastal embayments with various degrees of tidal flushing.

Permits issued by DEP and EPA are meant to address these impacts by setting allowable concentrations, or sometimes allowable loadings, of pollutants of concern from wastewater facilities. Discharge permits generally have requirements limiting the concentrations of suspended solids, biochemical oxygen demand (BOD), fecal coliform bacteria, and chlorine in the effluent.

During the 1990s, scientists and managers recognized that nutrient levels (nitrogen in saltwater and phosphorus in freshwater systems) in the discharge also caused problems in the receiving waters, and both DEP and EPA began requiring discharge limits for nutrients. In 2006, the Towns of Falmouth and Wareham completed upgrades to their wastewater facilities that enabled tertiary treatment for nitrogen. The Wareham facility was required to limit total nitrogen to 4 ppm during the period May to October. The Falmouth facility, which discharges to West Falmouth Harbor via groundwater flow, has a seasonal discharge limit of 3-ppm total nitrogen. This facility discharges some effluent from the secondary treatment lagoons by spray irrigation. The Falmouth facility achieves a greater amount of nitrogen treatment because the tertiary treated effluent is spray irrigated onto vegetated land.

The Fairhaven treatment facility discharges to New Bedford Inner Harbor and is a significant source of nitrogen to the eutrophic harbor, but the estuary is affected by other sources of pollution, including combined sewer overflows (CSOs) from New Bedford.

The Wareham and Marion facilities discharge to streams or rivers that flow into small embayments (Agawam River branch of the Wareham River estuary and Aucoot Cove, respectively). Nitrogen from these facilities, affects the receiving waters, especially in the poorly flushed estuarine area of the Agawam River.

In contrast to these facilities, the Town of Marion wastewater facility, which discharges to Aucoot Creek, was determined not to affect Aucoot Cove, a well-flushed embayment. Nonetheless, concerns have remained about eutrophic conditions in the tidal creeks in the salt marsh where Aucoot Creek discharges.

The Town of Fairhaven wastewater facility discharges to New Bedford Harbor (Acushnet River) just behind the hurricane barrier. The Buzzards Bay Coalition water quality-monitoring program has identified this harbor as one of the most eutrophic systems in Buzzards Bay. However, because of uncertainties of nitrogen source allocation among the three municipalities surrounding New Bedford Harbor (New Bedford, Acushnet, and Fairhaven), and because of potential costs of upgrading the facility, the EPA has deferred issuing a nitrogen limit within the wastewater permit pending future studies through the DEP Massachusetts Estuaries Project.

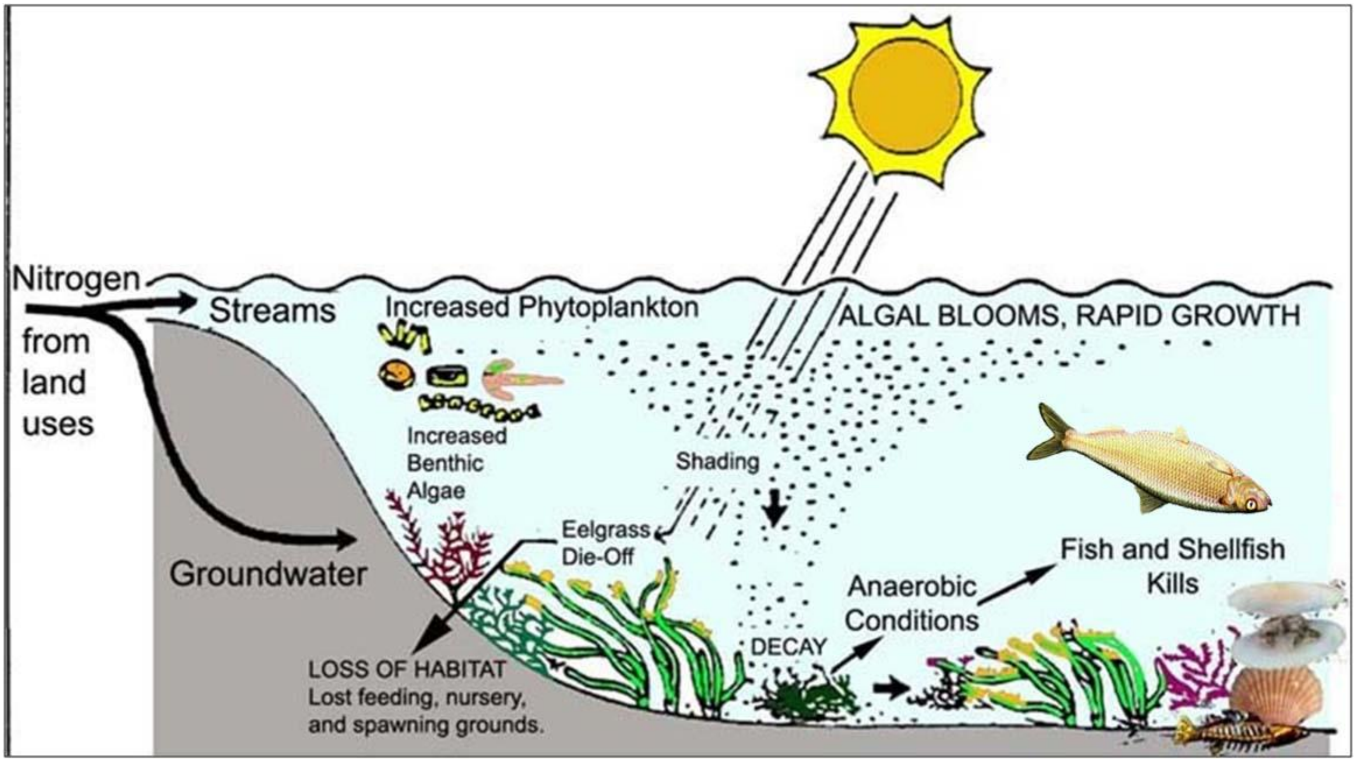
If an industry tied into the system is known to produce toxic materials, or if there has been an identified contaminant problem in the past, the permit may also contain chemical-specific limits, so that special attention can be focused on the contaminants of concern. All permits require self-monitoring by the discharger in order to demonstrate compliance with the specified permit limits. According to federal and state law, municipal plants that treat industrial and commercial contaminants must institute a pretreatment program. This program is designed to identify the sources of toxic compounds and require the contributor to reduce or remove these materials prior to their discharge into the sewer system. Each individual contributor must therefore remove specified pollutants from the flow before it is discharged into the municipal system. In some cases, industries are issued their own permits to discharge directly to the receiving water. The requirements for these permits are always at least as strict as those permit requirements for a municipal discharge.

All of the discharges are sources of bacterial contamination and require closure areas around the outfalls for the protection of public health. These discharges have a significant impact on shellfish resources and sometimes close swimming beaches. This is particularly true for New Bedford and Dartmouth and, to a much lesser extent, for the other communities. All of these treatment plants use chlorine to disinfect the treated wastewater. Although chlorine is an efficient and cost-effective means of disinfection, there is concern that chlorine residuals in wastewater discharged to the bay may have detrimental effects on marine life and the long-term viability of the ecosystem.

Until 2010, the Ocean Sanctuaries Act prohibited any new discharges from wastewater treatment plants directly into Buzzards Bay (part of the Cape and Islands Ocean Sanctuary). This included any increase over the design capacity of the discharge, even if it is of significantly higher quality, or a relocation of the outfall.

However, in 2008, because of the prospect of new industrial scale offshore electrical generating wind facilities, the Massachusetts state legislature passed the Ocean Act requiring the Massachusetts Office of Coastal Zone Management to help resolve conflicts in waters mostly more than 1/3 mile offshore. The new law required that Massachusetts Coastal Zone Management (CZM) develop an Ocean Management Plan that established “goals, siting priorities and standards for ensuring effective stewardship of its ocean waters held in trust for the benefit of the public.” It also resulted in amendments to the Ocean Sanctuaries Act that now allow new ocean outfalls through a not-yet fully defined variance process.

The anti-degradation provision of the Commonwealth’s water quality standards is a potent regulatory tool that protects the beneficial uses of the state’s waters from contamination by municipal treatment plants and other sources. The anti-degradation policy (1) safeguards present water quality conditions necessary to protect existing uses; (2) maintains water quality that exceeds the level necessary to support propagation of fish, shellfish, wildlife, and recreation unless lower water quality is necessary to accommodate economic or social development; and (3) maintains and protects outstanding resource areas designated by the state in an absolute fashion with no qualifications.



Modified from a U.S. Fish and Wildlife circular, Restore Chesapeake Bay (2/90) and the 1991 Buzzards Bay CCMP.

Figure 28. Generalized response of shallow coastal embayments to excessive nitrogen loading.

Major Issues

As populations in the basin grow, there will be a need to increase the capacity of existing wastewater facilities or to build new ones. To protect marine water quality, the preferred option for disposing of sewage appears to be land-based disposal, particularly if it includes tertiary treatment (as is the case in Falmouth). However, in many areas, land-based application is not a feasible option, because of either hydrologic conditions, or a shortage of suitable land. In these cases, other alternatives must be considered that would best protect human health and the environment. In most cases, disposal of effluent to surface waters without nitrogen removal is not desirable, particularly if they are nitrogen sensitive, or have significant living resources or uses.

All treatment plants produce sludge as a by-product. Given the capacity problem at local landfills to receive sludge, the long-term disposal is an issue. Sludge with low concentrations of toxic materials can be composted and used as a soil additive. However, sludge with high concentrations of toxic materials is harder and more costly to dispose of. Toxicants in sludge result largely from materials entering the sewer systems from homes and industry. For this reason, the reduction of toxic contaminants entering the waste must be accomplished through aggressive programs of industrial pollution prevention and if necessary, pretreatment and homeowner toxic use reduction.

Many of the treatment plants in the area have antiquated sewer collection systems. In New Bedford, sanitary sewers are combined with stormwater overflow systems (CSOs). In some towns, flows increase appreciably during storms or periods of high groundwater. The introduction of stormwater and groundwater into sewer collection systems can reduce the effectiveness of wastewater treatment. Although the cost is prohibitive to correct all the sources of groundwater and stormwater entering these sewer networks, correction of the major problem areas can improve plant operation and capacity. Water-conservation measures can also help reduce volume of flow at treatment facilities.

Priority Pollutants

In the 1991 Buzzards Bay CCMP, the Buzzards Bay NEP focused its efforts on three priority pollution problems: pathogen contamination, toxic contamination, and increasing nitrogen inputs and how they affect water quality and living resources in Buzzards Bay. The Buzzards Bay management conference selected these pollution problems because they had the greatest impact on the economic, ecological, and aesthetic values of Buzzards Bay.

These three sources remain the focus of pollution-related recommendations in the Buzzards Bay CCMP 2013 Update, but new emerging contaminants, like pharmaceuticals, also need to be addressed and are discussed in this updated management plan. Below is a thumbnail overview of the pollution sources and impacts to Buzzards Bay and the surrounding watershed.

Nutrients and Eutrophication in Buzzards Bay

Nitrogen, the primary nutrient of concern in marine waters such as Buzzards Bay, is essential for the proper growth and reproduction of individual organisms and, consequently, for the general productivity of the bay. In nature, nitrogen occurs in many forms (e.g., ammonia, nitrates). The addition of excessive amounts of nitrogen (also called “nutrient enrichment” or “nitrogen loading"), to coastal waters results in eutrophication and a general decline in the health of coastal ecosystems (Howarth et al., 2000).[35]

In general, excessive nutrient inputs can result in increased growth of microalgae (such as phytoplankton, for Buzzards Bay see Turner et al. 2009) and macroalgae (seaweeds), which in turn changes the distribution and abundance of species present and in food-web relationships. For example, increased turbidity from phytoplankton growth prevents sunlight from reaching submerged vegetation like eelgrass, and beds of eelgrass begin to disappear (Short et al., 1996). Because eelgrass beds are a valuable habitat and nursery for many organisms, the loss of this community can cause shifts in many populations of animals. Excessive algal growth, coupled with decay of accumulated algae, may result in the depletion of oxygen in the water. Depressed oxygen concentrations (anoxia or hypoxia) can lead to fish kills and death of sensitive benthic organisms. These events are graphically represented in Figure 28 and have been discussed in numerous reviews.

There is also increasing evidence that the effects of high nutrient loading, turbidity and the release of dissolved organic matter from algae, contribute to the prolonged survival and possible growth of coliform bacteria in coastal waters (e.g., Davies et al., 1995; Byappanahalli et al., 2003; Haller et al., 2009). Because coliform levels are used to classify swimming and shellfish areas, nutrient loading may contribute indirectly to the closing of these areas.

Coastal embayments receive nitrogen from a variety of sources including onsite wastewater systems (generally called septic systems), centralized wastewater treatment facilities, atmospheric inputs, and fertilizers used on lawns, golf courses, and agricultural areas. The nitrogen from these sources is conveyed to the bay by effluent outfalls, streams and rivers, overland runoff, and groundwater that drains from the land. The relative importance of these sources depends on the specific land use within each drainage sub-basin.

Elsewhere, atmospheric nitrogen loading is often the focus of management concern, and using the MEP loading model rates, it accounts for a third of the total nitrogen load to Buzzards Bay as a whole (Table 13). However, only about half the dissolved inorganic nitrogen from the atmosphere can be considered pollution from human sources, the other half is part of a natural global nitrogen cycle. Moreover, the central area of Buzzards Bay is not nitrogen impaired; instead, the fringing embayment systems suffer impairments, and in these areas, atmospheric deposition accounts for typically 15% or less of estuary nitrogen loading.

Another important facet of nitrogen inputs from the atmosphere is that they have been declining in the northeastern US for several decades, partly because of Clean Air Act regulatory mandates (Christopher et al., 2005). Despite the decline in atmospheric nitrogen loading, indicators of nitrogen loading such as eelgrass distribution (e.g. Figure 10) support the idea that increases in local watershed loading; not atmospheric loading is the cause of these declines. That is, the dramatic declines of eelgrass around Buzzards Bay during the 1980s and 1990s appeared to follow the rapid population growth and development in the region during the 1970s and 1980s, with water quality and habitat in some estuaries continuing to decline today. More recent water quality data show that trends in declining water quality are continuing in some embayments (Figure 29).

In the 1991 Buzzards Bay CCMP, it was recognized that many areas of the bay were impaired by eutrophication, and that nitrogen sources in the watershed around each embayment were the principal sources of this coastal eutrophication. It was stressed that each watershed had its suite of nitrogen sources, and each watershed needed a management strategy customized to those sources. A concern of many was that the wastewater discharges from New Bedford (the wastewater facility outfall and CSOs) were very large, perhaps accounting for half the watershed loading (exclusive of precipitation to the bay). Nonetheless, the impacts from these discharges were largely confined to within a few miles of the outfalls (Borkman and Turner, 2003; Turner et al., 2000, 2009), and expressed mostly in the form hypoxia with respect to eutrophication impacts.

Twenty years later, nitrogen concentrations and organic loadings from the New Bedford wastewater facility discharge have declined, as has the volume of the CSO discharges. Sewering in other towns has also expanded. Today, at the Buzzards Bay basin level, the New Bedford wastewater facility and CSOs now account for only about 20% of the total non-atmospheric

[35] Andersen et al. (2006) defined eutrophication as ’the enrichment of water by nutrients, especially nitrogen and/or phosphorus and organic matter, causing an increased growth of algae and higher forms of plant life to produce an unacceptable deviation in structure, function and stability of organisms present in the water and to the quality of water concerned, compared to reference conditions.’

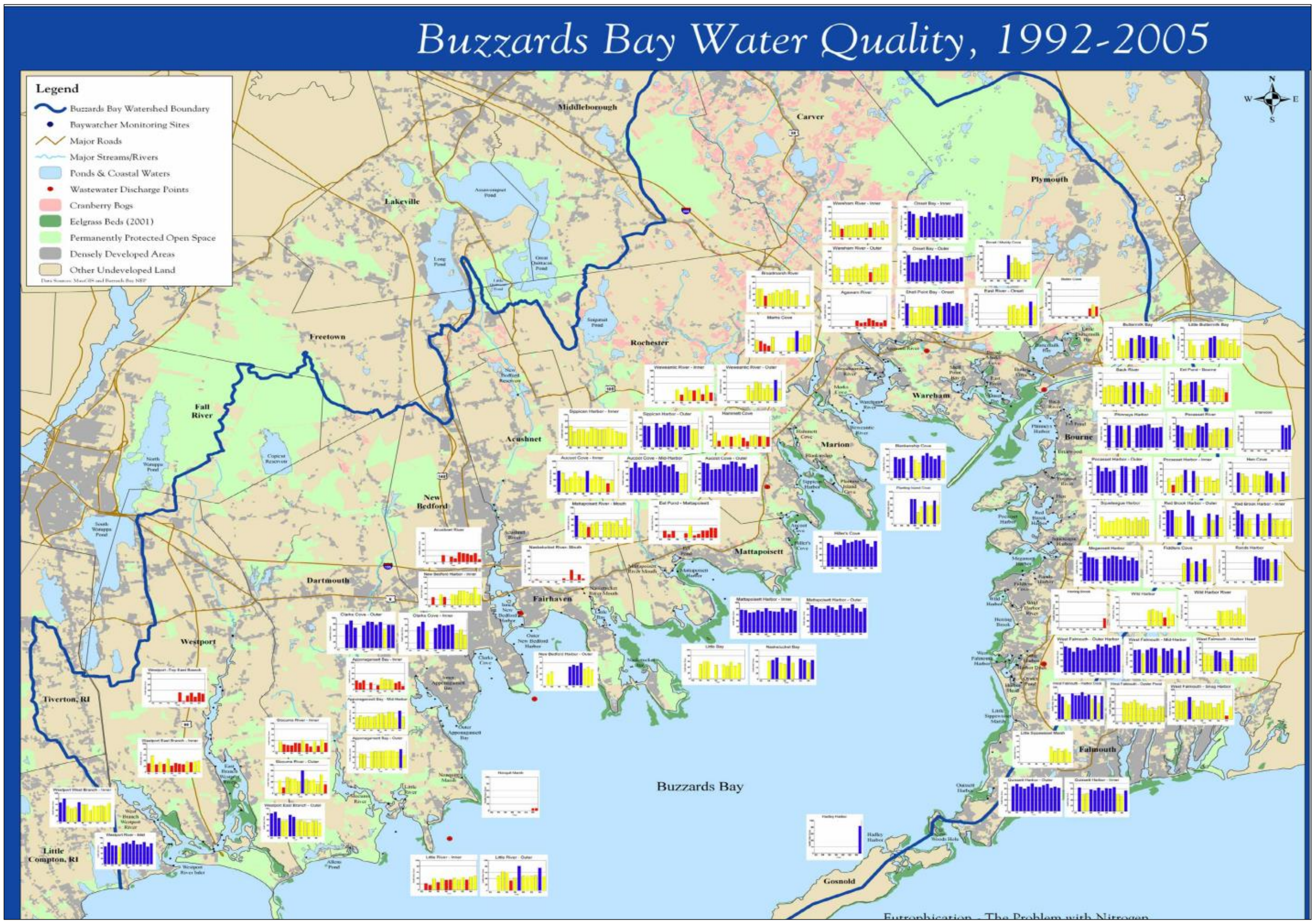


Figure 29. Embayment eutrophication trends from a 2005 Buzzards Bay Coalition bay health index poster.

loading, but the New Bedford outfall is still the single largest non-atmospheric source, and collectively all wastewater outfalls still discharge roughly twice the nitrogen discharged to Buzzards Bay as from septic systems (see Table 13). This is true because more than half the watershed population and most of the industrial businesses in the watershed are connected to these sewer networks.

Despite these statistics, sewage outfalls are generally not the largest source of nitrogen in most embayment watersheds. The more serious effects of nitrogen loading observed in Buzzards Bay occur in the localized network of shallow embayments that border the bay, and the water quality in these systems is the result of inputs from the mostly “non point” sources particular to their surrounding drainage basin. As shown by Table 13, septic systems remain the largest single nitrogen source in most embayments.

Septic systems release large amounts of nitrogen as ammonia, which is rapidly transformed in the groundwater to nitrate in the presence of oxygen. In general, nitrate in groundwater flows great distances without attenuation (or dilution) and with little chance of uptake by plants, although the latest MEP nitrogen models generally assume that about 50% of the nitrogen is lost when it enters ponds, and 30% through the passage of large river systems, but those findings vary among watersheds.

The sources of nitrogen in a watershed can be diverse, and deciphering their contributions can be difficult and complex to resolve. For example, in Phinneys Harbor, septic systems now account for 63% of the nitrogen to the watershed (Figure 30). In rural agricultural areas like Westport, far more nitrogen is contributed to the estuary by fertilizers and animal wastes than by septic systems. In a recent draft TMDL report for the estuary, waste from dairy and beef cows alone, exceeds loading from septic systems in the watershed. In the town of Wareham, loadings from the wastewater facility and cranberry bogs together exceed septic system loadings (Figure 31).

Table 13. Comparison of wastewater and atmospheric nitrogen loading (kg/y) to Buzzards Bay and its subwatersheds.

Embayment	Water area mi^2	Basin Land area mi^2	est. subbasin occupancy	septic system load	wastewater facility and CSO load	atmosphere to embayment	Watershed +atmosph. +outfalls	Comment
Allens Pond	0.30	3.17	2.7	496	0	839	5,707	(1)
Apponagansett Bay	0.52	7.67	3.0	2,718	0	1,461	24,213	(1)
Aucoot Cove	0.50	4.06	2.6	1,970	5,490	1,406	12,787	(1)
Brant Island Cove	0.13	0.64	2.3	419	0	371	1,225	(1)
Buttermilk Bay	0.83	9.91	2.1	16,941	0	2,333	33,175	(1)
Clarks Cove	1.10	2.91	2.5	0	8,845	3,117	30,813	(1)
Hen Cove	0.10	1.67	2.0	2,364	0	283	5,244	(1)
Little Bay	0.29	5.46	3.0	6,821	0	807	31,192	(1)
Little River	0.13	2.05	3.3	773	0	378	4,603	(2)
Mattapoisett Harbor	0.61	26.82	3.0	16,554	0	1,733	51,071	(1)
Megansett / Squeteague Harbor	0.66	4.50	2.5	6,206	0	1,853	31,168	(1)
Little Bay / Nasketucket Bay	0.29	5.46	3.0	6,821	0	807	31,192	(1)
New Bedford Harbor (Acushnet River)	1.49	26.17	2.4	15,503	62,839	4,197	93,830	(3,6,7)
Onset Bay	0.92	4.82	1.9	6,527	0	2,605	18,578	(1)
Phinneys Harbor / Back River	0.84	4.87	2.4	7,934	0	2,365	21,230	(1)
Pocasset Harbor	0.39	1.09	1.4	2,268	0	1,090	5,806	(1)
Pocasset River	0.31	3.33	2.5	4,841	0	872	9,449	(1)
Quisset Harbor	0.18	0.52	1.6	604	0	512	2,234	(1)
Red Brook Harbor	0.24	3.98	2.4	2,582	0	665	9,299	(1)
Sippican Harbor	0.66	3.83	2.7	4,769	0	1,853	18,189	(1)
Slocums River	0.76	36.61	3.0	8,710	0	2,147	34,234	(3)
Wareham River	0.96	43.00	2.3	12,118	9,184	3,950	52,332	(3,4,5)
Weweantic River	0.92	82.77	2.8	43,085	0	2,594	162,264	(1,4)
West Falmouth Harbor	0.31	3.48	2.0	3,665	7,980	910	24,125	(2)
Widows Cove	0.21	2.02	1.8	125	0	589	1,765	(1)
Wild Harbor	0.19	4.04	1.6	4,091	0	534	9,467	(1)
Wings Cove	0.34	1.29	2.7	1,033	0	959	4,319	(1)
Westport Rivers	5.15	68.98	2.9	43,158	0	17,020	192,289	(2)
Non-embayment watersheds						5,799	114,631	(1)
Buzzards Bay, precipitation to bay						716,799	716,799	(5)
New Bedford Wastewater Outfall					368,214		368,214	(6)
Dartmouth Wastewater Outfall					97,892		97,892	(6)
Grand Total				223,097	560,444	780,848	2,219,337	
% of total				10%	25%	35%	100%	

(1) Buzzards Bay NEP approximation from MassGIS land use and MEP loading assumptions.

(2) MEP draft or final report, includes precipitation to estuary areas.

(3) Buzzards Bay NEP estimate from parcel data and other sources.

(4) Calculation using MEP 2000-2010 cranberry bog loading rates.

(5) Atmospheric loading to entire bay surface in the NEP study area (MA waters to RI border), but does not include estuary surface waters in embayment watersheds (total= 162,429 acres), times the MEP loading rate of 4.41 kg per acre.

(6) Outfall loadings as reported to EPA, July 2010 to June 2011, at echo.epa.gov/?redirect=echo.

(7) Total based on Fairhaven Outfall data as per note 6 and CSO estimates in a draft MEP report.

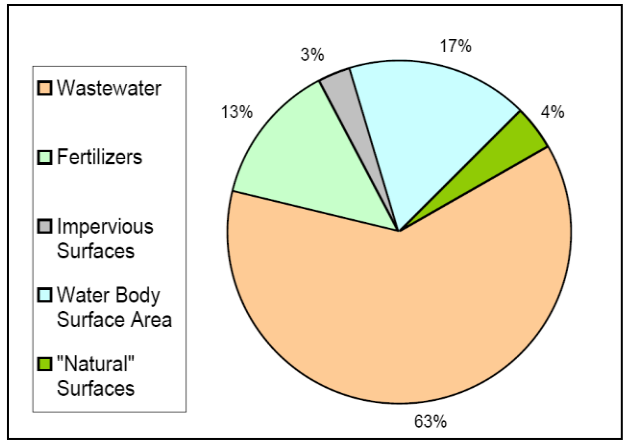
Management Responses to Nitrogen Pollution

Buzzards Bay remains an estuary in transition, and many embayments have shown declining water quality because of nitrogen discharges associated with increased development (Figure 29). In the 1980s, many government officials believed the bay's pollution was largely caused by the legacy of industrial and wastewater pollution from the greater New Bedford area. However, today it is widely understood that each embayment is adversely impacted by land use in its surrounding watershed. With the advent of increasingly sophisticated knowledge and models of estuarine processes in response to nitrogen pollution, local government is now in an excellent position to address coastal eutrophication caused by nitrogen loading. Furthermore, the Massachusetts DEP is now helping develop, and the U.S. EPA is approving, nitrogen TMDLs for impaired coastal embayments, as required by the Clean Water Act. Nitrogen pollution, and the complex political, financial, and regulatory issues and solutions surrounding the problem are the subject of Action Plan 1 Managing Nitrogen Sensitive Embayments.

Pathogen Contamination

Degradation of water quality due to contamination by pathogens represents a serious health risk and economic loss to many parts of Buzzards Bay. The pathogens associated with sanitary waste disposal that are of primary concern to humans are disease-causing bacteria and viruses. Some bacteria are free-living organisms able to survive on their own and grow in an aquatic habitat; viruses, on the other hand, can grow only inside a suitable host. Of the many different viruses associated with human wastes, most are responsible for causing gastrointestinal illness, but some cause significant illnesses such as hepatitis and polio. Pathogenic bacteria found in waste material are responsible for a variety of diseases.

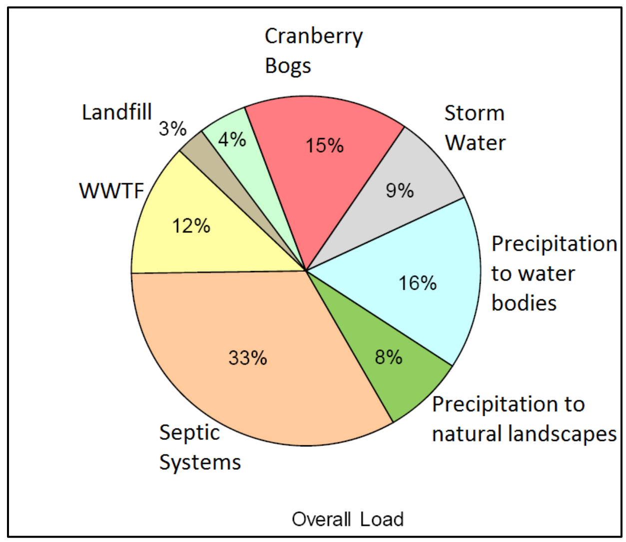
The presence of certain bacteria (fecal coliforms or Enterococci) in waters overlying shellfish harvesting areas and swimming beaches has historically been the primary index of the "health" of Buzzards Bay. Because public health agencies are not able to measure the entire spectrum of potential human pathogens in the water directly, these "indicator" bacteria are used to assess the probability of the presence of pathogens and human health risks. Enterococci have been the principal indicator used for swimming beaches since about 2001. Managers have used fecal coliforms for evaluating pathogen risks in shellfish since the 1980s. Formerly 'total coliforms' a superset of fecal coliform, was used by health agencies as the basis of regulatory action for both swimming and shellfish areas back to the 1920s.



From Howes et al., 2006.

Figure 30. Sources of nitrogen to Phinneys Harbor-Back River estuary complex in Bourne as reported by the MEP.

Because a small percentage of this loading is attenuated, the ratio of sources of nitrogen actually reaching the bay is quite similar.



From Howes et al., 2013.

Figure 31. Sources of "attenuated" nitrogen to Wareham River estuary as reported by the MEP.

Large numbers of fecal coliform bacteria are present in the fecal material of warm-blooded animals. For the most part, most fecal coliforms themselves are not pathogenic, but are often found associated with other organisms that do cause disease in humans. When predetermined concentrations of fecal coliforms are reached, the area is considered unsafe for certain uses. Shellfishing is prohibited when concentrations reach 14 fecal coliforms per 100 milliliters (ml); bathing may be closed by the public health agency overseeing the beach when bacteria concentrations reach 200 fecal coliform per 100 ml.

A number of problems are associated with the use of fecal coliform as an indicator of public-health risk. Although this method may protect human health from bacterial pathogens, the same may not be true for viral pathogens. Under certain circumstances, fecal coliforms bear little, if any, quantifiable association with pathogens of concern, including viruses such as hepatitis A. In addition, the fecal indicator does not differentiate between human and animal wastes. The health risk and implications of the presence of fecal coliform originating from nonhuman sources have not been determined.

Prior to 2001, in Massachusetts, under Chapter 111 of the Massachusetts General Laws, the Massachusetts Department of Public Health regulations (105 CMR Section 445) required that bathing beach samples be taken at least twice monthly during the bathing season. These regulations had also failed to spell out any objective standard requiring beach closure, and instead state, "A [total] coliform count of 1000 per 100 ml shall be considered a guide requiring additional investigation, survey, or special analyses as may be necessary."

All this changed in 2001 when the Massachusetts Department of Public Health issued new regulations requiring weekly testing, and a new bacterial standard for public and semi-public beaches[36]. For marine waters, the Enterococci became the indicator organism[37], and for fresh water, the indicator organisms became either E. coli or Enterococci[38].

Sewage Treatment Plants

The most significant potential point sources of human pathogens into Buzzards Bay are the discharge of sanitary wastes from sewage treatment plants (Figure 32). The combined capacity of all such discharges to the bay exceeds 37 million gallons per day (MGD). Although these plants should be discharging only disinfected wastewater, occasional plant malfunctions and failures do occur. In general, closed "safety zones" around the immediate discharge areas are designed to protect the public from exposure to pathogens and are sized to allow adequate time to close adjacent shellfishing areas in the event of plant failure. However, a growing body of scientific evidence strongly suggests that, in some cases, traditional fecal indicator organisms are not adequately portraying real pathogen risks. For example, following chlorination, many pathogens, as well as fecal coliforms, may enter a temporary state where they may not be detectable using standard assay methods, but may later recover and pose a health risk. Fecal coliforms may also die off more rapidly than some viruses. Because of the high volume of untreated sewage that they release, CSOs in New Bedford are a major source of fecal coliforms to Buzzards Bay. The impacts of bacteria and pathogens from both sewage treatment facilities and CSOs are largely localized near these discharges.

Vessel Sanitary Wastes

Discharge of sanitary wastes from marine craft is a locally significant direct source of pathogens to Buzzards Bay. The more than 4,300 slips and moorings in the bay and the nearly 20,000 vessels passing through the Cape Cod Canal yearly create a considerable potential for waters to become contaminated with untreated sanitary waste from boats. Because of the intermittent and often covert nature of disposal from vessels, the overall impact of sanitary wastes on Buzzards Bay is difficult to assess. Roughly, 60% of the marinas in Buzzards Bay provide pump-out facilities. Marinas that do have these facilities report that they are seldom used.

The impact of sanitary waste pollution from boats tends to be site specific. In poorly flushed areas that have low dilution, the effect may be substantial and unpredictable. Health implications are difficult to evaluate from such unpredictable, and usually undetectable, changes. Nonetheless, direct illegal discharge of human wastes is a potential threat that managers must address because of the large number of boats using Buzzards Bay.

On-Site, Sub-Surface Sewage Disposal

Approximately half of the residents of the Buzzards Bay watershed use on-site, subsurface sewage disposal systems (cesspools or septic systems) to dispose of sanitary wastes. Construction of these systems is regulated by the state's sanitary code, known as Title 5, which sets minimum standards for design and placement. Pathogens are removed from septic-system wastes by two mechanisms: physical retention (or straining) by the receiving soil, and adsorption (or adherence) of pathogens onto soil particles.

Some larger onsite systems collect waste from commercial development and apartments, as well as smaller shared systems. If any of these groundwater discharges exceed 10,000 gallons per day, they must have a state permit issued by the Massachusetts Department of Environmental Protection (Figure 33). Developers often either scale back, or segment projects to create discharges less than 10,000 GPD to avoid state permit requirements.

[36] Semi-public beaches are those operated by trailer parks, campgrounds, motels, condominiums, clubs, and similar entities.

[37] The standard became, "No single Enterococci sample shall exceed 104 colonies per 100 ml and the geometric mean of the most recent five (5) Enterococci levels within the same bathing season shall not exceed 35 colonies per 100 ml."

[38] The new standard was either: 1) No single E. coli sample shall exceed 235 colonies per 100 ml and the geometric mean of the most recent five E. coli samples within the same bathing season shall not exceed 126 colonies per 100 ml or (2) No single Enterococci sample shall exceed 61 colonies per 100 ml. and the geometric mean of the most recent five (5) Enterococci samples within the same bathing season shall not exceed 33 colonies per 100 ml.

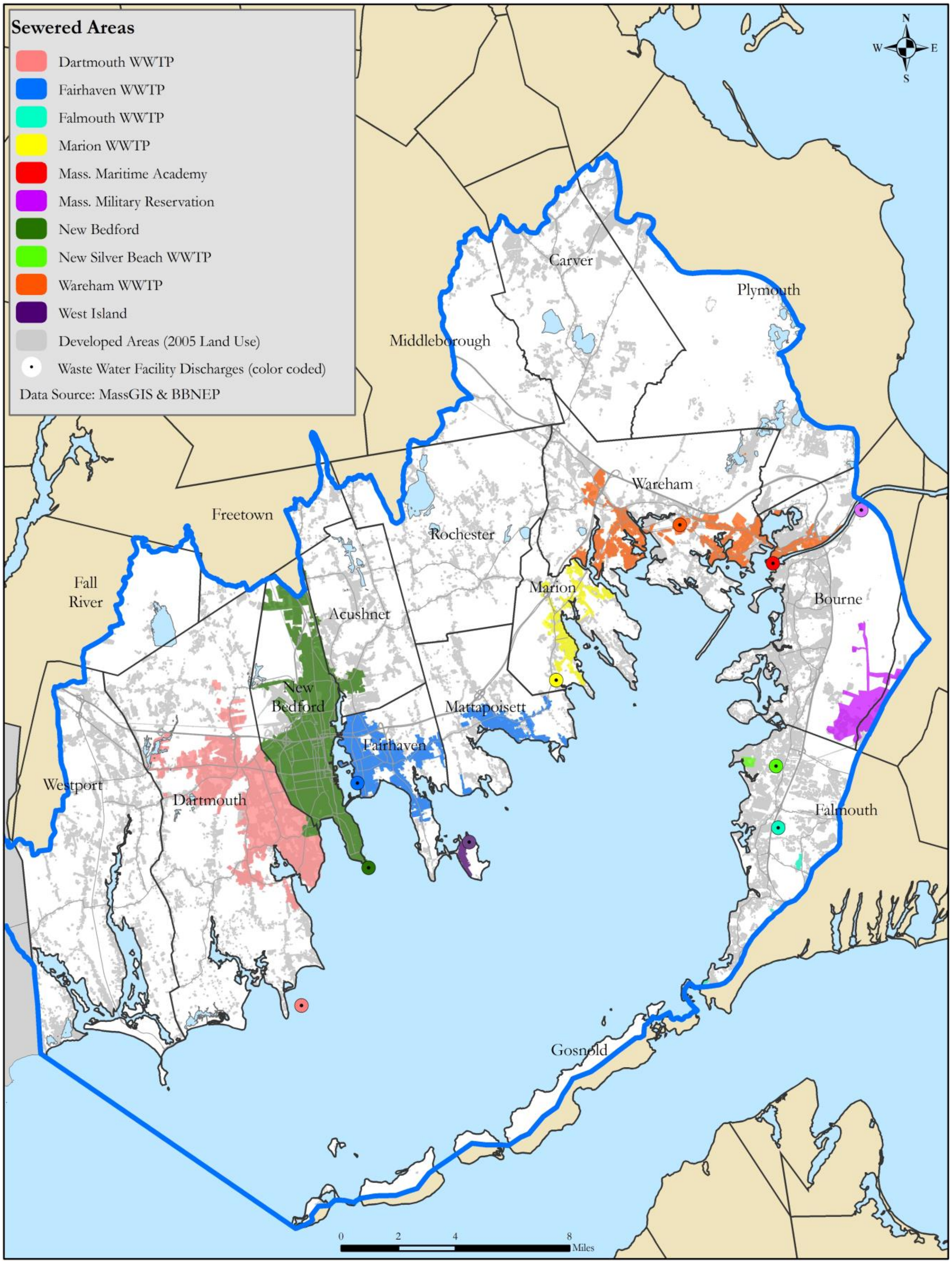


Figure 32. Sewered areas of the Buzzards Bay watershed as of 2010.

Municipal wastewater discharges located color-coded circles.

With the rewrite of the state Title 5 regulations in 1995, the code was amended to include performance standards for nitrogen concentration for nitrogen removal systems. The new code also set total suspended solids (TSS) and biological oxygen demand (BOD) limits for alternative design systems where separation to groundwater, or other design standards cannot be met, or where the system was sited in a nitrogen sensitive area. Title 5 only conferred the nitrogen standard to "nitrogen sensitive areas" (borrowing the term from the 1991 Buzzards Bay CCMP), which by default, only automatically included Zone 2 recharge areas of public wells. Other nitrogen sensitive areas were to be designated under an undefined state designation process that was never implemented. The lack of other types of nitrogen sensitive designations occurred because DEP had decided that the best process for tackling the nitrogen problem was through the more comprehensive efforts under the TMDL process.

Pathogen contamination of Buzzards Bay from onsite wastewater systems can occur in at least three ways. The most obvious threat to public health is an overt system failure. Such a failure occurs when soils can no longer receive septic effluent, and sewage collects on top of the septic system, often breaking out onto the surface of the ground. Sewage may then be transported into the receiving waters by stormwater drainage systems or overland flows. Overt system failure during dry weather probably plays a minor role in the overall pathogen contamination of Buzzards Bay. During heavy rains, many inadequately designed or maintained systems overflow, and this may be a significant source of coliforms in some areas. Many of these failures can be prevented by routine maintenance such as pumping out the solids that collect in the tank.

Closely related to overt failure is the existence of overflow pipes. Such pipes were once connected to the leaching component of septic systems to prevent failure and subsequent surface breakout. Overflow pipes were often designed to empty directly into a major water body or connecting ditch or stream. This practice of connecting overflow pipes is thought to have been quite common in past years, but is now illegal. Past surveys by state and local authorities has documented the locations of many of these overflow pipes around Buzzards Bay, and resulted in their elimination.

Improperly functioning (hydraulically failing) septic systems have long been recognized as a potential contributor of bacterial contamination of the bay. For decades, concerns have been raised about bacterial contamination of groundwater, and these concerns have been the basis of the 100-foot setbacks of septic systems from public and private wells. Still, studies conducted by the Buzzards Bay NEP in the 1980s documented that soils filter pathogenic bacteria out of wastewater over a distance of only a few yards (Heufelder, 1988), and this conclusion has been affirmed in subsequent studies (e.g. Bales et al., 1994). Virus transport remains an ongoing concern (e.g. Nicosia et al., 2001), and these concerns will remain the basis of setbacks of septic systems from water supplies.

Stormwater Runoff

Stormwater refers to that portion of precipitation that is returned to a water body via surface routes from an adjacent land mass. Although precipitation when it falls is generally devoid of fecal indicator organisms, as it flows over the ground, it washes debris and sediments into surface waters. This debris may be composed of, or contaminated with, human or animal wastes.

Historically, stormwater was managed simply to reduce or eliminate local flooding or to drain road surfaces for safety. Roadways and other developments are often designed so that excess water collects in drainage basins, ditches, and pipes, and is then directed to the nearest river, stream, estuary, or other surface water body. Little thought was given to the environmental impacts of these discharges. New development further contributed to the amount of runoff to existing stormwater networks by increasing the amount of paved or impervious surfaces and reducing the surface area available for precipitation to percolate naturally into the ground.

An additional facet of stormwater runoff that is of particular significance in agricultural areas is the sheet flow from landmasses. In this case, instead of being collected and discharged through pipes, the flow is unconsolidated and enters the receiving water in broader, less defined areas.

Numerous investigations have confirmed that stormwater runoff is a major contributor of fecal indicators to surface waters. Agricultural runoff, which dominates the western portion of the bay near Westport, and urban runoff, which dominates New Bedford, and other urbanized areas of the watershed, enters the bay both at discrete points such as pipes and open ditches and in broader, less defined areas of sheet flow.

Two distinct classes of urban runoff enter Buzzards Bay. Many older cities, including New Bedford, built wastewater systems combining stormwater and commercial and residential sewerage in a single pipe, referred to as a combined sewer. During heavy rainstorms, the waste treatment facility in New Bedford is unable to handle the combined volume of sewage and stormwater, and the untreated excess flow is discharged directly into Buzzards Bay through overflow pipes. These pipes are called combined sewer overflows or CSOs. There were 38 such discharges into the Acushnet River Estuary and Clarks Cove when the Buzzards Bay CCMP was completed in 1991. Since that time, 15 have been eliminated by the City of New Bedford (Figure 34). Data show that the highest densities of fecal coliform from all storm pipes investigated generally come from CSOs.

In addition to the CSOs of the New Bedford area, stormwater from other urban or suburban areas around the bay often shows high fecal coliform counts, even where storm and sewer systems are not tied together. The source of elevated coliform concentrations in non-CSO stormwater discharges is the subject of considerable speculation. In some cases, the contamination is believed to originate from pets or wildlife. In other cases, the contamination was due to accidental or illegal septic home hook-ups to stormwater pipes, illegal septic overflow pipes, or from failing septic systems whose sanitary wastes may pool on the top of the ground and find a surface pathway to the receiving water during a rainstorm. Some of these problems can be difficult to identify without upstream testing of stormwater.

Under the Interstate Shellfish Sanitation Program, the Massachusetts Division of Marine Fisheries (DMF) is responsible for conducting shellfish area sanitary surveys in Massachusetts waters every few years to identify existing and potential sources of coliform and pathogens in shellfish resource areas.

These surveys have identified more than 500 discharge pipes in open shellfish resource areas in Buzzards Bay and ranked their potential for contamination. This information is routinely used by the Buzzards Bay NEP and Buzzards Bay municipalities to prioritize stormwater pipes and other sources for remediation, along with other data sources, like the Buzzards Bay stormwater atlas.

The extensive use of the western shore of Buzzards Bay, particularly near Westport, for agricultural purposes makes this area highly susceptible to agricultural runoff. Fecal coliforms from this type of runoff originate primarily in animal feces, resulting from animal husbandry and crop-management practices (i.e., manure spreading).

Wildlife, Waterfowl, and Domestic Animals

Animal wastes enter Buzzards Bay in at least two ways. Stormwater, previously discussed, periodically washes animal wastes from both wildlife and domestic animals into the bay. A more continuous input is from aquatic birds such as Canada Geese and other shore birds. The effects from these inputs vary. Generally, the impact is less in well-flushed areas and greater in poorly flushed areas with organic sediment where the longevity of bacterial species is enhanced. A Buzzards Bay Project study in Buttermilk Bay has indicated that waterfowl waste can accumulate in other protected environments such as beach wrack (the free-floating plant material that washes up with the tide), which appears to

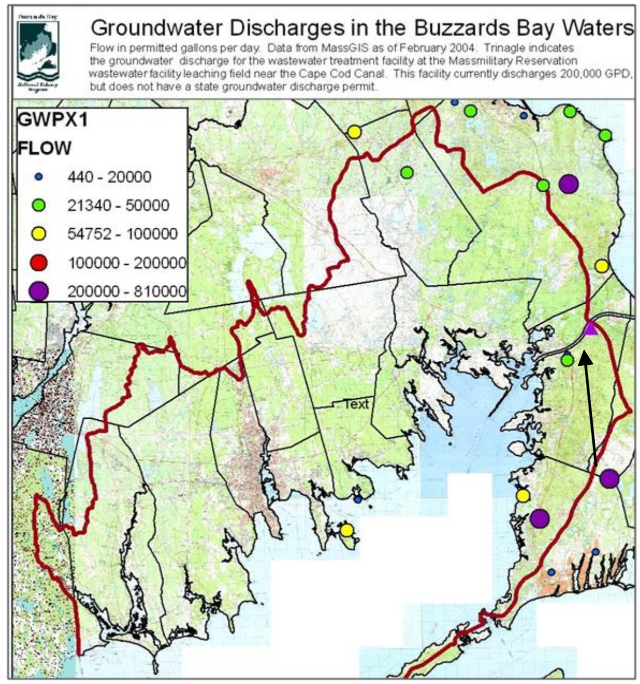


Figure 33. Groundwater discharges in the Buzzards Bay watershed.

Nearly all are wastewater discharges. All have state groundwater discharge permits except a 200,000 gallons per day infiltration bed operated by the federal government for wastewater disposal for the Massachusetts Military facility (outside the watershed), which was relocated in the 1990s to a leach field near the Cape Cod Canal. This discharge is shown as the magenta triangle near the Cape Cod Canal.

prolong bacterial survival (Heufelder, 1988). Thus, it is believed that wildlife, waterfowl, and domestic animals may be locally important sources of coliform contributing to the closure of resource areas.

Other Sources of Coliforms and Pathogens

Although not an original source, certain sediments in Buzzards Bay may act as a protective sink for fecal coliform and pathogens, releasing them back into the water column when the sediment is disrupted during storms or tidal fluxes. It is likely that in areas close to point-source discharges, such as CSOs and stormwater pipes, the sediments provide a protected habitat for settled microorganisms and prolong their survival. Soft organic sediments (e.g., muds) are more able to support bacterial survival and viral stability than are inorganic sediments such as sand and gravel. The introduction of nutrients from septic systems or sewage treatment plants may also play a role in the proliferation of pathogens harbored in sediments (Heufelder, 1988).

In addition to coliforms and pathogens stored in protective sediments, a number of human pathogens have been found to be normal inhabitants of estuaries elsewhere. No attempt has been made to document the presence of these pathogens in Buzzards Bay, but it is presumed they exist.

Toxic Contamination to Buzzards Bay

Buzzards Bay receives a wide range of toxic or carcinogenic chemical contaminants from industrial and municipal wastes, dredged material, atmospheric fallout, river inputs, and other nonpoint pollution sources (Howes and Goehringer, 1996). Chemical contaminants enter Buzzards Bay through accidental oil spills, effluent discharges, river discharges, atmospheric transport and deposition to the bay, or deposition to land and direct runoff to the bay. Chemical pollutants associated with urban and industrial activities enter Buzzards Bay primarily in the western portion near the New Bedford, Fairhaven, and Dartmouth urban areas. Chemicals associated with agricultural activities are more likely to enter the bay from runoff, creeks, and small rivers in the Westport, Dartmouth, Fairhaven, Mattapoisett, Marion, Wareham, Bourne, and Falmouth areas. Chlorine residuals from disinfected sewage discharged from treatment plants may also represent a threat to marine organisms.

The greater New Bedford area is clearly the major contributor of chemical contaminants to Buzzards Bay. The harbor itself is extremely polluted with polycyclic aromatic hydrocarbons (PAHs), trace metals, and polychlorinated biphenyls (PCBs) because of industrial discharges between the 1940s and 1970s and stormwater runoff. On a regional scale, stormwater runoff, particularly from paved surfaces, is also a major source of hydrocarbons to Buzzards Bay.

Evaluation of the fate and effects of chemical contaminants in the marine environment requires an understanding of the temporal and spatial distribution of contaminants; the partitioning of contaminants in the ecosystem among the sediment, the water column, and the living resources; and the level of damage imposed by accumulation of contaminants in the living resources.

Concern about toxic contaminant input to coastal waters is focused on the accumulation and transfer of metals and organic contaminants in marine food webs, including accumulation in seafood species and potential impacts on human health. These concerns are often expressed by regulatory agencies in the form of advisories against the consumption of fish. Figure 35 shows some freshwater ponds in Buzzards Bay so listed. Additional concerns include toxic effects of contaminants on the survival and reproduction of marine organisms and the resulting impact on marine ecosystems. Chemicals of concern are those that have known or potentially deleterious effects on populations of living marine resources and on humans either through mortality, illness, changes in fertility, or other factors that may affect a population's reproductive success.

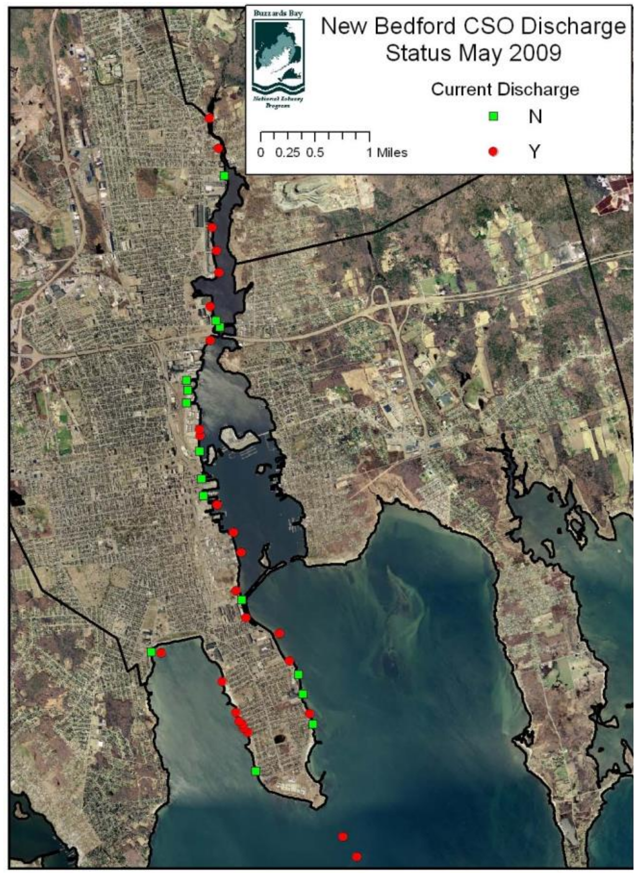


Figure 34. Combined sewer overflows in the City of New Bedford.

Metals and Inorganic Compounds

Certain metals occur naturally at low concentrations in seawater and in marine and estuarine sediments. Additional metals can be added to the marine environment through municipal and industrial wastewater discharges, atmospheric deposition, stormwater runoff, and leaching from boat paints and moorings. Once in the marine environment, metals are generally incorporated into the sediment. Marine invertebrates that live in sediments with high metal contamination may accumulate the metals above natural levels. These toxic metals may then be passed along the marine food web that includes humans.

The U.S. EPA has identified 12 to 15 metals that are of particular concern to humans and ecosystem health due to their toxic effects. Metals of concern include arsenic, antimony, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. Tin is used in marine anti-fouling paints (e.g., tributyltin) because of its toxic effects on marine fouling organisms, and elevated concentrations in sediment may indicate contamination by such paints. Although it is common and is not toxic in itself (except at very high concentrations), iron is important because many other more toxic metals have an affinity for iron, and thus iron can act as a carrier for more toxic metals.

Metals do not break down in the environment, but can transform from one form to another. Depending on the particular metal and its form, toxicity can vary greatly. Metals frequently become more soluble and mobile when the pH decreases (becomes more acidic). In general, the more soluble a metal becomes, the more bioavailable it becomes to organisms, and thus the more toxic it becomes. This is particularly important in the Northeast where acid precipitation is widespread due to sulfur dioxide emissions from fossil fuel-burning power plants located in the region and in the Midwest. Where acid precipitation is common, fresh water bodies will tend to be acidic and thus may contain more dissolved metals than water of a higher pH (seawater contains buffering compounds that counteract acid precipitation; also, acid precipitation is diluted in the ocean, so the oceans so far do not show the effects of acid precipitation). To reduce metal loadings to coastal waters, it is important to manage the acidity (pH) of public water supplies to minimize the rate of copper and lead leaching from plumbing. (The exception may be areas where the underlying bedrock or soils are rich in calcium carbonate (limestone), which can dissolve in response to acid precipitation, acting as a buffer).

The mobility of metals in sediment or water is also affected by the oxidation potential. The oxidation potential, or redox potential, indicates how much oxygen there is in the environment. Oxidizing conditions are characterized by moderate to high oxygen and the presence of oxidized metals (such as rust), while reducing conditions are characterized by low or no oxygen and the presence of reduced compounds. For example, buried organic-rich sediment is often reducing and contains reduced compounds such as hydrogen sulfide ("rotten-egg gas") or methane, whereas well-oxygenated surface sediments, sediments that lack organic matter, or sand that is being actively transported in the turbulent surf zone will be oxidized. Metals such as iron, arsenic, lead, copper, and others, become more soluble and biologically available in reducing sediments. On land, reducing conditions can exist beneath landfills, in organic-rich soils, wetland soils, and in debris piles. In eutrophic ponds, lakes, or coastal embayments, the combination of organic-rich sediments and low oxygen levels will tend to release any toxic metals that may be present in sediments or water.

There are many potential sources of metal contamination. Metals are used in manufacturing, industrial uses, metal-plating, jewelry-making, textile mills, and leather processing. Metal debris, including municipal and industrial solid waste, is another important source. Metal contamination also occurs due to abrasion and wear of metal parts in vehicles, equipment, and industrial facilities, resulting in metals in stormwater runoff and other discharges. Dissolved metals from metal pipes, metal-containing solutions, acids, wastewater, and other sources end up at wastewater treatment facilities. Metals such as chromium, copper, and arsenic, among others, are used as wood preservatives, which can leach out of wood. In the environment, metal concentrations in sediments and water tend to be highest where there is industrial activity, urban harbors, use of chromated copper arsenate (CCA) treated wood, and untreated stormwater runoff. Decreases in metal inputs are typically related to implementation and enforcement of pollution prevention and pre-treatment controls on industrial users, and elimination of lead in gasoline. Specific metal contaminants are discussed below.

Mercury

Mercury is a naturally occurring metal that can occur as a liquid, gas, or solid. At room temperature, pure mercury is a liquid and can evaporate into the air as a gas. Mercury has been and is still widely used for a wide variety of industrial, medical and research uses. Mercury is used in fluorescent bulbs, thermometers, and electrical switches because of its excellent conducting qualities. Because it is highly toxic to living organisms including pathogenic microorganisms, it was used for centuries as a treatment for venereal disease (e.g., mercuric chloride) and mercury is still used today for antiseptics and medical preservatives (e.g., thimerosol). In the environment, mercury contamination is widespread. Important sources of mercury contamination include emissions from the combustion of fossil fuels, particularly coals and oil shale, which are naturally enriched in mercury; and emissions from landfills and solid-waste incinerators processing items that contain mercury.

Mercury and methylmercury pose particular concerns because of proven links between consumption of mercury-contaminated seafood and severe human health impacts. One of the most dramatic cases of methylmercury poisoning ever occurred in Minamata, Japan, between 1932 and 1968, when a petrochemical plastics-manufacturing factory dumped tons of mercury-containing compounds into Minamata Bay. Over 3,000 people were affected by "Minamata syndrome" which caused severe neurological damage and birth defects. This event helped raise public awareness of the health and ecological dangers of mercury exposure.

Mercury and methylmercury are bioaccumulated by fish and other aquatic organisms, and human consumption of mercury-contaminated fish can result in mercury bioaccumulation in human tissue. Federal and state agencies (FDA, EPA, and DEP) have issued fish consumption advisories warning against consuming ocean fish that bioaccumulate mercury (typically predators such as tuna where mercury can bioaccumulate along the food chain) and fish from fresh water bodies affect-

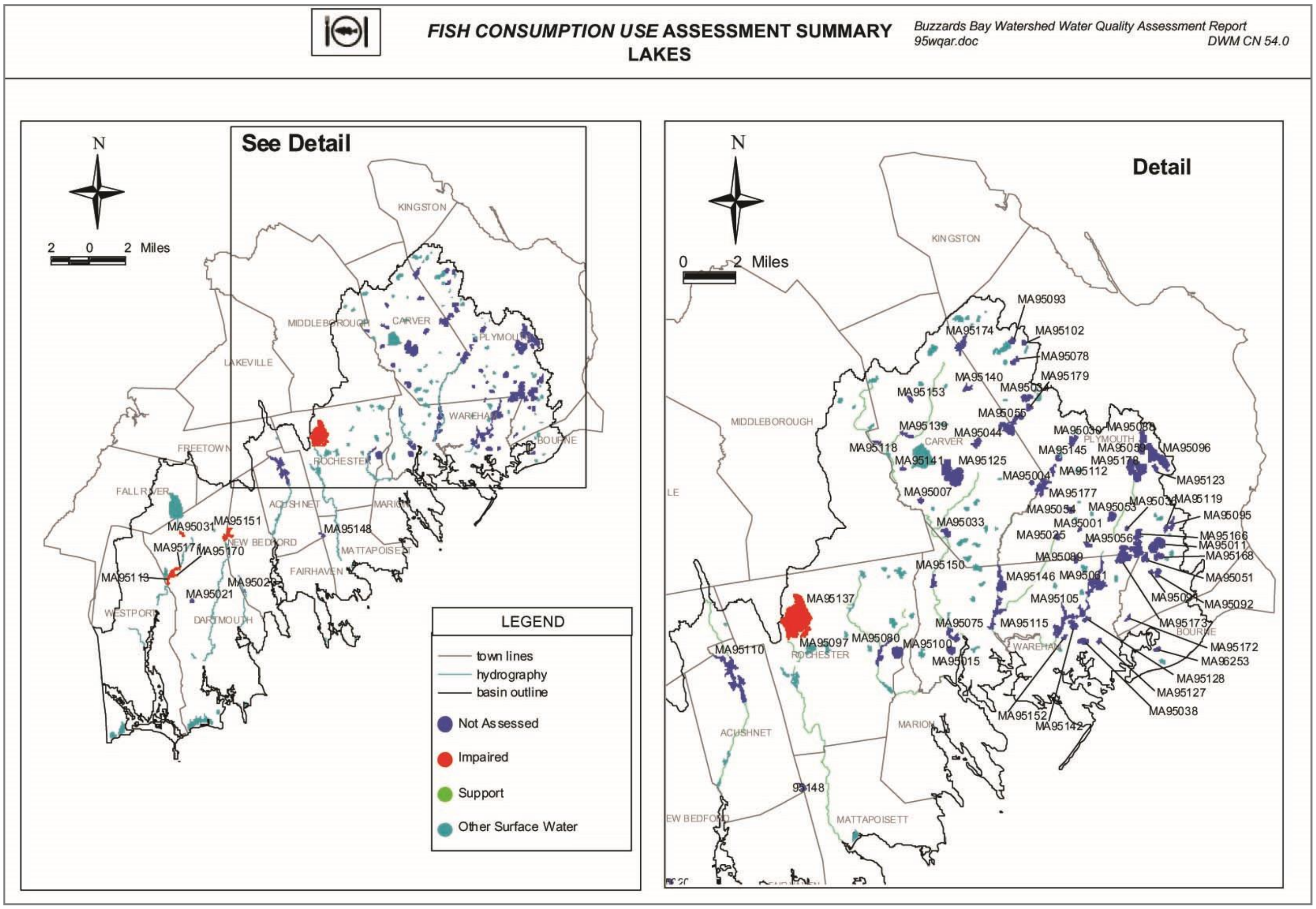


Figure 35. Freshwater fish consumption impairments in the Buzzards Bay watershed.

Most health advisories related to fish consumption are due to elevated mercury concentrations. Figure from DEP 2000 watershed assessment (O'Brien and Langhauser, 2003).

ed by mercury contamination. In 2001, the Massachusetts Department of Public Health (MDPH) issued statewide consumer advisories recommending against consumption of freshwater fish due to mercury contamination, based on widespread testing throughout the state. Fish consumption advisories are issued when elevated levels of a specific contaminant in edible portions of fish poses a health risk for human consumption. For mercury, the FDA's consumption advisory concentration is 1 ppm. In the Buzzards Bay watershed, MDPH also issued site-specific fish consumption advisories[39] for specific fresh water bodies due to elevated mercury contamination in fish (see Table 14).

The suspected source of mercury in this area is atmospheric deposition (i.e., fallout of mercury the air to the earth via rain, snow, gasses, or particles). Most of the water bodies in the Buzzards Bay watershed are not assessed (Figure 35), but it is assumed that they are impacted, and it is the reason why the statewide fish consumption advisory remains in effect.

In the November 2003 Water Quality Assessment of Buzzards Bay[40], DEP estimates that 98% of the rivers (66.22 miles), 56% of estuaries (22.7 square miles) and 79% of lakes (3,563 acres) in the Buzzards Bay watershed have not been assessed for water quality impairments due to contaminants.

Lead

Lead is a dense, soft, malleable metal that is found in metal ore deposits and metal-rich shales, along with

[39] Massachusetts Department of Public Health (MDPH). Fish Consumption Advisories. Retrieved from www.mass.gov/eohhs/gov/departments/dph/programs/environmental-health/exposure-topics/fish-wildlife/fish/. Last accessed October 1, 2013.

[40] O'Brien, K., and A. Langhauser. 2003. Buzzards Bay 2000 water quality assessment report. Department of Environmental Protection Division of Watershed Management Report Number: 95-AC-2 DWM Control Number: 085.0 Massachusetts Department of Environmental Protection Division of Watershed Management. Worcester, Massachusetts. November 2003. www.mass.gov/eea/docs/dep/water/resources/71wqar09/95wqar1.pdf. Last accessed October 11, 2013.

iron, nickel, copper, arsenic, and other metals. Lead's toxic effects on humans and wildlife include neurological, kidney, and liver damage. Examples of extensive use of lead include ammunition, lead pipes, drinking vessels, plates, solder, lead weights, paint, and pesticides (e.g., lead arsenate). Between the mid-1920s and the mid-1980s, tetraethyl-lead was used as an additive in gasoline, which resulted in widespread emissions of lead into the atmosphere, particularly in industrial or heavily traveled areas of the world. The resulting lead fallout has contaminated surface water resources throughout the world. Lead was also used extensively in paints, until it was discovered to cause lead poisoning; removal of such lead paint is now conducted according to state-certified procedures to protect the health of workers and to ensure proper removal and disposal of lead-containing wastes, which are treated as hazardous waste. Like many other metals, it is more soluble in water that has a low pH. The FDA's "action limit" for lead in crustaceans (e.g., crabs, lobsters) is 1.5 ppm and 1.7 ppm for molluscan bivalves (e.g., clams, mussels).

Arsenic and other metals

Other metals like arsenic, antimony, barium, cadmium, chromium, copper, nickel, selenium, silver, thallium, tin, and zinc are also environmental concerns. Silver from home darkrooms and small photographic businesses continues to enter the bay at elevated levels. Chromium and cadmium are associated with automobiles and other vehicles and enter via road runoff.

Organic Compounds and Mixtures

Organic compounds are compounds that contain at least one carbon atom. The major categories of organic compounds and organic mixtures of concern, many of which are synthesized from petroleum and coal, are highlighted in the sections below.

Petroleum and Fossil Fuel Hydrocarbons

Hydrocarbon inputs to Buzzards Bay are the result of accidental oil spills, industrial and municipal wastes, stormwater runoff, small boats and other marine craft, and creosote-treated wood pilings. Buzzards Bay and the Cape Cod Canal serve as a major transportation route for small tankers and barges carrying petroleum products to the Boston market. It is estimated that over 370,000 gallons of fossil fuel hydrocarbons have been accidentally spilled into the bay between 1973 and 2001. However, the everyday, more insidious inputs of hydrocarbons to the bay from stormwater and wastewater from industry and sewage treatment facilities have been calculated to be equal to or greater than the inputs from accidental spills.

PAHs

PAHs are pervasive compounds that represent a significant threat to humans and the ecosystem. Both combusted and non-combusted fossil fuels contribute to the pollution of the environment via the atmosphere, road runoff, oil spills, and point sources of discharge. Some PAHs cause cancers and birth defects and others are accumulated in tissues, causing physiological damage[41]. Greatest accumulations are found in busy harbors, near old creosote pilings, and in areas with industrial discharges.

Pesticides

The use of older, non-organic pesticides such as lead arsenate has largely been discontinued, but their long-term residual impacts are uncertain. Similarly, most chlorinated pesticides have been banned and replaced by shorter-lived, target-specific chemicals, but residual legacy amounts can be found in bay and marsh sediments. However, most existing pesticide related impairments are probably the result of commercial and residential applications and misapplications, including use of pesticides before heavy rains.

Pesticides enter Buzzards Bay largely from nonpoint sources, e.g., agricultural runoff, golf courses, lawn care, and gardens. Cranberry growers have lowered pesticide input by reducing applications and adopting integrated pest-management practices, yet water testing in Wareham shows that low levels of some agricultural biocides (below action thresholds) enter the recharge zones of public wells at detectable levels (SEA Consultants Inc., 2010). In addition, however, other users of pesticides and lawn care products, such as golf courses, institutions, municipalities, and residential owners, need to be informed about the risks posed by the use of pesticides and lawn care products. Such uses are typically not regulated, and therefore the potential contribution from these non-agricultural pesticide sources needs to be considered.

PCBs

PCBs are a family of organic compounds used since 1926 in electrical transformers as insulation, and in liquid coolants, flame-retardants, lubricants, carbonless paper, adhesives, caulking compounds, and marine paints. They are extremely persistent in the environment because they do not readily break down into less harmful chemicals.

PCBs in the Buzzards Bay watershed were principally derived from several industries in the New Bedford area that manufactured capacitors and generators. The manufacturers discharged PCB-containing effluent and

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[41] A good summary of PAH threats is found at www.mass.gov/eea/agencies/massdep/toxics/reports/polycylic-aromatic-hydrocarbons-pahs.html.

materials through outfalls, the sewage treatment plant, and direct dumping principally between the 1940s and 1970s. High PCB levels in the New Bedford area resulted in designation of the Upper Acushnet River as a Superfund site. Feasibility studies to remove and destroy the PCBs, and remediate the affected areas of New Bedford Harbor were developed in the 1990s, and are still being implemented today. Although the manufacture of PCBs ceased in 1979, they remained in many types of older electrical transformers in use. Leaks from these and other types of equipment, along with illegal dumping contributed to nonpoint pollution sources of PCBs in the environment.

PCBs are persistent compounds in the environment and bioaccumulate in sediments and some seafood species. Because of this contamination, over 18,000 acres (encompassing all of New Bedford Harbor and areas into Buzzards Bay) were closed to fishing and shellfishing (lobsters), and remain so[42] (see Figure 36). PCBs persist in sediments to levels that violate water quality standards, posing a risk to humans and the ecosystem. Enforcement of the closure has proven to be difficult because of work force shortages, and in 2009, the Division of Marine Fisheries proposed suspending the permits of lobster fisherman who placed pots in these areas, but this rule was not enacted.

Sediments in the harbor continue to act as a major source of PCB contamination to Buzzards Bay. Other past sources include atmospheric transport from New Bedford and other industrial areas in the northeast, and the disposal of New Bedford Harbor dredged materials into the bay.

The extent of PCB contamination in marine resources taken from areas outside of New Bedford has been studied. Results show that although edible tissues of the three species tested (lobster, flounder, and quahog) generally have PCB levels below the FDA Action Level of 2.0 ppm (parts per million), some samples are dangerously close to the FDA limit, especially lobster hepatopancreas, or tomalley (Schwartz, 1987).

In some sections of Buzzards Bay, shellfishing, fishing, and lobster trapping is prohibited due to high concentrations of contaminants such as PCBs in sediments. Consumption advisories for these areas, warning against consumption of any shellfish or fish, are posted permanently until cleanup activities have been completed. These areas include New Bedford Harbor and the Acushnet River estuary (see Action Plan 16 Reducing Toxic Pollution).

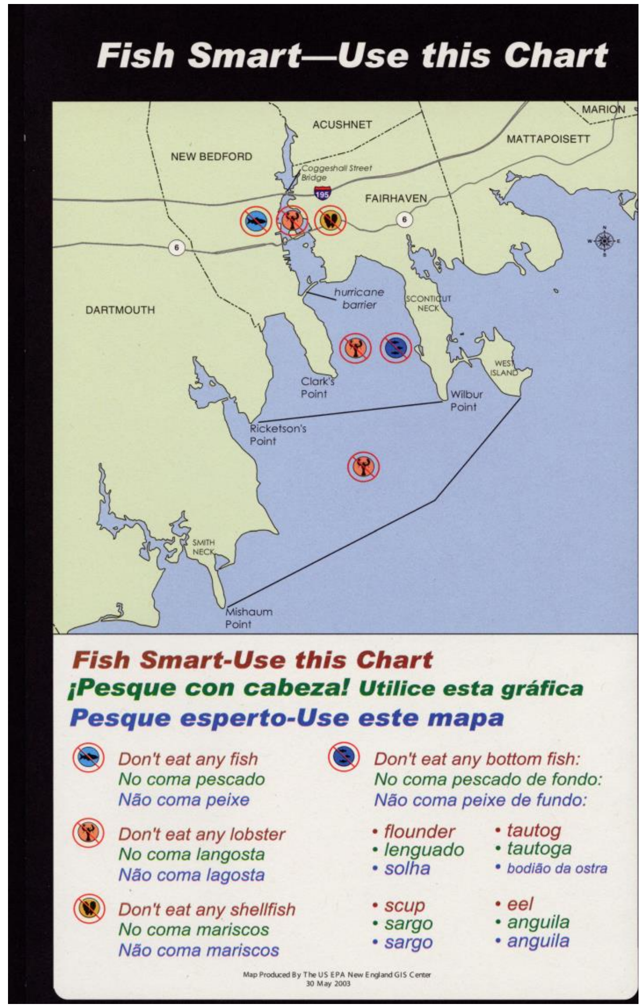


Figure 36. New Bedford area fisheries closures as shown on an outreach poster produced by the U.S. EPA in 2003.

Included in a mailer titled "New Bedford Harbor & PCB Contamination - A Fisherman's Guide, August 2003." Retrieved from www.epa.gov/region1/superfund/sites/newbedford/213062.pdf. Last accessed November 7, 2013, part of EPA's Fish Smart Campaign.

In addition to these marine areas, several watershed freshwater ponds have health advisories of the consumption of fish because of elevated PCB levels (these areas are shown in Table 14).

Dioxins and Furans

Dioxins are a family of toxic chemicals that share a similar chemical structure and include certain polychlorinated dibenzo dioxins (PCDDs), polychlorinated dibenzo furans (PCDFs) and twelve of the polychlorinated biphenyls (PCBs). These compounds are unintentional byproducts of certain industrial chemical processes, and the combustion of certain chemicals. Generally, dioxins and furans are found in trace amounts, but because of their toxicity and strong carcinogenicity and their persistence and tendency to bioaccumulate, they

[42] The Massachusetts Department of Public Health (MDPH) regulation "Prohibition against certain fishing in New Bedford Harbor" (105 CMR 260) was implemented on September 25, 1979 to protect seafood consumers from PCB (polychlorinated biphenyl)-contaminated fish and shellfish in 3 areas of the Acushnet River estuary.

Table 14. Freshwater fish consumption advisories in the Buzzards Bay watershed.

Location	Water body	Fish Species	Advisory	Hazard
Acushnet	New Bedford Reservoir	Largemouth Bass; American Eel	Yes	Mercury, DDT
Bourne	Great Herring Pond	Smallmouth Bass	Yes	Mercury
Carver	Sampsons Pond	Brown Bullhead, Yellow Perch	Yes	Mercury, DDT
Dartmouth	Copicut River	All fish; American Eel; Largemouth Bass	Yes	PCBs, Mercury
Dartmouth	Cornell Pond	All fish; American Eel; Largemouth Bass	Yes	PCBs, Mercury
Dartmouth	Noquochoke Lake	All fish; Largemouth Bass; American Eel	Yes	Mercury, PCBs
Dartmouth/ New Bedford	Turner Pond	All fish	Yes	Mercury
Rochester	Long Pond	Largemouth Bass; Black Crappie	Yes	Mercury
Rochester	Snipatuit Pond	Largemouth Bass; Black Crappie	Yes	Mercury

Data from MDPH Freshwater Fish Consumption Advisory List Massachusetts Department of Public Health Bureau of Environmental Health August 2013. Retrieved from www.mass.gov/eohhs/gov/departments/dph/programs/environmental-health/exposure-topics/fish-wildlife/fish/. Last accessed October 1, 2013.

represent an important human health and environmental risk.

In the Buzzards Bay watershed, New Bedford Harbor and the surrounding landscape is the area of the greatest known concentrations of dioxins and furans. This contamination is principally related to the manufacture and disposal of PCBs[43]. The threat posed by these compounds should be greatly diminished with the completion of the Superfund efforts in New Bedford Harbor.

Other Organic Pollutants

Analysis of the effluent from the New Bedford sewage treatment plant has shown that several of the synthetic organic compounds listed by EPA as priority pollutants are present in measurable quantities. These compounds are typical of what is found in sewage from urban industrialized areas.

Historically, a variety of industrial wastes containing chemicals of concern, were discharged into New Bedford Harbor. More recently, research has shown that tributyltin (TBT), which is sometimes added to marine paint as an antifoulant, is toxic and harmful to marine organisms in coastal ecosystems, even at the extremely low concentrations observed when TBT leaches from boats. Federal legislation and regulations have been phasing out the use of TBT as an additive. In April 1988, Massachusetts banned the use of TBT-containing paints on all non-aluminum vessels under 25 meters in length. Paints with low TBT release rates (micrograms per day) can be used on larger vessels.

Contaminants of Emerging Concern

Contaminants of emerging concern (CECs) is a broad catch-all category of novel, or previously unstudied, or previously presumed harmless compounds now found with increasing frequency in the streams, lakes, and groundwater. Awareness of these compounds stems in part from the fact that laboratory methods have improved where parts per billion and parts per trillion detection limits are now possible. In addition, studies have shown that certain persistent compounds may exert important non-toxic effects that may affect the health, ecological fitness, and fecundity of various aquatic and terrestrial species.

CECs include pharmaceuticals, flame retardants (polybrominated diphenyl ethers), endocrine-disrupting chemicals (EDCs), carbon nanoparticles, and pharmaceutical and personal care products (PPCPs) that enter groundwater and surface waters, most often from wastewater disposal discharges (septic systems or wastewater facilities). Some of these compounds in drinking water have been correlated with human disease or development problems, and other compounds, particularly endocrine disruptors, may affect sexual development and sex ratios in fish and invertebrates.

In 1985, the EPA established guidelines to determine ambient water quality criteria for aquatic life. The guidelines addressed acute risk (short-term effects on survival and growth of adults and juveniles) and chronic risk (longer-term effects on reproduction) for traditional pollutants. However, these tests do not evaluate the more subtle impacts of CEC and PPCPs on populations of aquatic species, and new tests must be developed.

For these and other reasons, CECs remain unregulated. In 2008, the U.S. EPA developed a white paper highlighting the problem, and including recommenda-

[43] See summary by Wang, S. T. 1989. Relative Risks posed by Polychlorinated Biphenyls, Polychlorinated Dibenzodioxins and Dibenzofurans in New Bedford Harbor sediments. Retrieved from www.epa.gov/region1/superfund/sites/newbedford/225118.pdf. Last accessed October 31, 2013.

tions for future action[44]. The principal actions recommended in the white paper focus on the development of aquatic life criteria tests based on sound science to evaluate CECs. This effort will require EPA to establish panels to develop criteria and tests for compounds with similar environmental modes of action. Until these criteria are developed, CECs will remain largely unregulated. Because it may take many years and millions of dollars to answer these questions, EPA will need to establish priorities on which CECs must be first evaluated.

Until the regulatory strategies are worked out, the principal focus of CEC management in the Buzzards Bay watershed should be to reduce the amount of unwanted CECs and toxics being flushed down toilets and other wastewater streams. For example, it is estimated that roughly 10% of the pharmaceuticals entering the environment originate from consumers disposing of unwanted prescription and non-prescription medicines in toilets. Because most Buzzards Bay communities have their solid waste incinerated at the SEMASS waste to energy facility, or disposed of at lined landfill facilities, the recommended disposal strategy for those communities is to throw away their medicine in the household trash. For those still disposing of waste in landfills, because these landfills are lined, this is still a preferable disposal mechanism, although these municipalities can also consider waste disposal collection days, and most pharmacies are increasingly accepting unused and outdated prescriptions. Municipal sewer operators should also work proactively with hospitals, doctors' offices, nursing homes, laboratories, and pharmaceutical or chemical manufacturers to encourage non-wastewater disposal of a variety of these not yet regulated CECs

Sources of Toxic Contaminants

Industrial or Commercial Uses

Urban centers such as New Bedford and Fairhaven contribute substantially to mass loadings of toxicants largely via point sources of discharge through sewage treatment facilities, industrial discharges, combined sewer overflows, stormwater outfalls, and surface runoff. Because of the intensive sampling for the Superfund site, wastewater treatment facilities, and compliance monitoring requirements for NPDES permits, more data are available on types and levels of contaminants in the New Bedford area than elsewhere. Both organic compounds (PAHs and PCBs) and metals make this area one of the most contaminated in the nation. With respect to metals, the New Bedford Inner Harbor is noted for elevated concentrations of copper, nickel, zinc, and chromium. Dredging and sediment suspension from storms probably contributed to past export of these contaminants to areas outside the harbor.

Marinas, Docks, and Boats

Less well known are the cumulative impacts of chronic pollution from nonpoint sources that enter small embayments and harbors from marinas, docks, and boats. Nonpoint sources of contaminants include boat antifouling paints, oil spills, creosoted and chemically treated pilings, and overland runoff carrying metals, organic compounds, and pesticides into receiving waters. These contaminants are often associated with particles and accumulate in sediments; but without an adequate monitoring program, the extent of contamination remains undocumented.

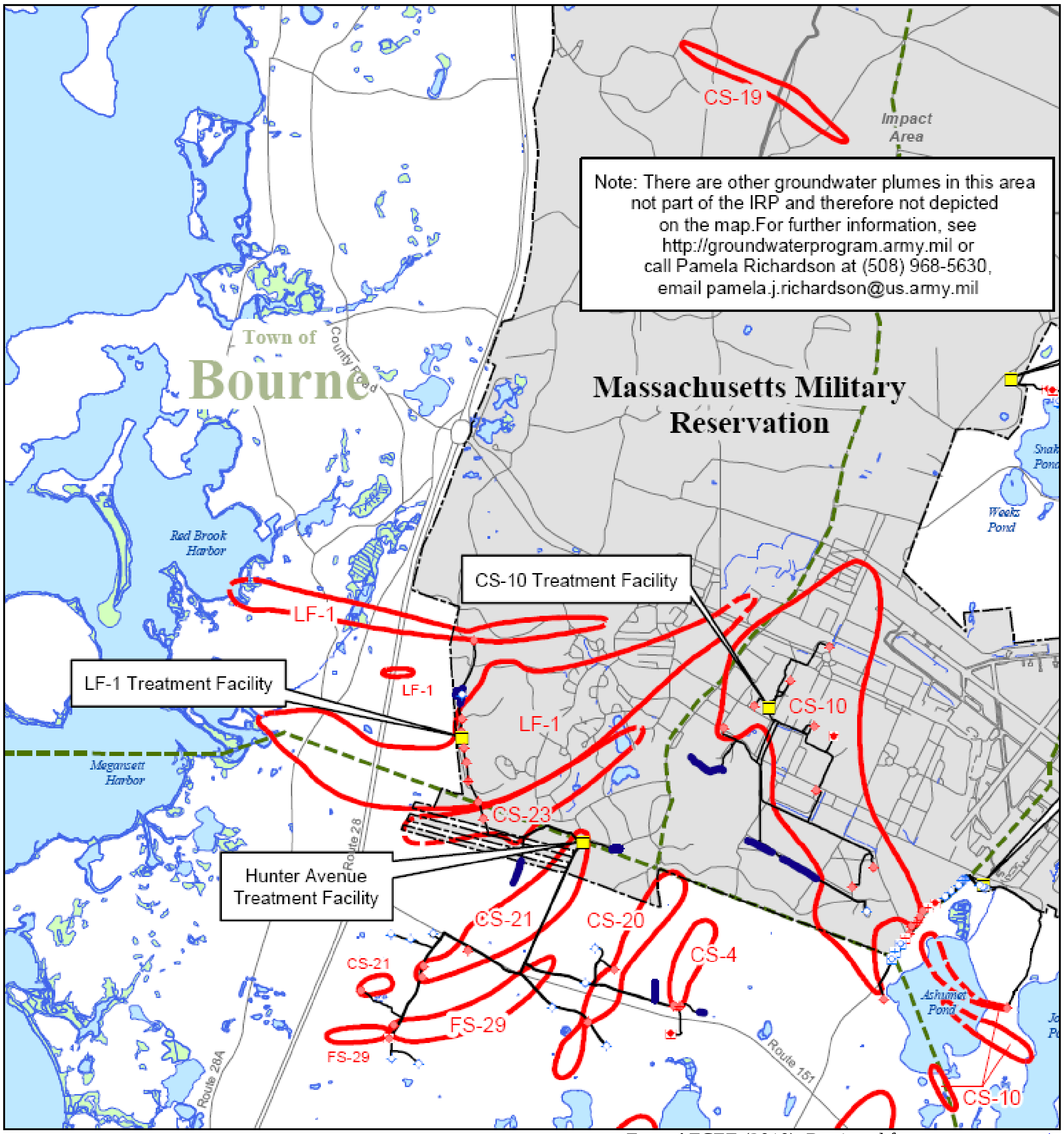
Residences

Homes are responsible for 25% of the hazardous waste disposal in the Commonwealth and discharge a wide variety of toxic materials into the wastewater stream and landfills. Contaminants from this source include everyday household products such as paint, paint removal products, used oil, batteries, fuel, fluorescent lamps, mercury thermometers, solvents, cleaning products (ammonia, chlorine bleach), insecticides, pesticides, herbicides, fungicides, antifreeze, rat poison, shampoos (which may contain high levels of selenium), oven cleaners, metal polishes, spot removers, and many other products. Empty and partially empty containers are disposed of in landfills or the contents are poured directly into drains to enter sewers and septic systems. Degreasing agents used in some septic systems may be toxic; one of these cleaners contains trichloroethylene (TCE), which is a common contaminant of drinking water and is difficult or impossible to eliminate once it reaches water supplies. Disposal of household chemicals into septic systems may cause contamination of groundwater, which may be an important nonpoint source of toxic inputs into embayments throughout Buzzards Bay.

Landfills

Although newer landfills are required to have nonpermeable liners beneath them to prevent toxic liquids from infiltrating into groundwater or seeping out into adjacent water resources, liners can leak, allowing pollutants to contaminate water resources (U.S. EPA, 1987). Older landfills that do not have liners have generally been closed and are being monitored to ensure that contaminated groundwater plumes do not reach

[44] White Paper, Aquatic life criteria for contaminants of emerging concern. Part I - General challenges and recommendations. Prepared by the OW/ORD Emerging Contaminants Workgroup. June 3, 2008 Draft, Response document, EPA-SAB-09-007. Retrieved from water.epa.gov/scitech/swguidance/standards/upload/2008_06_03_criteria_sab-emergingconcerns.pdf. Last accessed October 11, 2013. See also December 18, 2008 draft.



From AFCEE (2010). Retrieved from www.epa.gov/region1/mmr/pdfs/454664.pdf.

Figure 37. MMR Superfund groundwater plumes on Cape Cod.

drinking water supplies. Some landfill plumes are being actively remediated, such as the LF-1 plume originating on the Massachusetts Military Reservation that discharges to Red Brook Harbor in Bourne (AFCEE, 2010). The Carver-Marion-Wareham landfill is located within the 100-foot buffer zone to the Wankinco River, and there is observable seepage from the base of the landfill into the river itself, near a monitoring station specified by the Department of Environmental Protection.

Agricultural Sources

Agricultural chemicals that may be toxic or harmful to fish, wildlife and/or plants include herbicides, fungicides, insecticides, and others that are grouped together and commonly called pesticides. By their very nature, they are designed to inactivate or kill specific target organisms. The USDA's NRCS has developed a pesticide evaluation approach (Windows Pesticide Screening Tool, or WIN-PST) that utilizes information on soils, water resources, and pesticide toxicity to evaluate whether the use of a specific pesticide could result in a risk to aquatic life due to leaching and runoff of the pesticide. According to NRCS Technical Notes NM WQ Technical Note 9, pesticide-soil combinations which result in a hazard rating of 'Intermediate', 'High', or Extra High' should be mitigated (Scheffe and Sporcic, 2001).

Groundwater Plumes from Contaminated Sites

Contaminated groundwater plumes originate from sites where contaminants have leached into the groundwater from soil and/or surface water. Contaminated groundwater plumes are typically associated with sites on land such as automotive repair stations that have experienced fuel spills, dry cleaning facilities, or other commercial facilities that have experienced solvent spills, or other commercial, industrial, medical, institutional, or household facilities where contaminant spills have occurred. For example, there are several groundwater plumes entering or heading toward Buzzards Bay from the Massachusetts Military Reservation (see

Figure 37; AFCEE, 2010). These are located in Bourne and Falmouth. Plumes are now reaching Buzzards Bay near Squeteague Harbor (Bourne and Falmouth) and Red Brook Harbor (Bourne). These represent two branches a plume emanating from the landfill (LF-1) on the Massachusetts Military Reservation. Other notable plumes include one from the Falmouth wastewater treatment facility. It is likely that other occurrences of groundwater contamination in the Buzzards Bay watershed have not been identified because they are not in the zone of contribution to a municipal water supply or otherwise investigated.

Wastewater

Wastewater can contain many contaminants other than heavy metals, PAHs, PCBs, dioxin, and pesticides. Examples include estrogen compounds and endocrine-disrupting compounds (found in pharmaceuticals, personal care products, pesticides, plastics and many other industrial materials), surfactants, caffeine, optical brighteners (used in detergents as a substitute for bleach), and chlorination by-products (e.g., trihalomethanes and others[45]). Chlorination of drinking water supplies and wastewater is widely used for basic disinfection, and the by-products of the reaction between chlorine and organic matter present in wastewater are organochlorine compounds such as trihalomethanes that are toxic in themselves. Unless dechlorination is done, such by-products can persist in drinking water and wastewater and may occur in the environment.

Estrogen and endocrine-disrupting compounds are commonly present in wastewater and are not removed by present methods of secondary or tertiary wastewater treatment. Such compounds can cause developmental and/or reproductive changes in aquatic organisms such as fish and crustaceans. Some scientists believe these compounds have contributed to skewed sex ratios in Buzzards Bay lobster populations[46].

Transport, Fate and Effects of Toxic Compounds

In order for a toxic chemical to affect an organism, there must be an exposure. The factors that determine toxicity of a particular compound include physical and chemical characteristics of the compound, how it affects an organism, the exposure pathway, the duration of exposure, and the concentration of the toxic compound. Exposure to toxic chemicals can occur through ingestion of contaminated sediments, water or tissue; dermal contact with contaminants; or inhalation of dust, gases or aerosols containing toxic chemicals. The duration of exposure is also important, as well as the concentration.

Where possible exposure pathways exist, toxic chemicals can adversely affect aquatic and terrestrial organisms, ecosystems, and humans. Human consumption of contaminated seafood or human exposure to other sources of toxic compounds poses the greatest concern. Exposure of aquatic organisms to toxic compounds can result in bioaccumulation of toxic chemicals in tissues, biomagnification (increasing concentration of tissue contaminants moving up the food chain) and/or food web effects.

The fate and effect of contaminants in Buzzards Bay depends on several factors. Most contaminants are associated with particles and accumulate in sediments, usually near the source of the input or in depositional areas. The greatest concentrations are found closest inshore where there is the greatest human activity and productive shellfishing. Metals do not degrade, but usually accumulate in sediments. Some organic compounds (e.g., low molecular weight PAHs) may be degraded or broken down by organisms into compounds that are more or less toxic. Other organic compounds (e.g., PCBs and high molecular weight PAHs) are persistent, bioaccumulate in tissues, and are transferred in the food chain to higher organisms. PAHs are known carcinogens. PCBs have deleterious effects on nervous systems; and both PAHs and PCBs negatively affect reproduction, survival, and growth.

The numerous pathways by which contaminants enter, accumulate, and move in marine ecosystems make them difficult to regulate. In general, it is easier to regulate point sources of discharge than nonpoint sources. Regulations are designed to protect the ecosystem and human health, and criteria have been established for chemicals in the water, in sediments, and in tissues (of seafood). Even if new discharges of toxic chemicals

[45] The U.S. EPA is considering regulating the amounts and kinds of chlorination by-products in drinking water, based on their toxicity to living organisms.

[46] "Human hormones hurt lobsters." www.southcoasttoday.com/apps/pbcs.dll/article?AID=/20070114/NEWS/701140339&cid=sitesearch. Last accessed October 11, 2013.

could be eliminated immediately, it could take many years for previous discharges of even biodegradable contaminants to dissipate, or for some ecosystems or populations to return to their original state.

There remain many unknowns about the pathways and impacts of toxic contaminants. For this reason, scientists and managers must continue to collect field data and document biological responses so that managers can continue to set realistic and cost-effective goals to reduce their impact on the environment.

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Chapter 4. Action Plan Introduction and Organization

The action plans contained in this chapter form the centerpiece of the new Buzzards Bay Comprehensive Conservation and Management Plan. Meeting the goals and objectives of these action plans should lead to achieving the overarching Buzzards Bay CCMP goals: to protect and restore the water quality and natural resources of Buzzards Bay and its surrounding watershed.

Each action plan begins with a one or two page overview that includes a brief statement of the **Problem** addressed by that action plan, the **Goals** adopted to address the problem, and more specific **Objectives** to meet these goals. Goals are broad and long-term and articulate the desired condition for Buzzards Bay, whereas objectives are the more specific, shorter-term targets for attaining goals. Other distinctions between goals and objectives as used in this document are listed in Table 15.

Each action plan summary page also has an **Approaches** section, outlining possible or likely implementation approaches to meet the objectives. This is followed by a **Costs and Financing** section, which provides a thumbnail summary of costs and funding options to meet the action plan. This section is followed by **Measuring Success,** which provides a thumbnail overview of monitoring progress.

These overview pages are meant to be stand-alone pages to be included in the Buzzards Bay CCMP Executive Summary and for outreach.

These action plan overviews are then followed by information that is more detailed in sections titled **Background**, **Major Issues**, **Management Approaches**, **Financing Approaches, and Monitoring Progress**. These sections provide the more specific information needed to understand and implement the action plan.

The format of this new management plan differs from the original Buzzards Bay CCMP in that this management plan does not include a full list of all specific recommendations to meet each objective. This change was made in recognition of the fact that actions needed to achieve a specific goal or objective may differ depending upon existing laws, regulations, and the economic and political conditions in each community or other level of government. Moreover, in many instances there is more than one path to achieve a goal or objective. The Management Approaches sections identifies some, but not all possible mechanisms to achieve the Goals and Objectives, and often includes links and references to additional resources to help implement the plan.

After the new Buzzards Bay CCMP is adopted, the Buzzards Bay National Estuary Program, under the direction of its Steering Committee, will develop annual workplans for the state-federal cooperative agreements, to guide Buzzards Bay NEP activities. Periodically, the NEP will develop strategic multi-year watershed action plans, and undergo performance reviews, to identify the new actions, retune ongoing activities, and to ensure continued progress under this Buzzards Bay CCMP.

Table 15. The difference between goals and objectives

- Goals are broad; objectives are narrow.
- Goals are general intentions; objectives are precise.
- Goals are intangible; objectives are tangible.
- Goals are abstract; objectives are concrete.
- Goals usually cannot be validated as is; objectives can be validated.
- Goals are long term, objectives are shorter term

One element of the Buzzards Bay CCMP that has not changed is the fact that local government still has the greatest authority to manage the cumulative impacts of existing and new development on the environment, and therefore local government will need to take the most action to achieve the goals and objectives of this management plan. It is also true that the greatest financial burden of implementing the management plan will be borne by municipalities. Because municipal government is already financially overburdened, unless the state and federal government collaborate on financial solutions, solving certain problems like nitrogen loading and stormwater pollution will take decades.

In recognition of this problem, more general principles and opportunities for financing the Buzzards Bay CCMP are contained in Chapter 6. Additional strategies to track or monitor implementation of the Buzzards Bay CCMP are specified in Chapter 5.

Action Plan Outline

[Overview Page]

Problem
Goals
Objectives
Approaches
Costs and Financing
Measuring Success

[Supporting Information]

Background
Major Issues
Management Approaches
Financial Approaches
Monitoring Progress

Action Plan 1 Managing Nitrogen Sensitive Embayments

Problem

Impairments to water quality and living resources caused by excessive nitrogen inputs to Buzzards Bay are one of the most pressing issues identified in this Buzzards Bay CCMP. Nitrogen total maximum daily load (TMDL) studies have not been completed for all embayments, but impairments are apparent in all the somewhat less well-flushed embayments that fringe Buzzards Bay. Loss of eelgrass beds, accumulation of benthic algae smothering shellfish beds, and low oxygen concentrations and resulting fish kills are among the impacts that must be remedied. Elimination of excessive nitrogen loads will ensure that all designated uses for those embayments are met[47]. Wastewater discharges are typically the largest source in most watersheds. While state and federal agencies regulate permitted discharges like outfall pipes, some sources of pollution like cumulative loadings from septic systems are difficult to regulate. Solutions typically focus on municipal sewer expansion or nitrogen removing onsite systems, both of which have high costs.

Goals

Goal 1.1. Ensure that no designated uses will be lost, nor ecosystems adversely affected by excessive contributions of nitrogen to any area of Buzzards Bay.

Goal 1.2. Restore lost designated uses and adversely affected ecosystems impaired by the excessive contribution of nitrogen to any area within Buzzards Bay.

Objectives

Objective 1.1. To develop and adopt scientifically based nitrogen total maximum daily loads (TMDLs) for nitrogen impaired areas of Buzzards Bay.

Objective 1.2. To reduce the amount of nitrogen currently entering nitrogen-impacted embayments, including all areas identified on 303(d) and Integrated Lists, according to limits specified in approved TMDLs.

Objective 1.3. To ensure new additions of nitrogen to coastal waters do not cause, or contribute to, a violation of state surface water quality standards, or exceed federally approved TMDLs.

Objective 1.4. To ensure that state and federal discharge permits meet nitrogen loading limits and waste load allocations specified in approved TMDLs.

Objective 1.5. To promote the development and implementation of local plans to manage nitrogen sources to meet TMDLs and waste load allocations.

Objective 1.6. To promote the development and support the use of alternative and advanced nitrogen reducing wastewater treatment technologies at all scales of flow.

Objective 1.7. Monitor water quality and natural resources like eelgrass beds at a sufficient frequency to document management needs, assess the effectiveness of actions taken, and to document ongoing changes and variability in water quality and ecosystems health.

Approaches

Municipalities should take action to reduce nitrogen inputs to impaired waters. In most watersheds, sewering with disposal at centralized or satellite wastewater treatment systems with nitrogen removal will often be the most viable solution for reducing wastewater nitrogen inputs from areas with dense development. In less developed areas, advanced nitrogen removal onsite systems and small community scale systems may be part of a solution, as well non-structural alternatives. To ensure action, it is imperative that DEP develop, and for the U.S. EPA to adopt TMDL nitrogen limits and waste load allocations for all impaired areas. These limits only directly affect discharges requiring a federal permit, so municipalities must develop comprehensive strategies to manage all nitrogen sources to meet adopted TMDLs.

In some watersheds, better management of agricultural fertilizer release or manure management is needed. In the case of the cranberry bogs, nitrogen reductions can be achieved in part through various water use BMPs. Although typically a secondary source, stormwater discharges and residential fertilizer use can be locally important. All stakeholders should work closely with municipalities to reduce nitrogen to meet TMDLs, and implement comprehensive strategies, including managing or offsetting nitrogen inputs from new development.

Costs and Financing

Preliminary estimates by the Buzzards Bay NEP suggest that sewer expansion in the Buzzards Bay watershed may exceed $2 billion. Because of the costs and scale of the effort, meeting TMDLs will remain one of the most formidable political, financial, and management challenges facing municipalities in this CCMP. Implementation will likely take decades and require more state and federal support.

Measuring Success

The issuance of TMDLs, compliance with loading limits, and the area of impaired waters will be the management measures tracked. Restoring water quality and recovery of habitat will be the long-term tracking measure. These will be assessed through the Coalition's Water Quality Monitoring Program and the state's eelgrass mapping and listings of impaired waters.

[47] Unless additional impairments are caused by other pollutants. "Designated Uses" are those listed in Massachusetts Water Quality Standards, see entry in Glossary.

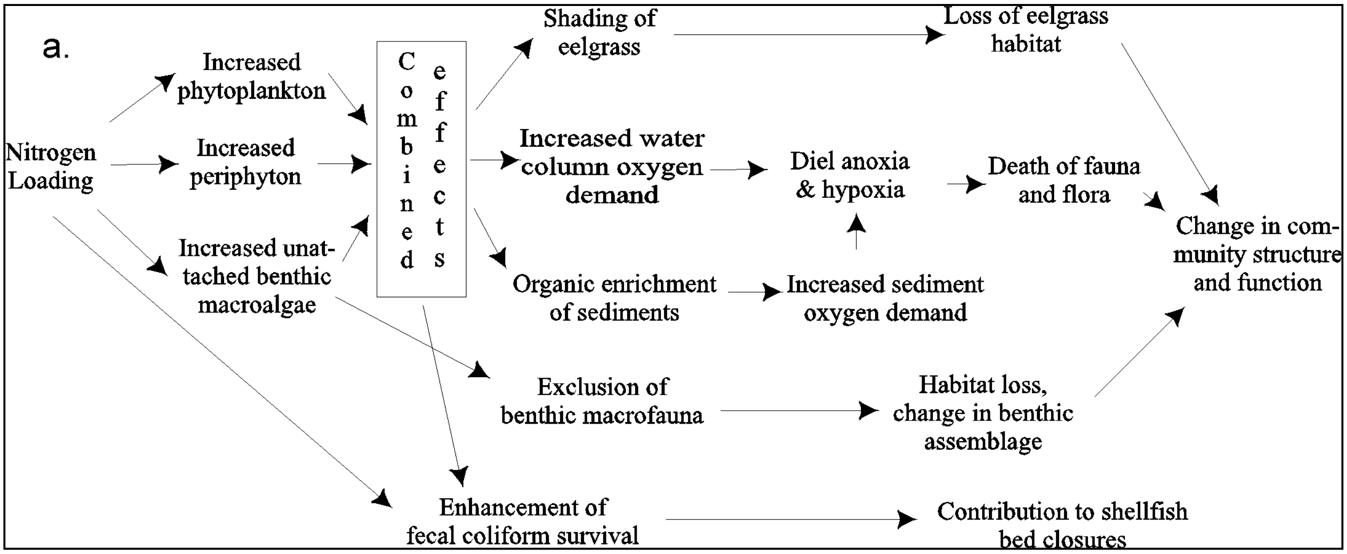

Figure 38. Generalized ecosystem response of a shallow embayment to nitrogen loading.

From Costa et al., 1992.

Background

As summarized in Chapter 3, and as articulated in the Massachusetts DEP's Integrated List of Impaired Waters, many areas of Buzzards Bay are impaired by excessive inputs of nitrogen[48]. In Buzzards Bay, as in most coastal waters, nitrogen, which is an essential nutrient, typically limits the growth of algae. Algae, which include macroalgae or "seaweeds" and microalgae that live in the water (phytoplankton) or grow on surfaces (periphyton), form the base of many marine food webs. Increased inputs of nitrogen from human activities threaten many embayments in Buzzards Bay by stimulating excessive growth of both microalgae and macroalgae (Figure 38 and Figure 39).

This increased production and accumulation of micro- and macroalgae can result in many adverse changes to coastal ecosystems, in a process called "coastal eutrophication" or "nutrient enrichment." For example, increased abundance of algae can limit the transmission of light reaching eelgrass leaves, resulting in the loss of eelgrass beds that provide habitat for shellfish and other animals. The loss of eelgrass because of eutrophication has occurred in many parts of Buzzards Bay, as has happened at the north end of Buzzards Bay in the Wareham River estuary (Figure 40), one of the more eutrophic areas of Buzzards Bay.

Dense layers of macroalgae can also accumulate on the bottom of some shallow bays, which destroys valuable habitat for shellfish and other invertebrates. In addition, decay of macroalgae depletes oxygen in the water and causes unpleasant odors. Severe oxygen depletion can kill fish and shellfish. There is also evidence that excess nitrogen promotes, directly and indirectly, the survival of coliform bacteria, which contributes to closures of shellfish areas. Algae blooms and accumulation of macroalgae may also cause aesthetic problems and inhibit typical recreational uses of the water such as swimming and boating. Overall, the addition of excess nitrogen is one of the most serious long-term problems threatening many embayments around Buzzards Bay.

The response of coastal ecosystems to excessive anthropogenic (human generated) contributions of nitrogen is complex and varied but most pronounced in embayments with restricted water exchange or where the amount of nitrogen added is large as compared to the volume of the receiving water (Figure 41). Perhaps the most overriding feature that defines the response of coastal ecosystems to nitrogen loading is the bathymetry of the receiving waters, particularly the area of bottom within the photic zone; that is where there is enough light for either seagrasses or algae to grow on the bottom.

Photo by Joe Costa.

Figure 39. Excessive algal growth shading out eelgrass (here green algae is rafting on eelgrass leaves) is one of the many adverse impacts of nitrogen pollution.

[48] This action plan principally targets management of point and nonpoint sources of nitrogen at an embayment level, rather than bay-wide. This Buzzards Bay CCMP addresses nitrogen loading from sewer outfalls in more detail in the Sewage Treatment Facilities action plan.

Table 16. Summary of subwatershed loading reaching the estuary and total loadings to Buzzards Bay from various sources.

Embayment	Existing N Load (kg/y)	Note
Allens Pond	5,707	(1)
Apponagansett Bay	24,213	(1)
Aucoot Cove	10,574	(1)
Brant Island Cove	1,225	(1)
Buttermilk Bay	33,175	(1)
Clarks Cove	30,813	(1)
Hen Cove	5,244	(1)
Little Bay	31,192	(1)
Little River	4,225	(2)
Mattapoisett Harbor	51,071	(1)
Megansett / Squeteague Harbor	31,168	(1)
Little Bay / Nasketucket Bay	31,192	(1)
New Bedford Harbor (=Acushnet River, includes Fairhaven WWTF)	89,633	(3)
Onset Bay	20,169	(1)
Phinneys Harbor / Back River	19,704	(1)
Pocasset Harbor	5,555	(1)
Pocasset River	9,417	(1)
Quisset Harbor	1,722	(1)
Red Brook Harbor	9,474	(1)
Sippican Harbor	17,175	(1)
Slocums River	51,562	(3)
Wareham River (includes WWTF)	51,489	(2)
Weweantic River	160,509	(1,4)
West Falmouth Harbor (includes Falmouth WWTF)	15,234	(2)
Widows Cove	2,016	(1)
Wild Harbor	9,772	(1)
Wings Cove	4,199	(1)
Westport Rivers	212,963	(2)
Non-embayment watersheds	108,832	(1)
Buzzards Bay, atmos.	785,258	(5)
New Bedford Wastewater Outfall	368,214	(6)
Dartmouth Wastewater Outfall	97,892	(6)
Mass Maritime Academy Outfall	3,864	(7)
Grand Total	2,304,452	

(1) Buzzards Bay NEP estimates are approximations from MassGIS land use and MEP loading assumptions, with 50% average attenuation above first river impoundments. These estimates will be superseded by better estimates from MEP studies.
(2) MEP draft or final report, includes precipitation to estuary areas.
(3) Buzzards Bay NEP estimate from parcel data and other sources.
(4) Calculation using MEP 2000-2010 cranberry bog loading rates.
(5) Atmospheric loading to entire bay surface in the NEP study area (MA waters to RI border), but does not include estuary surface waters in embayment watersheds (total=162,429 acres), times the MEP loading rate of 4.41 kg per acre.
(6) Outfall loadings as reported to EPA, July 2010 to June 2011, at echo.epa.gov/?redirect=echo.
(7) Based on 2012 average daily flows × 30-ppm TN (assumed conc.)

Sources of anthropogenic nitrogen reaching coastal waters (also defined here as embayment “nitrogen loading") include sewage treatment facilities, septic systems, atmospheric deposition, and fertilizer used on lawns, golf courses, and agricultural land. Atmospheric loading to Buzzards Bay as a whole is quite large, accounting for about one-third of total loadings reaching the bay (Table 16). However, atmospheric loadings to individual embayment watersheds only averages 15% of total loadings among publicly available MEP studies, with wastewater disposal averaging 57% of estuary watershed loading (Table 17). These values do not include watershed attenuation as Table 16 does, and the relative contribution of septic loads actually reaching each estuary is greater than shown.

The relative importance of other nitrogen sources varies among watersheds. For example, agriculture sources are important in some watersheds. In the Westport Rivers, agriculture, mostly related to dairy farm animal waste accounted for 57% of the controllable unattenuated watershed nitrogen loading, whereas septic systems accounted for only 34% (Howes et al., 2012). In the Weweantic River and Wareham River watersheds, loadings from cranberry bogs account for a large portion of watershed nitrogen loadings. In the Wareham River estuary system as a whole, cranberry bogs contribute 20% of the watershed controllable nitrogen load, whereas in the Agawam River/Mill Pond subwatershed, cranberry bogs account for 57% of the watershed controllable loading (Howes et al., 2013). In these same systems, septic systems accounted for 43% and 20% respectively of the controllable unattenuated watershed nitrogen loading.

Nitrogen from watershed sources enters the bay via streams, groundwater, direct rain deposition, stormwater runoff, and by effluent discharge. Cumulatively, the single largest sources of nitrogen entering Buzzards Bay are discharges from sewage facilities; with the next largest amount derived from home septic systems (see Chapter 3, Table 13).

This overview of nitrogen sources in approved MEP reports does not adequately reflect loadings in many Buzzards Bay watersheds. Draft reports for Westport and Wareham show agricultural sources as large as (Wareham) or exceeding septic system discharges (Westport). In New Bedford Harbor, the watershed is mostly sewered, so the Fairhaven wastewater facility discharge is one of the largest sources, although stormwater and CSO discharges are also significant. As noted in the original 1991 CCMP, even a discharge from a large sewage treatment such as New Bedford’s, primarily affect waters close to the outfall. The MEP findings continue to affirm both the localized nature of coastal eutrophication, variability among watersheds sources, and the need for watershed-specific strategies to manage nitrogen inputs.

Although such discharges are important, and managers may limit their nitrogen discharge, Buzzards Bay as a

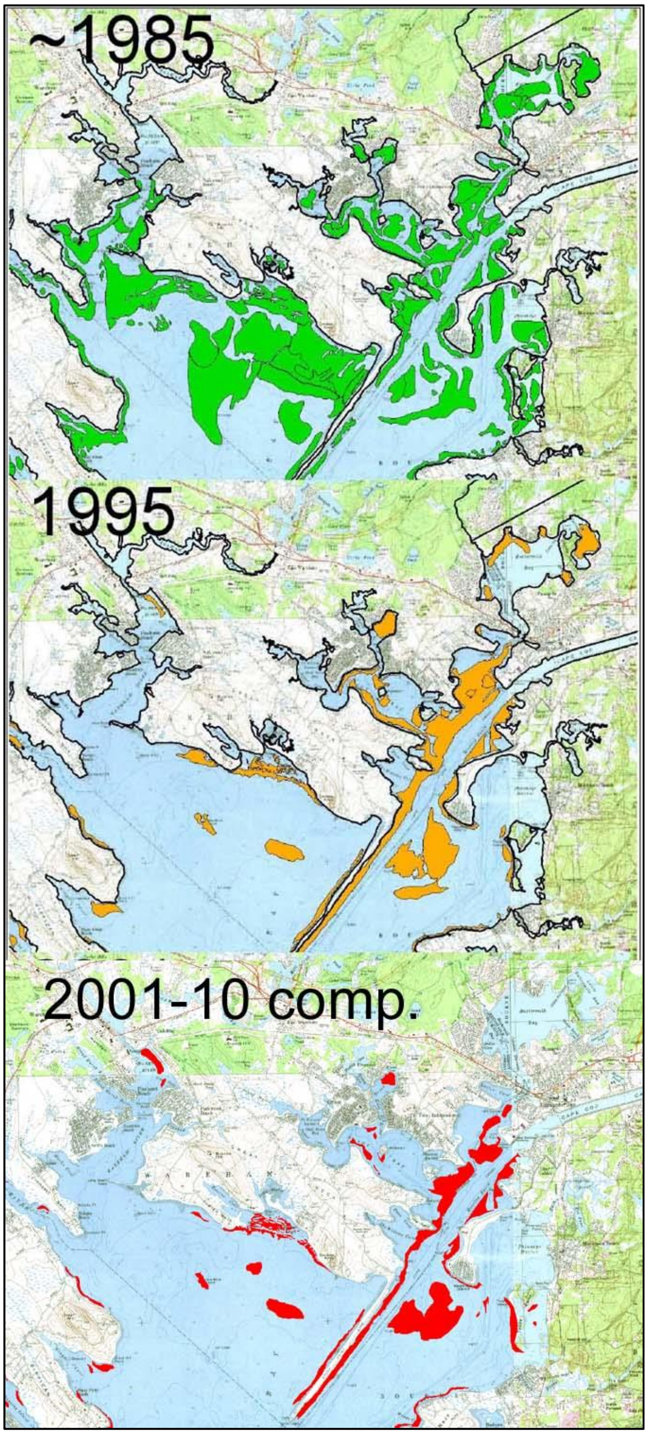

Figure 40. Recent losses of eelgrass in northern Buzzards Bay.

Top panel from data in Costa 1988a,b (posted at buzzardsbay.org/eelgrass.htm), middle panel from DEP eelgrass surveys, data posted at MassGIS, bottom from DEP 2001, 2006, and 2010 maps and Buzzards Bay NEP additional data combined to create a composite of the most recent data (2001 was the date of the last complete survey of Buzzards Bay).

Table 17. Relative contribution of septic system, atmospheric, and wastewater facility loading <u>to watershed loading</u> in various published MEP studies.

Studies of Buzzards Bay embayments are mostly incomplete as of 2013. Most Buzzards Bay embayments will have a lower proportional septic load than on Cape Cod. Because population and septic systems are clustered near the coast, their % contributions reaching the bay relative to other watershed sources are greater than the percentages shown because of watershed attenuation losses.

Estuary System	septic system load	wastewater facility load	atmospheric to estuary surface
Rock Harbor	84%	1%	1%
Centerville River System	80%	0%	2%
Green Pond	78%	6%	7%
Taylors Pond	77%	0%	3%
Bournes Pond	74%	0%	11%
Great Pond (Falmouth)	72%	3%	6%
Oyster Pond (Falmouth)	68%	0%	15%
Three Bays System	68%	0%	11%
Popponesset Bay	66%	0%	11%
Farm Pond	63%	6%	8%
Lagoon Pond	63%	0%	15%
Stage Harbor System	62%	0%	21%
Phinneys Harbor System	62%	0%	18%
Sulphur Spring System	59%	13%	2%
Sengekontacket Pond	58%	0%	23%
Lewis Bay System	55%	20%	11%
Little Pond	53%	0%	3%
Great Pond (Edgartown)	36%	16%	27%
Wareham River Estuary	33%	12%	16%
West Falmouth Harbor	23%	49%	6%
Slocums River	14%	0%	4%
Nantucket Harbor	8%	0%	71%
Average	**57%**	**6%**	**15%**

whole has a large well-flushed volume of water relative to nitrogen inputs so that human activity has not yet appreciably affected the central portion of the bay to the same degree that small embayments along the periphery of the bay have been affected. In Buzzards Bay, shallow, less well-flushed embayments are most sensitive to nitrogen additions and are most likely to exhibit the symptoms and impacts described above. The Buzzards Bay NEP coined the terms "Nitrogen sensitive Embayments" and "Nitrogen-Impacted Embayments" to describe these systems in the 1991 Buzzards Bay CCMP.

Evolving Management Approach

Since the 1980s, the U.S. EPA has required that states that list waters as impaired by contaminants (on their "303 (d)" or "Integrated Lists)," develop a Total Maximum Daily Load for that contaminant to mitigate those impairments (see Figure 42 for current listed embayments in Buzzards Bay). However, in 1991, the Commonwealth had not yet adopted a methodology to define nitrogen TMDLs for coastal waters. The 1991 CCMP sought to address this problem by suggesting the

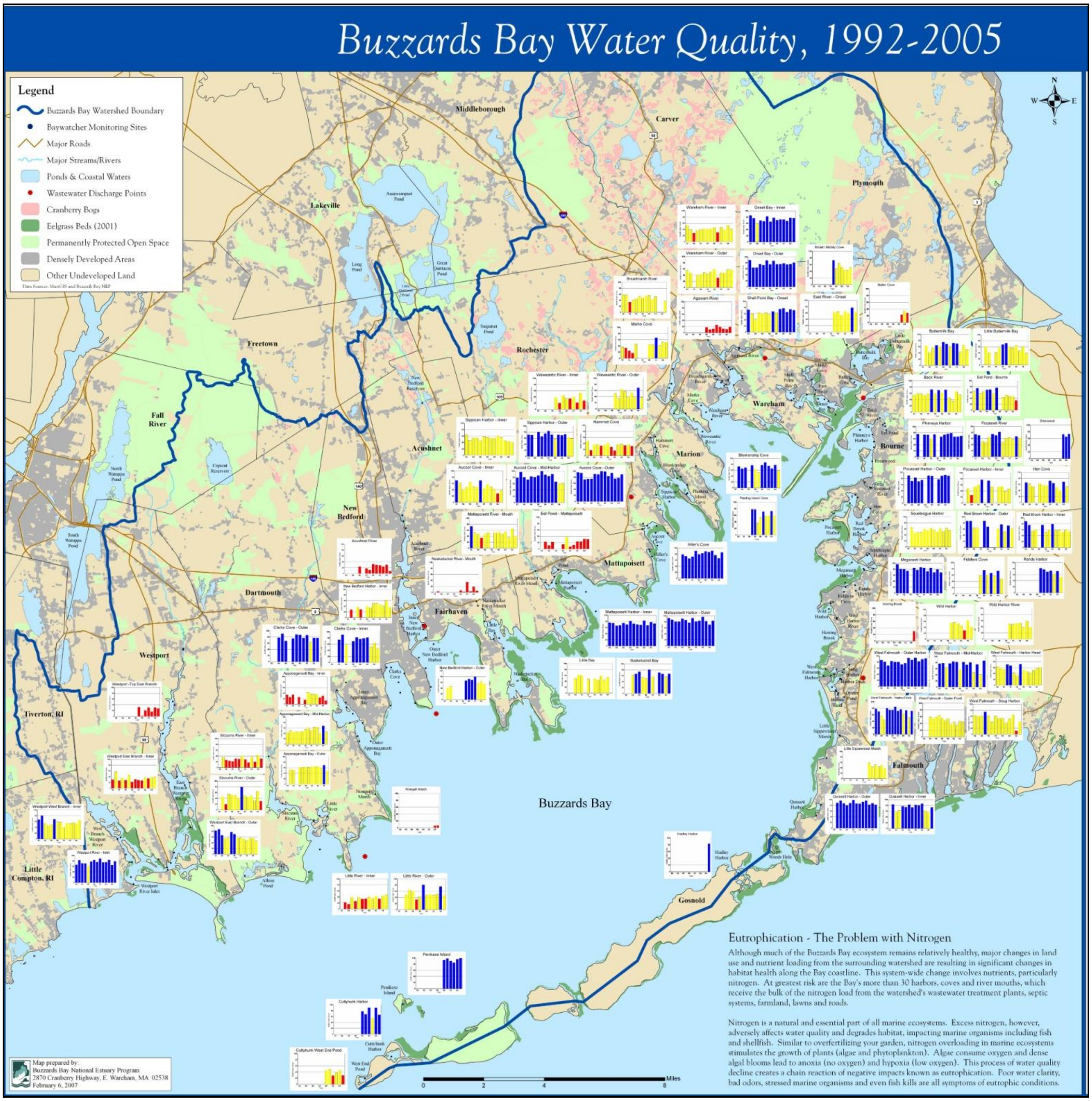

Figure 41. Summary of 13 years of coastal monitoring data collected by the Buzzards Bay Coalition.

Graphic of eutrophication index trends was from a poster prepared by the Buzzards Bay NEP for the Buzzards Bay Coalition water quality monitoring outreach program

use of parcel level data[49] to calculate watershed nitrogen loading and to set watershed nitrogen loading limits by considering the relationship between watershed loading and total nitrogen concentrations and eelgrass loss relationship to define embayment specific TMDLs[50].

[49] "To calculate anthropogenic nitrogen loads, a parcel level land-use analysis is required using a well defined set of nitrogen loading assumptions." [pg 45].

[50] In the 1991 CCMP the TMDLs were defined as Total Maximum Annual Loads because it was felt that it was impractical to determine the actual loading to an estuary from groundwater and river water on a daily basis, however a subsequent legal ruling (U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA et al., No. 05-5015, April 25, 2006) determined that TMDLs must be expressed as daily loads, because that is the precise term used in the Clean Water Act.

The proposed strategy attempted to integrate classifications of surface water quality so that degraded systems (SB waters) had higher acceptable thresholds than SA waters or Outstanding Resource waters (ORWs). To set the appropriate watershed mass-loading standard for each of these coastal systems, the Buzzards Bay NEP examined the empirical relationship between theoretical nitrogen loading (based on land use loading models) and ecosystem response, based on available eelgrass distribution information, and limited water quality data. The estimated nitrogen loading was scaled to the degree of tidal flushing of each embayment, based on the established principle that well flushed embayments have less eutrophication impacts than otherwise similar, but less well-flushed systems (see also Costa et al., 1992).

At the time the 1991 CCMP was developed, data to evaluate and model water quality in embayments was lacking, and existing embayment modeling was quite challenging. Consequently, the Buzzards Bay NEP in 1991 adopted a simple tiered system of recommended loadings based on the empirical response between nitrogen loading and various ecosystem measures like eelgrass cover, and assigning loading standards that corresponded to state water quality classifications. Our approach was used for setting or initiating watershed-loading targets in several estuaries during the 1990s, including the upgrade of the Wareham wastewater treatment facility, planned originally in the late 1990s.

In the 1991 CCMP the Buzzards Bay NEP recognized the limitations of its approach and noted,

"Future nitrogen management strategies may be based on embayment-specific nitrogen limits determined from computer models based on a large number of variables. This approach has not yet been developed and the proposed tiered approach is the most practical strategy based upon existing scientific understanding of coastal ecosystem response to nitrogen loading. Nonetheless, the proposed loading rates in table 5.1 should not be used if it can be well documented that a more appropriate limit be selected. For example, if it has been documented that an embayment showed catastrophic decline of eelgrass habitat or shellfish abundance at a certain time in its recent history -- *and that it has been demonstrated that this loss was due to nitrogen loading, then an appropriate loading limit goal for remediation activities should be set for nitrogen impact rates before the catastrophic degradation."*

The Buzzards Bay NEP also recognized that for nitrogen management actions to be justified, it was important to collect water quality data in all of Buzzards Bay's more than 30 embayments. This data was essential to justify the costs of remediating impacts to coastal embayments already degraded. Because of this need, and because volunteer based water monitoring programs had proved effective on Cape Cod, in 1992, the Buzzards Bay NEP set up a water quality monitoring program with the Buzzards Bay Coalition called Baywatchers. By 1996, the Coalition assumed all management aspects of this program, and provided most of the funding for the effort. The effort led to important insights into water quality conditions in Buzzards Bay embayments (Figure 41) and began raising public awareness of the problem. This water quality data also demonstrated that the 1991 approach for setting limits for coastal embayments was simplistic and often too lenient. In the late 1990s, the Buzzards Bay NEP attempted to revise downward the recommended limits based on the findings of the monitoring program, then in 2000, the program also proposed nitrogen water quality standards for classified surface waters based on this data (see footnote 53).

The original recommendations to manage nitrogen in Buzzards Bay met with some successes (changes in zoning in some municipalities, adoption of the most stringent nitrogen loading limits in the state for the Wareham sewage treatment facility[51], DEP action to require TMDL studies and an upgrade of the Falmouth wastewater facility, see also Table 18). However, ultimately, the methodology did not meet the site-specific rigor needed by DEP, when the agency planned a statewide program to establish watershed nitrogen TMDLs for Massachusetts coastal estuaries in the late 1990s. By 2000, DEP developed an initiative to meet their needs called the Massachusetts Estuaries Project (MEP) that would incorporate embayment-specific water quality hydrodynamic models that would be linked and build upon existing nitrogen loading models.

The MEP effort represents fulfillment of one of the goals of the original Buzzards Bay CCMP to identify embayment specific nitrogen loading limits based on sound science. The key elements of the MEP effort are defined by several documents. Howes et al. (2000) evaluated nitrogen management approaches, including the one defined by the Buzzards Bay NEP in the 1991 Buzzards Bay CCMP and subsequent documents, and settled upon an approach they had developed to evaluate loading in other Cape Cod embayments (e.g. Howes et al., 1997).

Specifically, the MEP would employ what they called a "Linked Watershed-Embayment Model" for their evaluations of 89 embayments. This approach linked a water quality circulation model[52] to a parcel based watershed loading model, a conventional nitrogen loading spreadsheet uses loading coefficients quite similar to those used by the Buzzards Bay NEP and Cape Cod Commission. This linked approach enabled the in-

[51] A 4-ppm total nitrogen discharge limit 7 months of the year.

[52] The water quality and loading software used by the MEP were proprietary customizations of the SMS, WMS, RMS software packages produced by BOSS International. These software packages allow the user to import GIS shapefiles, bathymetric data, and site-specific tidal elevation data to model the embayment's circulation patterns.

vestigators to predict for each embayment concentrations of compounds that act conservatively with mixing (e.g. salinity), or near conservatively (total nitrogen, with adjustments made for benthic flux of nitrogen from sediments) at any location within an embayment. It is the linkage between the water quality and circulation models and the watershed nitrogen loading model (including groundwater and surface flow pathways and attenuation estimates) that represent the core predictive modeling approach used by the MEP for recommended loadings for the TMDLs.

Among other elements included in the MEP model was the use of municipal water use records to estimate septic system loadings in seasonal and intermittently occupied vacation communities common on Cape Cod. The adoption of upper subwatershed attenuation coefficients based on differences between stream loadings and the watershed-loading model added additional watershed specificity to each analysis.

The MEP approach is used to calculate load reductions to achieve embayment-specific target total nitrogen concentrations at sentinel stations within each estuary. Because the Commonwealth of Massachusetts had not adopted numeric criteria in its water quality standards, which were narratives of water quality goals, the MEP presented the basis for site-specific nitrogen thresholds in Howes et al. (2003). This approach allowed for embayment-specific water quality standards at sentinel stations in order to identify appropriate watershed nitrogen TMDLs, which in turn, would become the basis for identifying corrective actions needed to achieve the water quality narrative.

As noted in the supporting documentation, "as a nutrient specific watershed management tool, the nitrogen thresholds and the process by which they are developed help communities focus implementation strategies on manageable (anthropogenic and subject to TMDL allocation process) sources of nutrients versus those that are naturally occurring." The MEP further states that the approach helps "bridge the gap in the existing water quality standards by providing a translator between the current narrative standard and nitrogen thresholds (as they relate to the ecological health of each embayment)." In 2003, DEP released a guidance document as to how municipalities may comply with TMDLs (DEP, 2003; c.f. EPA 1999,2000).

A fundamental first step in developing a recommended TMDL for an estuary in the MEP approach is to select a location for a sentinel monitoring station and to establish a threshold target total nitrogen concentration for that station. Typically the MEP selects a sentinel station of around 0.4 ppm or less total nitrogen, if the water quality goal is to restore or protect eelgrass, and 0.5 ppm or higher, if the goal is only to protect or restore benthic habitat like shellfish beds[53].

Table 18. Some successes and timeline related to the 1991 Buzzards Bay CCMP Nitrogen Management action plan.

- In 1991 Wareham, Plymouth, and Bourne adopt zoning changes to manage future nitrogen inputs to Buttermilk Bay.
- In 1992, in partnership with the Buzzards Bay Coalition, the Buzzards Bay NEP creates a volunteer-based water quality monitoring program to collect eutrophication related water quality data in order to justify management action.
- In 1993, the Buzzards Bay NEP creates the eutrophication index in an effort to simplify and communicate the results of the water quality monitoring program to residents and town officials.
- In 1995-1997, reports and analysis from the Buzzards Bay NEP of nitrogen loading impacts of the Falmouth wastewater facility to West Falmouth Harbor initiated further studies that lead to the construction, in 2002, of an upgraded facility to achieve high levels of nitrogen removal and a groundwater discharge limit of 5 ppm.
- In 1996, DEP adopts "nitrogen sensitive area" standards in the 1996 Title 5 onsite system regulations.
- In 1998, the Buzzards Bay NEP revises downward its recommended nitrogen loading limits based on the results of the monitoring program.
- In 1999, EPA uses Buzzards Bay NEP loading analyses and recommended limits, and the Buzzards Bay Coalition water quality data to justify Best Available Technology upgrades at the Wareham Wastewater Treatment Facility and an NPDES discharge limit of 4-ppm nitrogen during seven critical months of the year.
- In 2000, DEP recognizes the need to limit nitrogen to coastal embayments but realizes the Buzzards Bay NEP's tiered nitrogen loading strategy developed in 1991 is too simplistic to meet the development of TMDLs. Instead, they establish an ambitious 10-year effort to evaluate 89 Massachusetts. embayments using a linked watershed loading-water quality model approach as the basis of the program. Work in West Falmouth Harbor becomes a model for the program. The Buzzards Bay Volunteer Water Quality Monitoring Program data becomes the basis for evaluating the ecosystem response and nitrogen loading models.
- In 2006, the Massachusetts MEP completes the first TMDL for a Buzzards Bay embayment.

[53] The BBNEP proposed similar water quality standards in 2000 correspondence to DEP, Managing anthropogenic nitrogen inputs to coastal embayments: BBNEP (2000), Technical basis and evaluation of a management strategy adopted for Buzzards Bay. Supplementary information on water quality and habitat goals.

Table 19. Status of linked watershed-embayment model to determine critical nitrogen loading thresholds reports for Buzzards Bay embayments and approval date of the TMDL.

Town	Estuary (ies)	Report Status	TMDL Issued
Bourne/ Wareham	Buttermilk Bay	not scheduled	
Bourne	Red Brook Harbor	no report	
Bourne	Megansett/Squeteague Harbors	no report	
Bourne	Pocasset River	no report	
Bourne	Phinneys Harbor/Eel Pond/ Back River System	Final 2006	November 2007
Dartmouth	Slocums River	revised final 2012*	
Dartmouth	Little River	revised 2012*	
Dartmouth	Apponagansett Bay	draft 2013	
Fairhaven	Little Bay/Nasketucket Bay	draft 2013	
Falmouth	West Falmouth Harbor	Final 2006	November 2007
Falmouth	Fiddlers Cove	draft 2012*	
Falmouth	Rands Harbor	draft 2012*	
Falmouth	Quissett Harbor	draft 2012*	
Gosnold	Cuttyhunk Harbor	no report	
Gosnold	West End Pond	no report	
Marion/Matt	Aucoot Cove	no report	
Marion	Sippican Harbor	no report	
Mattapoisett	Mattapoisett Harbor/Eel Pond	no report	
Mattapoisett	Mattapoisett Harbor	no report	
New Bedford	Acushnet River/ New Bedford Inner Harbor	revised 2012*	
Wareham	Agawam/Wareham/Broad Marsh Rivers/Marks Cove	final 2013*	
Wareham/ Marion	Weweantic River	not scheduled	
Westport	Westport Rivers	final 2012	

Retrieve from www.oceanscience.net/estuaries/. Last accessed July 17, 2012. Other information from DEP. Other notes: *= drafts under review.

The placement of the sentinel station, and the selection of a target total nitrogen concentration, affects the recommended limits contained in the TMDL for the estuary, and thus, how much watershed nitrogen loading must be reduced. The actual selection of the specific TN concentration at a sentinel station in an estuary, and the location of that station, is based on a reference condition approach using a comparison with healthy sites in each system or similar systems with observed nitrogen concentrations. The location is chosen based on past observations of where healthy eelgrass beds were previously observed and best professional judgment. The MEP then extrapolates the results of their water quality models to determine what amount of watershed nitrogen loading reduction would result in the proposed target concentration at the sentinel station. Small changes in the nitrogen concentration targets can appreciably affect loading reduction targets.

The MEP reports are not TMDLs, but recommendations to the state and the U.S. EPA as to what the appropriate TMDL is for the estuary. After considering the information in the report, and if it is determined to be acceptable, the Massachusetts DEP will extract the core MEP findings, maps, and recommended limits, including any warranted margins of safety for the protection of the environment, and write a TMDL document, and submit this information to the U.S. EPA. The receipt of the TMDL will be noticed in the Federal Register, and the public will have 90 days to comment on the TMDL.

The Massachusetts Estuaries Project was originally estimated to cost $12.5 million in state, federal, and local funds to evaluate 89 Massachusetts embayments over 8 years. The complexity of analysis along with the availability of local match and escalating costs over time has resulted in delays and the reduction in the number of estuaries to be evaluated to 70. Due to the delays identified above, as of June 2012 only two Buzzards Bay embayments, Phinneys Harbor/Back River system and West Falmouth Harbors, had final reports and approved TMDL reports (see Table 19). However, DEP remains committed to completing the effort for many of the remaining systems originally planned for evaluation within Buzzards Bay.

With delays in the MEP program, some municipalities have sought to pass interim measures to limit nitrogen. The most notable of these efforts were the repeated attempts and failures of town officials in Wareham to pass bylaws in 2006, 2007, 2008, and 2012 to require nitrogen reducing septic systems. Eventually in 2013, the Board of Health adopted regulations requiring nitrogen removal septic systems within 500 feet of any surface water or wetland. Due to the extensive areas of wetlands and water bodies in the town, this requirement affects about 90% of the developable land in the town. All these efforts were prompted by a desire to address the poor water quality in the community, a recognition that the ongoing sewer expansion initiative will take years to complete, and that the town was unlikely to adopt new sewer expansion programs in the near future.

From TMDLs to Management Action

All conventional septic systems release nitrogen as ammonia that converts rapidly to nitrate in soils above the water table. Whether a system is properly operating, or fails to meet Title 5 standards, it is presumed to contribute the same amount of nitrogen to the environment[54]. Nitrate in groundwater flows great distances without attenuation and with little chance of uptake by plants, except in upper watershed areas, where ground-

[54] The exception may be those cesspools located in saturated soils close to water bodies. Properly designed leach fields help remove some nitrogen, and these processes do not occur when an anaerobic effluent plume is discharged directly to the water table close to a water body. See Costa et al., 2002.

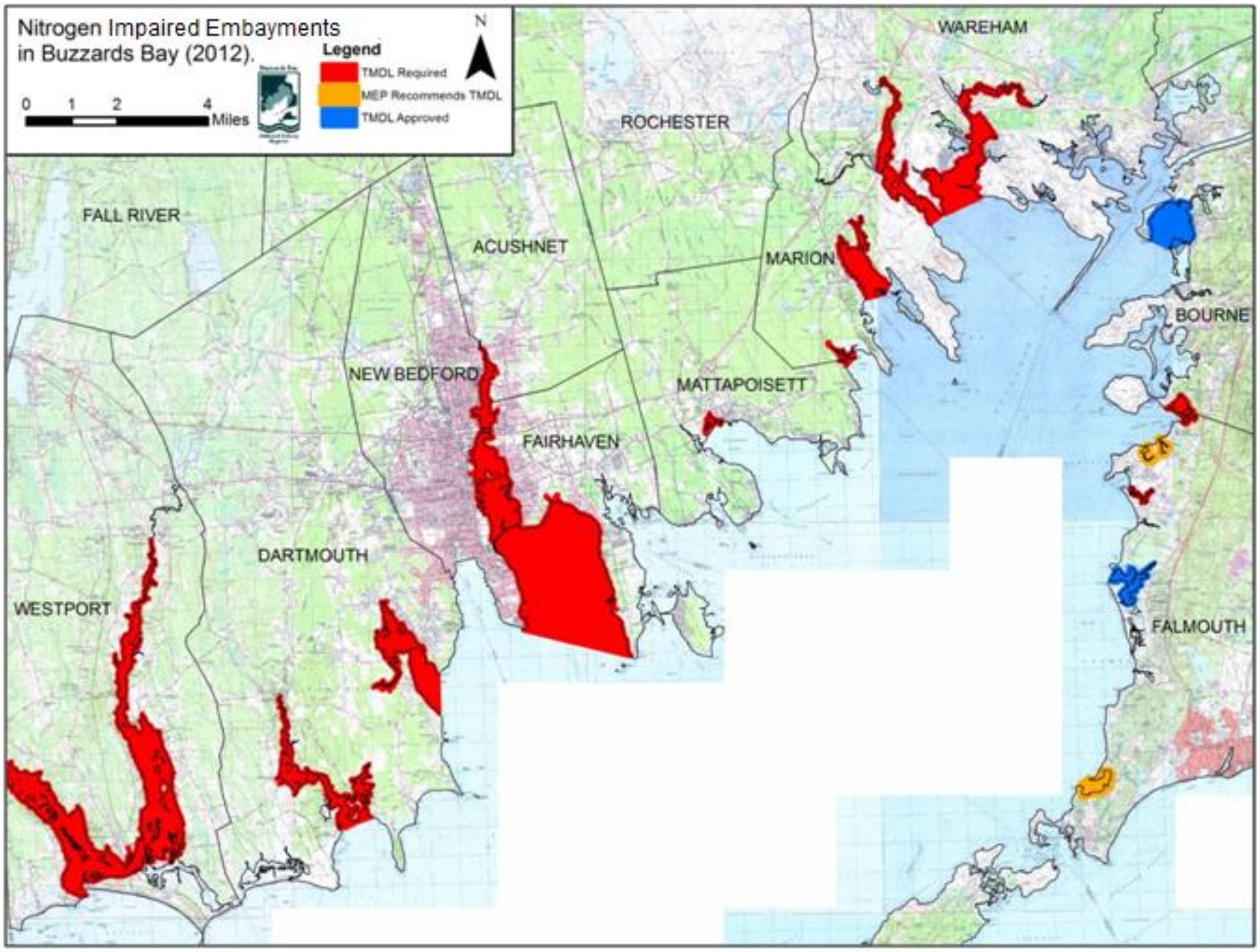

Figure 42. Coastal embayments impaired for nitrogen in Buzzards Bay.

Based on DEP's *Massachusetts Year 2012 Integrated List of Waters, Proposed Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act,* and a companion MassGIS coverage. Note that on Cape Cod, TMDLs have been set based on MEP reports even though they are not listed as Category 5 waters (TMDL Required) on the state's Integrated List. Consequently, the number of embayments where a TMDL will be developed will be greater than the number shown in red on this map. Additional TMDLs will likely include areas where draft MEP reports recommend nitrogen control (shaded orange), and areas where assessments may be conducted in the future (e.g., Buttermilk Bay, Onset Bay).

water may be intercepted by wetlands and fresh surface waters. Still, in the MEP loading models, in many river and upper watershed areas, net nitrogen transmission to coastal waters may still typically equal 50 to 70% of the presumed loading to groundwater in the watershed. Given the large number of septic systems in most watersheds, it is not surprising that septic systems typically account for 40-80% of the nitrogen entering coastal watersheds (averaging 57% as per Table 17), and after attenuation of upper watershed sources, account for a higher percentage of nitrogen actually reaching coastal waters.

Not all parts of Buzzards Bay have these suburban residential patterns of development. In some rural agricultural areas like Westport, Carver, and Middleborough, fertilizer on agricultural lands, or wastes from livestock[55], may be significant contributors of anthropogenic nitrogen. In many instances, these agricultural sources exceed septic system discharges. In an urban area like New Bedford, the Fairhaven wastewater facility and New Bedford CSOs and stormwater are the principal sources of nitrogen to the harbor. Because each embayments has its own specific sources of nitrogen, management strategies will be specific to those watersheds.

Whether or not septic systems are the largest single source, they are viewed as one of the easiest sources to control. Even in the 1991 CCMP, septic systems were viewed as one of the primary problems and sewering was identified as a solution, as was the allowance and use of nitrogen removing onsite systems, which at the time

[55] This appears to be true for the East Branch of the Westport River according to a 2012 draft MEP report.

were a novel idea[56]. Twenty-one years later, and after a decade of work, most MEP reports in support of DEP's TMDL program, identify elimination of septic loads as the modeled scenario to reduce nitrogen. Only in a handful of TMDL reports is improved tidal flushing a viable management option to meet a TMDL reports. Alternative strategies such as aquaculture have not been considered as general options, but given the weight of nitrogen in a clam or oyster, and the amount of nitrogen reduction required in some embayment, large areas of the embayments would need to be dedicated to aquaculture.

Restoration strategies in the original CCMP relied upon voluntary action by municipalities to expand sewer systems or take other measures. With the ongoing TMDL effort by the MEP, a far more scientifically defensible basis for watershed nitrogen TMDLs is now available. However, while existing permitted discharges must comply with the maximum extent feasible, actions by municipalities to expand sewer systems and eliminate septic system nitrogen discharges largely remains a voluntary action. Federal, state, and municipal governments have authority under various laws and regulations to control these discharges of nitrogen, but these powers have not yet been exerted to address watershed TMDLs. For example, DEP has broad authority to enforce the federal Clean Water Act under Massachusetts law[57], but these authorities have not been utilized.

DEP's development and EPA's approval of the TMDLs developed by the MEP are actions within the framework of Section 303(d) of the Clean Water Act. Although these new limits are also just mass loading limits based on best available science, once adopted as TMDLs, they are enforceable by state and federal agencies for regulated (permittable) discharges. However, efforts to solve the problem have been delayed and become more intractable because of the immense cost of sewering. Many state and local regulators do not view the widespread use of nitrogen removing onsite systems as a panacea because of costs and implications of possibly managing hundreds or thousands of these systems. While our scientific understanding and capacity to model nitrogen impacts have vastly improved since 1991, regulatory tools to deal with the problem, within either local bylaws or state regulations, have changed little during the same period, often resulting in continued inaction.

The failure of federal, state, or local government to meet these TMDLs can also be the subject of lawsuits under the Clean Water Act by members of the public and citizen groups. This fact led to the Buzzards Bay Coalition and the Conservation Law Foundation filing a citizen lawsuit, that among other things, challenged the EPA's policies and rules that groundwater discharges were not part of a TMDL's "waste load allocation"; that is, not a regulated discharge under the Clean Water Act. In 2013, this lawsuit was dismissed.

Major Issues

As described in the preceding section, several major issues have hindered progress on this issue since the adoption of the 1991 CCMP. Around the start of the program in 2002, the Massachusetts Estuaries Project and others had encouraged municipalities to delay adopting comprehensive nitrogen management strategies until final watershed nitrogen TMDLs were developed for the affected embayment. Some municipal boards have also felt they should delay action until the MEP reports are finalized. However, due to delays, cost overruns, and insufficient funding, as of June 2013 only two TMDLs have been approved for Buzzards Bay, so most communities continue to defer taking management action, all the while development continues, and sites for treatment solutions diminish.

Each TMDL notes that cost effective solutions can be explored and defined by municipalities to meet water quality targets at the sentinel site during the CWMP development process. On Cape Cod, in most cases, the only practical solution for reducing nitrogen appears to be the construction of new sewage treatment facilities and creation of or expansion of sewer networks (CCC, 2009a). However, some residents and municipal officials have expressed concerns that alternative approaches have not been fully investigated. Elimination of septic system loads can be achieved with alternative nitrogen removing onsite systems instead of sewers. Other proposed alternatives include treatment options rather than source reduction. These include shellfish and algal culture, installation of permeable reactive barriers, dredging, wetland creation and restoration, stormwater BMPs, and channel widening. Increasingly, towns are mandating that these alternative approaches be included in feasibility studies, including their potential environmental impacts. In 2013, the Cape Cod Commission completed a regional wastewater plan study that included an assessment of green infrastructure and alternative approaches addressing some of these issues (CCC, 2013). Despite the interest in these approaches, no town has yet presented a comprehensive wastewater strategy with these alternative approaches combined to meet a TMDL. They thus remain alternatives to be investigated.

Based on town estimates and press reports, these costs will likely total billions of dollars for Buzzards Bay watershed communities[58]. In some towns, betterments

[56] A specific recommendation in the 1991 action plan was that "DEP will actively promote the development and acceptance of cost-effective alternative technologies for wastewater denitrification by assigning additional personnel to overview pilot projects."

[57] MGL c. 21, Sections 26 through 53 directs DEP to "take all action necessary or appropriate to secure to the Commonwealth the benefits of the Clean Water Act, 33 U.S.C. §1251 et seq."

[58] On Cape Cod, where there is far less existing sewering than in the Buzzards Bay watershed, costs to comply with TMDLs will likely cost between $4 and $8 billion dollars (see Cape Cod

just for sewer tie-ins, have in some cases, exceeded $40,000 per home. This does not include the cost of new or expanded treatment facilities, annual sewer fees, or connection costs. These cost concerns have prompted financial studies of alternative approaches (e.g., Barnstable County Wastewater Cost Task Force, 2010). Such high costs, and the absence of federal grants and limited availability of SRF funds have made these management solutions politically unsellable to large sectors of the population if all the costs are borne locally.

Finally, because septic systems discharge to groundwater, they have not been regulated by the federal government under the Clean Water Act, and have been designated part of the watershed waste load nonpoint source pollution. Therefore, ultimately there has been no effort by the federal government to require municipalities to connect septic systems in the watershed to wastewater facilities to meet a TMDL for nitrogen. Thus for the foreseeable future, unless DEP exerts its authorities under state law, or federal jurisdiction is clarified, municipalities will only make progress toward reducing nitrogen discharges to coastal waters in a time frame defined by decisions and votes driven by politics and costs alone.

Management Approaches

The Buzzards Bay Coalition's water quality monitoring program and DEP's eelgrass mapping program have clearly documented which embayments in Buzzards Bay are impaired. The MEP studies on Cape Cod have resulted in the adoption of TMDLs in nearly every system where eelgrass loss or habitat degradation has occurred, so it is likely that most Buzzards Bay embayments, and many more than those shown in Figure 42, will have a TMDL.

The primary state-local planning tool to implement these TMDLs will be the Comprehensive Wastewater Management Plan (CWMP). The goal of the CWMP process is to make environmentally sound and cost effective decisions on the planning, design, construction, and maintenance of wastewater facilities, and reflect the collective input of residents, local officials and other interested stakeholders. The adoption of CWMPs that address watershed nitrogen TMDLs also makes communities eligible for 0% interest SRF loans.

The outcome of the CWMP process will vary from town to town. Even before a TMDL is approved for the Wareham River estuary, strict nitrogen limits were required for the Wareham wastewater facility based on recommended limits by the Buzzards Bay NEP and water quality data from the Buzzards Bay Coalition's Baywatchers Program. This translated to 4 ppm for 7 months (April through October) of the year, a performance standard that was incorporated into a past CWMP. An updated CWMP for Wareham will need to incorporate any newly adopted TMDLs.

In most watersheds, further reductions in watershed loading must focus principally on onsite septic systems discharges; although manure and agricultural fertilizer use can also be a major source in some watersheds (see additional discussion of sources in Chapter 3 Characterization of Pollution Sources). To reduce these agricultural nitrogen discharges, various best management practices (BMPs) can be implemented depending on the type of agriculture.

In the case of dairy farms (which are the largest source of watershed loading in the Westport rivers), farmers can better manage manure to ensure that less nitrogen reaches streams and the groundwater. These BMPs include maintaining fenced buffers to streams and wetlands, building manure storage structures to prevent runoff and discharge to groundwater, and even changing feed formulations[59].

In the case of agricultural fertilizer use or manure management, some normal farm practices are exempt from local control and are little regulated or exempt from state and federal environmental laws as well. This situation means that agriculture fertilizer management will focus on voluntary and collaborative work with farmers. Fertilizer use on residential and active recreational lands will also depend on voluntary efforts, but more opportunities for regulation of turf fertilizer exist[60].

With respect to cranberry bogs, how water is managed can greatly affect nutrient release, with older flow-through bogs releasing the most nutrients (Demoranville and Howes, 2005; Demoranville, 2010). How floodwater is managed is especially important (Demoranville et al., 2009). For example, flooding time, floodwater retention time, and discharge rates are important factors affecting phosphorus release from bogs (DeMoranville, 2006). New bogs constructed on mineral soils without confining layers are much more prone to release fertilizer and pesticides to groundwater (DeMoranville and Sandler, 2000). Practices, such as the construction of tailwater recovery ponds, bypass canals, and laser leveling of bogs can greatly assist in both reducing water use and contaminant release (NRCS, 2011).

Times, *Nonprofit groups hash out wastewater issues*, 28 September 2012, Retrieved from (last accessed October 17, 2012): www.capecodonline.com/apps/pbcs.dll/article?AID=/20120928/NEWS/209280336/-1/SPECIAL25. In contrast, the total cost to meet subwatershed nitrogen TMDLs in the Buzzards Bay watershed is likely to be only $2 billion (see calculations in the Financial Approaches section below).

[59] A more complete list of nutrient management related BMPs is found in Agricultural Best Management Practices Task Force and USDA NRCS (2011).

[60] The Massachusetts Legislature passed in the Acts of 2012 a law that enabled the state Department of Agriculture to "promulgate regulations that specify when plant nutrients may be applied and locations in which plant nutrients shall not be applied." As of June 2013, these regulations have not been promulgated.

To reduce these discharges, growers should continue to utilize best management practices in retrofitting existing bogs and constructing new ones, and for managing water, especially harvest water. Many growers have already installed tailwater recovery ponds, bypass canals, and implemented other water management and conservation measures. Growers should also continue to develop and implement farm plans with these and other beneficial fertilizer and water management practices. USDA and the Massachusetts Department of Agriculture should continue to work with the cranberry industry and its grower community to educate about the environmental and economic benefits of water management. These efforts will require continued technical and financial support from the USDA Natural Resource Conservation Service's Environmental Quality Incentives Program and the Massachusetts Department of Agricultural Resource's Agricultural Environmental Enhancement Program, among others. These needs include support for conservation farm plans and continued research into new and improved fertilizer and water management practices.

For the relatively few embayments that are nitrogen sensitive, but not yet nitrogen impacted, managers can implement a combined strategy of managing nitrogen from new growth through sewering, nitrogen removing community scale package plants, or advanced onsite systems. However, given that nearly all embayments studied on Cape Cod require nitrogen reductions, so too it is likely that all embayments in Buzzards Bay will require TMDLs and loading reductions, not just the impaired systems identified in Figure 42[61].

Separate from efforts to better manage nitrogen from wastewater, local legislative bodies and regulators have initiated other supporting measures to protect or restore estuaries. To reduce fertilizer impacts, municipalities can change fertilizer use on public lands, or require vegetative buffers between turf and wetlands in local wetland regulations. Applications of fertilizer can sometimes be addressed during the permitting process for new development and redevelopment[62]. Wetland regulations are also a mechanism to better treat stormwater, which can convey fertilizer, atmospheric nitrogen, and other sources. Some communities have adopted fertilizer ordnances that control the type and period of use of fertilizer. However, attempts to pass new fertilizer bylaws have now been blocked by the Attorney General because of the passage of a 2012 law that limited the authority for the control of fertilizer to the state and county government[63]. Barnstable County Assembly of Delegates approved the development of a Cape Cod-wide fertilizer regulation[64]. Ultimately these measures are only part of a broader management solution because in most estuary watersheds, fertilizer use and stormwater combined typically account for 20% or far less of the controllable load entering the estuary watersheds, and only somewhat more of the attenuated nitrogen load entering the estuaries.

Other tools municipalities could adopt to manage nitrogen sources include requirements of "nitrogen neutrality" or no net nitrogen for new development, minimum town-wide nitrogen standards for new development (which also become a negotiating point for new Chapter 40B projects), and Transfer of Development rights with elements to allow nitrogen trading. Zoning changes can also support these efforts (nitrogen overlay districts, minimum lot size), although these tools will be used primarily to manage new sources of nitrogen. It is important to coordinate TDR bylaw development between municipal environmental boards. Care must also be taken in developing these strategies to ensure that density bonuses or other incentives do not negate the environmental benefits of the strategy. Guidance on the development of TDRs and comparable strategies can be found in the state's Smart Growth Toolkit[65].

The localized nature of coastal eutrophication and watershed loading limits were novel to local officials when the Buzzards Bay CCMP was adopted in 1991. Today, the public is far more conversant with the seriousness of the problem, and the science defining coastal eutrophication is now widely accepted. Nonetheless, because of the high cost of solving the problem, the restoration of impaired estuaries seems far off. The loading analyses of the MEP and earlier assessments by the Buzzards Bay NEP point to common outcomes and needs. Even where TMDLs have not yet been developed, it is clear that wastewater management must be the primary focus in every community, and it is imperative that municipalities begin the wastewater planning process.

[61] Even Quissett Harbor, Falmouth, which has some of the best water quality conditions in the Buzzards Bay Coalition's Baywatchers program, has a documented eelgrass loss and recommended load reductions according to an MEP 2012 draft TMDL report.

[62] The state Wetlands Protection Act regulates activities in a buffer zone with the goal of protecting adjoining wetlands, not to protect or maintain a buffer zone. Through some municipal bylaws, the buffer zone may itself be a resource area to protect, or a no-build buffer is enforced. See Action Plan 7 Protecting and Restoring Wetlands for recommendations on this topic.

[63] A bylaw passed by Falmouth town meeting in 2012 to regulate fertilizers was disapproved by the Massachusetts Attorney General's office (Falmouth Annual Town Meeting of November 13, 2012 - Case # 6565) because it was inconsistent with the state law giving that authority to the Department of Agricultural Resources under Chapter 262 of the Acts of 2012. The Legislature subsequently inserted an exception for towns that had passed ordinances or bylaws on nutrient or fertilizer management in the past year.

[64] Driscol, S. F. Barnstable assembly OKs plan to limit fertilizer use on Cape. Cape Cod Times September 20, 2013, Retrieved from: www.capecodonline.com/apps/pbcs.dll/article?AID=/20130920/NEWS/309200321.

[65] Retrieved from www.mass.gov/envir/smart_growth_toolkit/pages/mod-tdr.html.

Financial Approaches

The main financial support offered by the federal and state government is the federally funded State Revolving Fund (SRF) program, which is jointly administered by the DEP Division of Municipal Services and the Massachusetts Water Pollution Abatement Trust. For municipalities with an approved CWMP, SRF offers loans with as low as 0% interest loan, for 20- to 30-year loan periods. In today's financial climate, these loans represent a cost saving on projects of 18-28% (Barnstable County Wastewater Cost Task Force, 2010). However, there is far more demand for the loan program than there are funds available. This means most of the costs of meeting TMDLs will be borne through local property taxes, betterment fees, and sewer fees.

On Cape Cod, estimated costs to comply with watershed nitrogen TMDL are high. Falmouth has estimated sewering costs at $650 million[66], Chatham $350 million, and Bourne $300 million. These are the costs to sewer only the densest developed portions of their communities, and may not cover the costs of sewage treatment upgrades. These costs translate into $40,000 to $100,000 per home connected. Some managers have criticized these projections as over-estimates (and in fact, the State Revolving Loan [SRF] program can reduce per unit costs), but a consensus is developing among municipal and state officials that Cape Cod sewering will in fact total four to eight billion dollars[67].

For the Town of Falmouth, most of the estimated $650 million price tag to comply with nitrogen TMDLs will be associated with projects outside of the Buzzards Bay watershed. However, some areas of West Falmouth Harbor and Quisset Harbor will need to be sewered, and the town's wastewater facility, which is in the Buzzards Bay watershed, may need to be expanded, with a new discharge outside of the West Falmouth Harbor watershed. These costs will likely exceed many tens of millions of dollars to $100 million.

Actual costs will be defined by the specific solutions or strategies a municipality adopts, and reports by the Barnstable County Wastewater Cost Task Force (2010) and Wright-Pierce et al. (2005) provide excellent summaries relevant to southeastern Massachusetts and Cape Cod. For most Buzzards Bay watershed communities, sewering costs may be ameliorated by the fact that many densely developed areas are already sewered, so most towns are merely facing sewer expansion, not the construction costs of new wastewater facilities. However, major expansions of sewer systems typically also require expensive upgrades or expansions of existing systems, so savings are not always realized. Still, upgrading existing facilities to meet more stringent discharge limits is sometimes also required. In the less densely developed areas, sewer tie-in costs per home can increase dramatically.

On top of these costs are connection fees and septic removal costs ($4,000 to $8,000 per home), household plumbing retrofit costs if the septic is located behind the home ($1,000 to $2,000 per home), sewer fees ($400 to $650 per year in Buzzards Bay communities), and hundreds of millions of dollars to upgrade the capacity and performance of existing wastewater facilities generally charged to sewer ratepayers. Thus, the unsubsidized 20-year cost for sewering will likely average between $50,000 and $110,000 per home connected for many areas of the watershed.

In the U.S. 2010 Census, in the Buzzards Bay watershed, there are 116,205 residential units[68]. Of these, 64,335 are sewered[69]. If 60% of the 51,870 estimated units served by septic systems in the Buzzards Bay watershed needed to be sewered[70], the cost of wastewater facility upgrades and betterments, system removals and house tie-ins could total $1.9 billion[71]. Thus, the total costs to comply with nitrogen TMDL in the Buzzards Bay watershed will likely exceed $2 billion dollars when other incidental costs are factored in.

For some embayments, simpler and less costly solution may be available. Dredging harbor entrances to increase flushing rates may be a viable option in only a few small systems. However, even when dredging is a potential solution, it may be controversial because enlarging channels may increase tidal ranges, change salinities, transfer nitrogen pollution elsewhere, or result in significant changes in sediments deposition; these changes could have significant impacts on the distribution and abundance of many species. At this time, dredging appears to be an option for only one small embayment (Eel Pond, Mattapoisett).

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66 See archive.capenews.net/communities/falmouth/news/442. Last accessed October 11, 2013.

67 Cape Cod Times, February 27, 2011, Wastewater: Cape Faces Costly Cleanup at: www.capecodonline.com/apps/pbcs.dll/article?AID=/20110227/NEWS/102270320/-1/SPECIAL25. Last accessed October 11, 2013.

68 Based on a Buzzards Bay NEP analysis using U.S. Census GIS data. For census blocks that were bisected by the watershed, the population and housing units were assumed to be directly proportional to the percent of the area of the block within the watershed. In specific cases, this may over or underestimate units, but given that there were only 391 of 8,950 census blocks clipped by the Buzzards Bay watershed boundary, the calculations presented here are likely to be a good approximation.

69 Same methodology applied using the sewered areas map in Figure 32. This calculation is based on a larger proportion of split census blocks and likely has a greater uncertainty in the estimate.

70 This totals 31,122. In the draft Westport, New Bedford Harbor, and Wareham River TMDL reports, nearly 20,000 homes will need to be sewered alone.

71 Calculation: 31,100 systems x $60,000 average total cost per unit; cost includes betterment ties, facility construction costs and upgrades, homeowner tie costs, system removal and plumbing expenses. 20 years of sewer fees may add an additional $12,000 to homeowner costs.

Some communities, like Wareham, have been considering requiring individual onsite or community nitrogen removal septic systems as an alternative to wide scale sewer expansion. The motivation for adopting this strategy is partly the result of the high costs of their wastewater facility upgrade ($30 million), and the cost of sewer expansion and septic system removal. For example, in the early 2000s, sewer expansion resulted in betterments of $12,000 to $15,000 per home. Because of distance from the wastewater facility and the lesser density of some planned sewered areas, future betterments are expected to range from $20,000 to $40,000 per residence, and possibly higher. In 2011, Wareham residents were challenging a sewer expansion that would have required a betterment totaling $32,000 per home[72]. These costs do not include $640 annual sewer fees, the cost of tying into the sewer system, or costs of removing abandoned septic tanks that may cumulatively exceed $4,000 to $8,000 per home, and are directly paid by the homeowner.

Similarly, betterments for sewer expansion in neighboring Marion in 2008 cost $30,000 per home. In 2010, a Mattapoisett sewer expansion that would cost $32,000 per home in betterments passed town meeting[73]. In all these communities, most of the expansion of sewering served parcels less than a quarter acre, and in some villages, parcels to a tenth of an acre. Small densely clustered parcels create an economy of scale and service costs in sewering, and efforts to expand sewering into less densely developed areas will result in dramatically higher costs.

In Wareham, the prospect of having to sewer 70% of the remaining existing homes[74] (to achieve a 50% septic reduction as proposed in their draft MEP report), not to mention the costs of sewering another 4,000 potential units in the Wareham portion of the Wareham River watershed has worried local officials about the capacity of communities to assimilate these costs. Consequently, the alternate strategy of adopting local regulations and standards requiring individual and community-scale wastewater systems[75] is attractive to some.

Such a strategy would entail requiring new construction and the retrofit of old construction with nitrogen removal septic systems. Local regulations could also require community scale plants for large new subdivisions. Such a strategy faces several obstacles. First, even for new construction the cost of adding a minimum-performing (19 ppm) nitrogen removal septic system will add an average of $10,000 over the costs of a conventional septic system already averaging close to $15,000, plus annual operation, maintenance, and monitoring costs. Second, a municipality would require a program to oversee these systems to ensure they are properly operated and maintained. Finally, the state minimum standard of 19-ppm total nitrogen discharge concentration is far greater than what is possible with a large-scale nitrogen removal facility (4 ppm 7 months a year). It is possible for the town to require better performing nitrogen removing septic systems, but more advanced residential nitrogen removal systems (10 ppm) might add $15,000 to $20,000 over the cost of a conventional system for new construction. Such solutions have been proposed in Articles at Wareham Town meeting, but all have been rejected.

A municipal oversight program to oversee advanced alternative onsite systems is achievable, and on Cape Cod, Barnstable County has implemented a program to require operation and maintenance contracts for onsite nitrogen removal systems. This program oversees 3,000 units on Cape Cod through a web based reporting system. At a cost of $15,000, Barnstable County created a website where vendors and operators of nitrogen removal septic systems can report on the existence of an operation and maintenance contract and submit data on discharge testing. One staff person oversees this reporting, and prepares correspondence based on reports from the software when systems do not comply with county regulations.

Regulators do not favor the widespread use of denitrifying onsite wastewater systems because those systems now allowed under general permitting under the state Title 5 regulations do not achieve the same high level of nitrogen removal as centralized advanced treatment municipal wastewater systems. Moreover, there are concerns that it may be difficult for government to track large numbers of alternative systems to ensure that they are properly maintained and performing well. These issues would need to be overcome, and more effective and reliable alternatives required, if alternative nitrogen removal onsite systems were to become a viable widespread mechanism to comply with watershed nitrogen TMDLs.

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72 New Bedford Standard Times June 30, 2011 article retrieved from www.southcoasttoday.com/apps/pbcs.dll/article?AID=/20110630/NEWS/106300345.

73 On the third attempt, see the Mattapoisett 2010 Town Report retrieved from www.mattapoisett.net/Pages/MattapoisettMA_annualtownreports/2010TRArchives/W-STownReport2010.pdf.

74 If 3,000 homes were sewered, tie-in costs, plus betterments and sewer fees spread over 20-years to pay for capital costs, the 20 year cost per homeowner could range from $40,000 to $60,000 per unit, and possibly more. The cost of sewering 3,000 existing homes to meet a TMDL might cost $120-180 million. Estimates for towns with no existing sewage infrastructure, like Westport, will be considerably higher.

75 Community scale systems are generally defined as having a discharge exceeding 10,000 gpd (roughly 23 homes) and requiring a state groundwater discharge permit. Shared systems are generally described as systems servicing two or more homes, but under 10,000 gpd, and are permitted by municipal boards of health under the Title 5 regulations.

Financial obstacles are not the only impediments, and establishing waste load allocations for meeting TMDLs is another problem that must be worked out. Some Buzzards Bay embayments will require management of sources from outside their watershed. This is because in a few instances a neighboring more eutrophic embayment system is dominating water quality in what would be a system with good water quality. This situation exists for Marks Cove in Wareham (nestled between the Wareham and Weweantic Rivers), and Little River in Dartmouth, with its small watershed at the confluence of the mouth of the larger eutrophic Slocums River.

Monitoring Progress

The development, issuance of, and compliance with TMDLs will be the principal management measures tracked to evaluate the success of this management plan. This will be accomplished by tracking embayments on the state's Integrated List of impaired waters.

At the local level, the adoption and implementation of specific milestones in CWMPs, together with adoption of companion regulations such as zoning and health regulations will be the principal tracking measures.

Restoring water quality and recovery of habitat is the goal of this action plan. These measures will also be used for long-term environmental assessment. Water quality and total nitrogen concentrations will be tracked by the ongoing Buzzards Bay Coalition Volunteer Water Quality Monitoring program. In some instances, the Coalition will need to add an estuary monitoring station to match the TMDL sentinel station defined by the MEP.

Eelgrass will be the principal habitat tracked for evaluating the success of nitrogen control measures. DEP must continue to monitor eelgrass cover at a frequency of no less than 5 years.

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Action Plan 2 Protecting and Enhancing Shellfish Resources

Problem

Shellfish (molluscs and crustaceans) are an important but diminishing resource in Buzzards Bay. Catch statistics suggest that populations of many mollusk species and lobster populations are declining. Declining catch of lobster may be related to disease and water quality degradation. Mollusk catch declines are the result of habitat declines and sanitary closures. Although the acreage of shellfish bed permanent closures has declined in Buzzards Bay in recent years, numerous areas remain permanently closed. Exacerbating the problem, funding for shellfish propagation and relay programs has been cut back appreciably in recent years.

The Massachusetts Division of Marine Fisheries (DMF) implements shellfish bed management based on ambient water quality in shellfish beds and a mostly visual evaluation of potential pollution sources along the coast (Shellfish Sanitation Survey Program). Additional coordination and collaboration is needed between DMF and municipalities to reduce closures further.

This action plan narrowly addresses steps to enhance the availability and productivity of shellfish resource areas. It compliments other action plans that target specific pollutants and impacts, especially Action Plan 3 Managing Stormwater Runoff and Promoting LID, and Action Plan 1 Managing Nitrogen Sensitive Embayments.

<u>Goals</u>

Goal 2.1. Increase availability of shellfish resources for recreational and commercial use.

Goal 2.2. Restore habitat to increase the abundance and distribution of shellfish resources.

<u>Objectives</u>

Objective 2.1. To keep open all shellfish resource areas now open, and to open priority resource areas that are now closed.

Objective 2.2. To increase the ability of DMF to carry out the sanitary survey program and provide technical assistance to municipalities to better manage shellfish resources.

Objective 2.3. To increase the capacity and commitment of municipalities to remediate pollution sources that are contributing to shellfish bed closures.

Objective 2.4. To expand the use of the conditionally approved classification for shellfish areas.

Objective 2.5. To eliminate pollution sources and disturbances contributing to the permanent loss of shellfish habitat and enhance and restore shellfish habitat.

Objective 2.6. Expand programs to propagate, seed, and relay shellfish.

Approaches

To achieve the goals and objectives of this action plan requires improved coordination and collaboration between the DMF and municipalities. To reduce bacteria concentrations, both municipalities and DMF must better monitor and document upstream pollution sources contributing to shellfish bed closures and take action to eliminate these pollution sources or minimize their impact. State sanitary surveys should be posted online to assist town boards and committees establish pollution remediation priorities. Solutions relating to shellfish habitat loss are addressed in other action plans.

Additional monitoring is essential, because “end of the pipe” solutions are expensive, and upstream source reduction strategies can often achieve the same benefits at less cost. Such monitoring can also help establish priorities to target available programs and funds to address the most problematic discharges contributing to shellfish bed closures. Additional water quality data can also enable the state to expand conditionally approved areas, or reduce the extent of permanently closed shellfish areas. These outcomes may also depend on municipalities eliminating identified pollution discharges.

Expansion of propagation or seeding programs can provide benefits to the public in the absence of broader water quality or habitat improvements. Towns can construct shellfish upwellers to meet these needs.

Costs and Financing

The legislature and local government need to provide funds for staff to implement this action plan. A watershed-scale upstream source identification program could be established at a cost of $100,000 per year if it utilized existing staff and a volunteer monitoring program like that established by the Buzzards Bay Coalition in their nitrogen pollution water quality monitoring program. Programs like EPA’s 604(b) can assist with these watershed assessments. Funding for shellfish propagation seeding (including upwellers) and habitat creation programs can be included in state and local budgets. Tackling pollution like treating stormwater discharges to open shellfish beds or reducing nitrogen to restore shellfish habitat will cost billions over decades. Those costs and issues relating to these efforts are addressed in other action plans.

Measuring Success

Acres of shellfish beds permanently closed, and commercial shellfish catch will be the principal long-term tracking measures to evaluate progress toward the goals of this action plan.

Background

The shellfisheries of Buzzards Bay have long been a valuable ecological and economic resource worth protecting. Today, quahogs are the principal species harvested in terms of poundage (see Figure 25 in Chapter 1), but in terms of dollar value, bay scallops, soft-shell clams, and oysters remain important. In 2003, DMF estimated[76] the annual value of shellfish harvested from Buzzards Bay was $4 million. Using an economic multiplier effect of 4.5, this catch contributed $18 million to the local economy.

Scallop landings, although always variable, have declined in recent years (Figure 43), with loss of eelgrass and change in bottom habitat from nitrogen loading being a likely important cause. Similarly, soft shell clams, long a popular recreational species, have seen a near collapse of the fishery (Figure 44). Recent studies have suggested that the population of this species has suffered greatly due to predation by non-native invasive crabs that are now common in the intertidal zone of Buzzards Bay. This problem is discussed further in Action Plan 11 Managing Invasive and Nuisance Species.

Lobsters are the most important crustacean species harvested in Buzzards Bay (Data from Massachusetts DMF annual Massachusetts Lobster Fishery Statistics Technical Reports.), but in recent years, like the rest of southern New England, populations have declined due to factors that may include shell disease, pollution, and elevated summertime temperatures. This action plan does not specifically address lobster catch issues, but some related management problems are included in Action Plan 16 Reducing Toxic Pollution.

Throughout the 60s, 70s, and 80s, shellfish beds in Buzzards Bay were closed due to fecal coliform contamination at ever-increasing rates, and these closings were one of the most pressing concerns with area residents (see Figure 46). In 1970, slightly more than 4,000 acres of shellfish beds were closed in Buzzards Bay; mostly near large wastewater discharges. By 1990, the state had closed more than 16,000 acres. This degradation of water quality due to pathogen contamination represented both a serious human health risk and an economic loss. Whenever the state and municipalities closed important recreational and commercial shellfish areas, the remaining open areas received additional fishing pressure, often depleting shellfish populations.

The story of Buzzards Bay shellfish bed closures is more complicated than these numbers alone indicate. In 1988, the Division of Marine Fisheries replaced DEP as the principal water quality-testing agency. When DMF assumed responsibility for the Shellfish Sanitation program, it received only half the necessary funding to implement the program, which was especially problematic because new federal mandates for testing and evaluation were imposed. Furthermore, during that decade, there was also a tremendous increase in new development

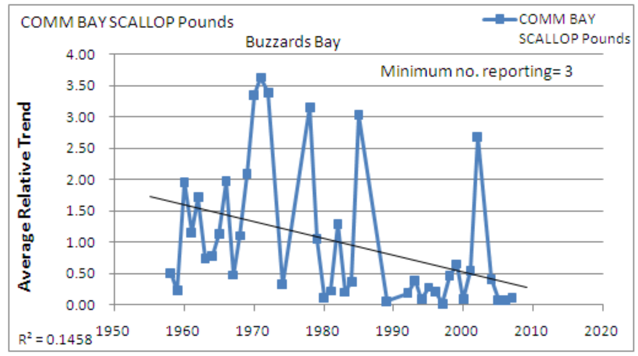


Figure 43. Relative trend of scallop catch in Buzzards Bay.

Calculated by the Buzzards Bay NEP, data and explanation at: buzzardsbay.org/shellfish_catch_trends.htm

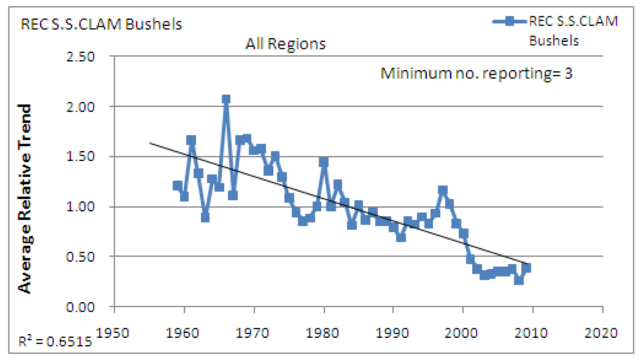
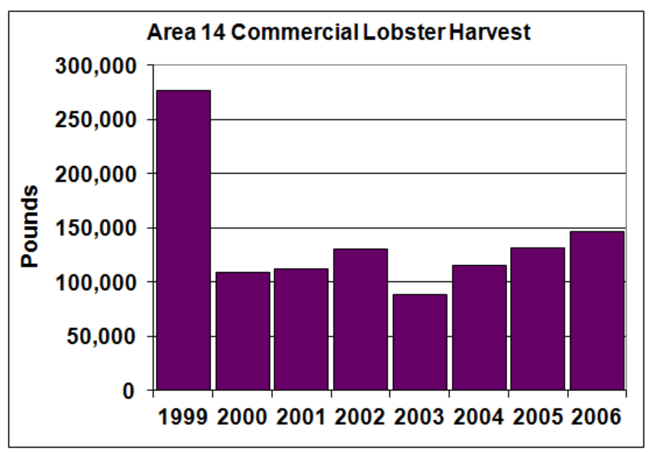


Figure 44. Relative trend of soft shell clam catch in Buzzards Bay.

Calculated by the Buzzards Bay NEP, data and explanation at: buzzardsbay.org/shellfish_catch_trends.htm.



Data from Massachusetts DMF annual Massachusetts Lobster Fishery Statistics Technical Reports.

Figure 45. Recent annual commercial lobster catch in NMFS Area 14, which includes Buzzards Bay.

[76] Reported in DMF 2003 newsletter at www.mass.gov/eea/docs/dfg/dmf/publications/dmfnq303.pdf. This is considerably less than the 1988 estimate for the 1991 CCMP, which was $4.5 and $18.8 million respectively in 1988. These values equal $6.9 and $28.9 million in 2003 dollars when adjusting for inflation dollars (based on inflation calculator at www.westegg.com/inflation/.

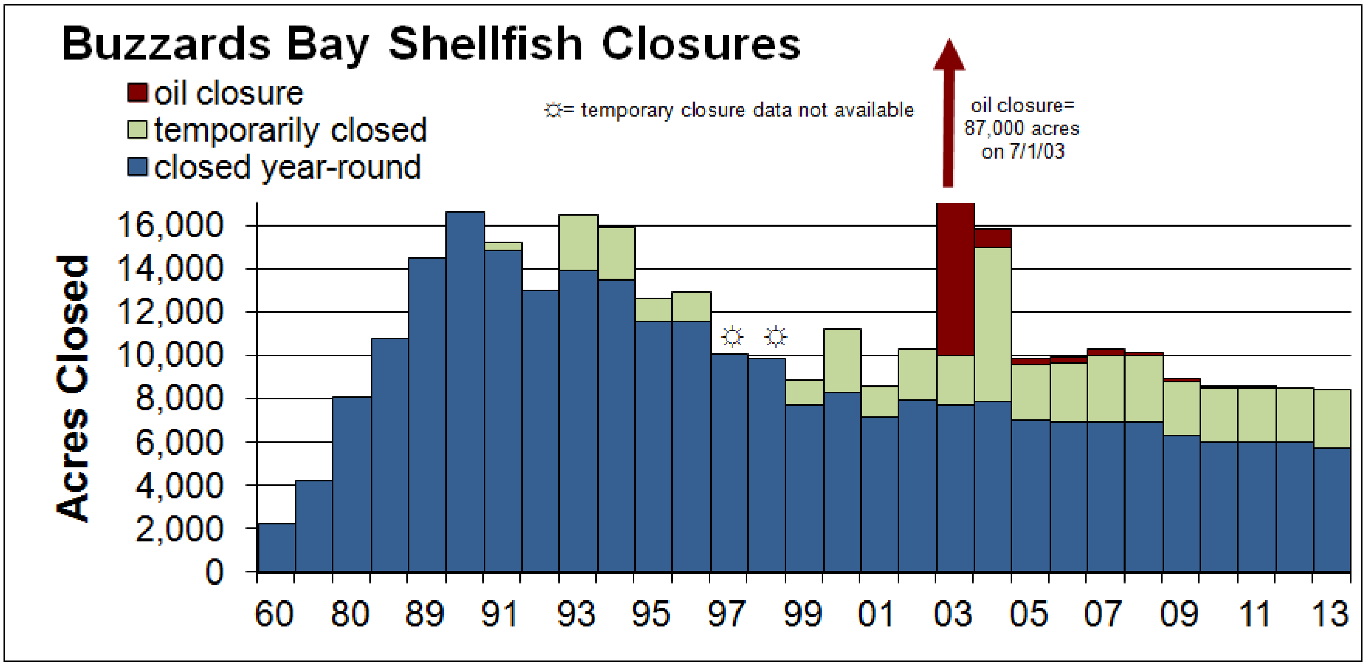


Figure 46. Permanent and rainfall or seasonally conditionally closed shellfish bed acreage in Buzzards Bay. Areas for July 2013 based on winter 2012-2013 classifications.

along the shore, coupled with a large increase in boating traffic, docks and piers, new shore roads, and discharges. The environmental impacts from the new development and associated nonpoint sources of pollution, coupled with more rigorous water testing requirements, account for most of the shellfish bed closures during the late 1980s and early 1990s.

An early challenge faced by DMF occurred in 1989 when approximately 420,000 acres of shellfish resource areas statewide were threatened with "Management Closures" because the new federal testing mandates would not likely be met, as DMF did not have adequate staffing to conduct sanitary surveys and water quality analyses. The Buzzards Bay NEP assisted DMF by providing funding for an additional staff person at DMF. Furthermore, Buzzards Bay municipal officials, principally health agents or shellfish wardens, took training programs and assisted DMF to complete the shoreline evaluation and water testing mandated by the new FDA Sanitary Survey requirements. This strong collaborative relationship of municipalities with DMF has continued to this day.

Another effort that began in the 1980s, and has continued to expand, is the use of the "rainfall conditional" shellfish bed closures to open shellfish beds during some portion of the year below certain rainfall thresholds (green portion of bars in Figure 46). This rainfall conditional approach recognizes that elevated bacteria counts in many of the bay's embayments are directly related to surface runoff during rain events. To implement a conditional program requires more testing and evaluation than the minimum required under the Sanitary Survey program. This strategy was defined as one of the primary goals in the 1991 Buzzards Bay CCMP.

The expanded use of the rainfall conditional closure approach by the Division of Marine Fisheries has been responsible for a large portion of the bed openings in Buzzards Bay since 1990. The Buzzards Bay NEP has supported testing related to the reclassification efforts beginning with a $10,000 grant to Westport. Westport was the first watershed community to begin the use of rainfall conditional closures in 1990, and similar efforts to establish rainfall conditional closures followed in New Bedford, Fairhaven, and Wareham. Large areas in the Westport River, Clarks Cove, outer New Bedford Harbor, and Little Bay in Fairhaven now have these rainfall conditional closures in place. This management technique establishes a rainfall threshold unique to each embayment, by which the local shellfish warden raises a red flag adjacent to the shellfish beds, alerting fishermen that the area is close.

The most striking of these were those around New Bedford and Fairhaven that were reopened for the first time in 40-80 years in 1992. These reopenings were made possible because of the elimination of dry weather discharges from CSOs, expansion of sewering, and upgrades to the city's municipal wastewater facility. They were also made possible because DMF conducted a rainfall conditional monitoring program (partly funded by the Buzzards Bay NEP), that allowed for a rainfall conditional closure status for the cove. This reopening of shellfish beds in Clarks Cove in 1992 resulted 1.3 million pounds of quahogs coming to market in 1993, worth $2-3 millions in economic value to the region. A comparable opening on the Fairhaven side of New Bedford

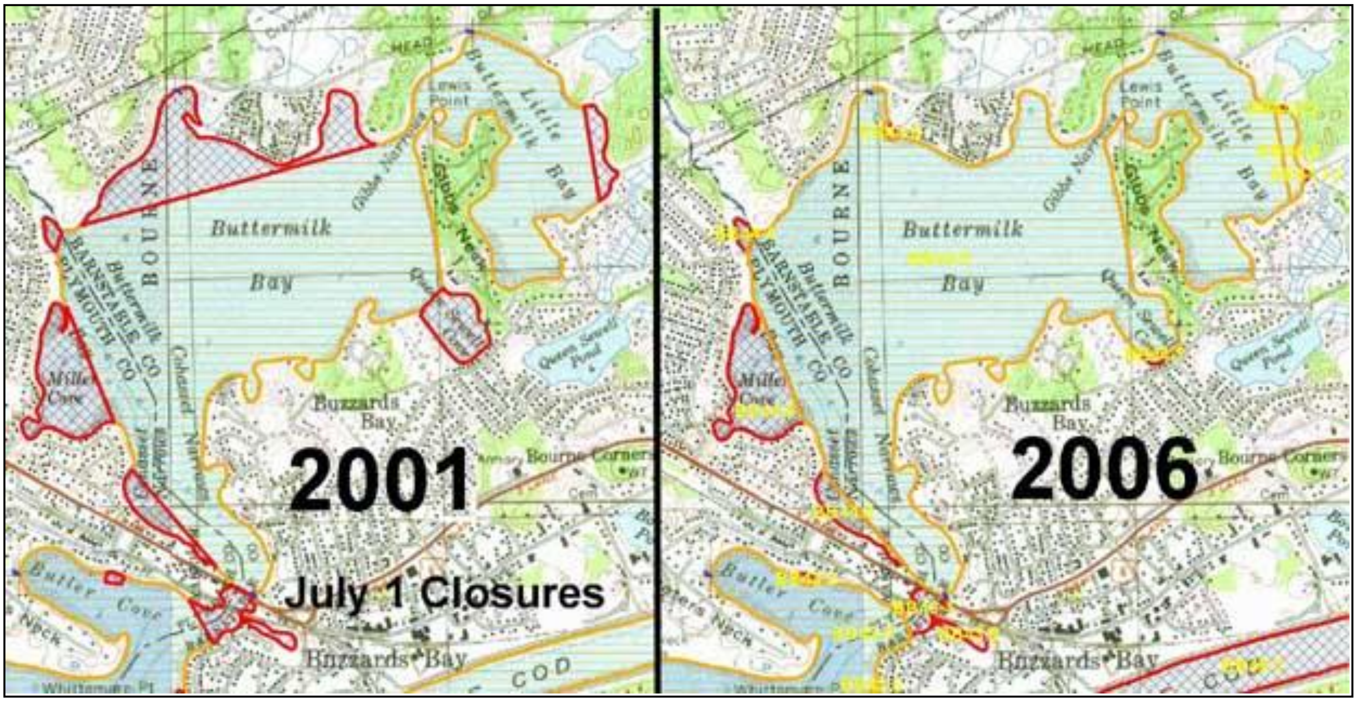


Figure 47. Incremental openings in Buttermilk Bay between 2001 and 2006 (closure status as of July 1 for each year). In 2011, Millers Cove was converted to a rainfall conditional closure and those became typically open during the summer months.

outer harbor showed similar benefits in 2008, also because of declines of pollution discharges, and enactment of a rainfall closure program.

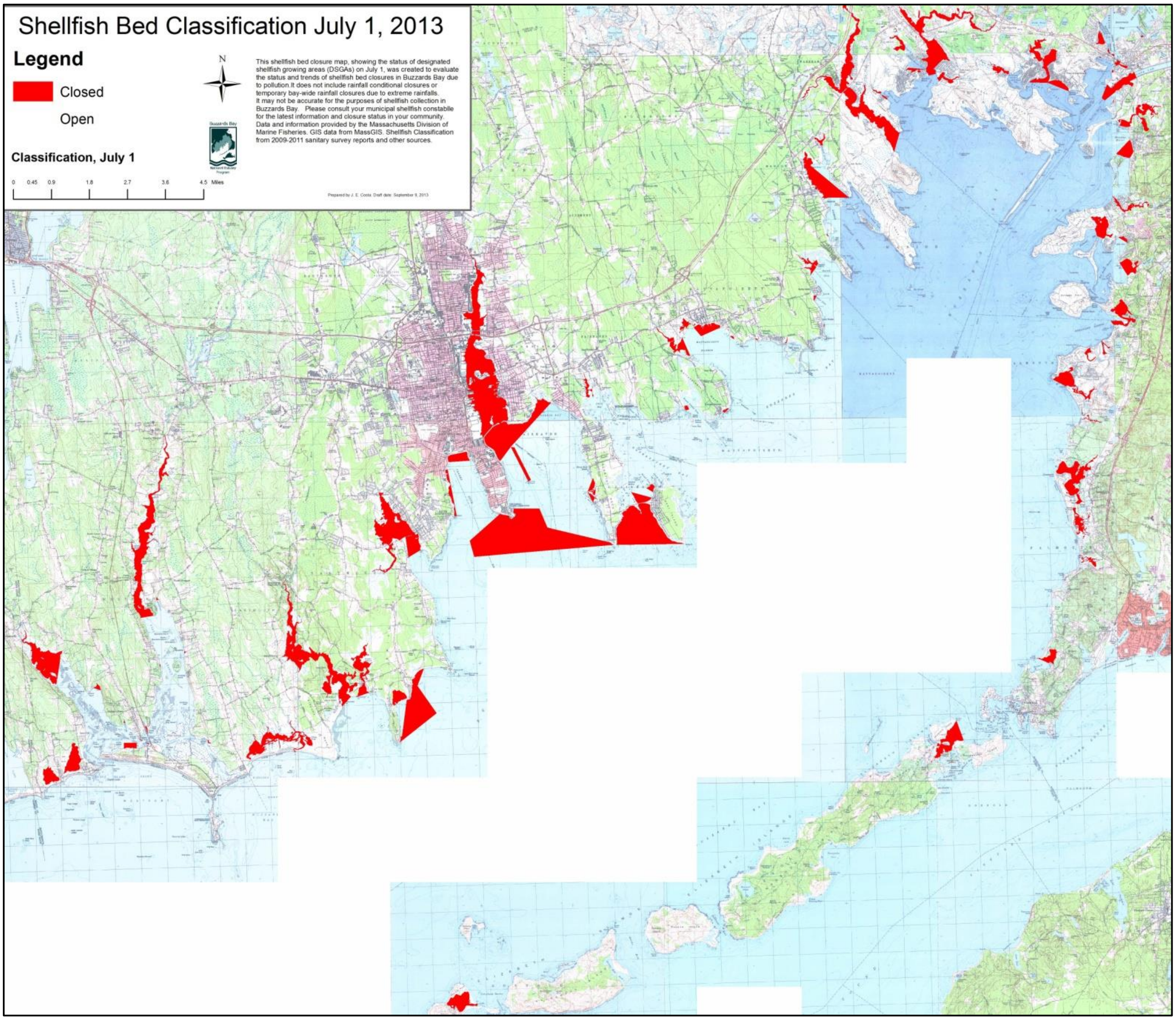
Of course, a large portion of shellfish bed openings in Buzzards Bay during the past decade was not the result of adopting the rainfall conditional approach. Instead, many smaller beds and some large areas around New Bedford Harbor were opened as the result of the reduction in pollution discharges and treatment of contaminated stormwater. The openings in Buttermilk Bay between 2001 and 2006 are typical of this pattern of openings (e.g., Figure 47). The shellfish resource area closure map for 2011 is shown in Figure 48.

The principal sources of pollution causing shellfish bed closures around Buzzards Bay remain pathogens and coliforms entering from sewage treatment plants, combined sewer overflows (CSOs; found only in New Bedford), stormwater runoff, boat sewage, and failed septic systems, but the relative importance of any of the sources in a particular embayment may have changed appreciably over the years. Chapter 3 Characterization of Pollution Sources, presents a fuller discussion of the sources of pathogens entering Buzzards Bay, but overall, the management and treatment of stormwater is increasingly the focus of management programs. This is because in most urban and suburban areas stormwater runoff remains the most significant potential source of pathogens affecting shellfish-harvesting areas.

Beginning in 1989, DMF completed an extensive effort to survey shellfish-growing areas along the coast (sanitary surveys) as required by FDA. These reports have been updated every few years ever since. These reports, together with DMF notices are the basis of closure maps like the one shown in Figure 48.

Besides the closure of shellfish beds, the productivity of open areas, and the impact of fishing pressures are a focus of concern. In general, the state delegates the authority for shellfish management, including catch limits, to local communities, with only size limits and possible open areas set by the state. To help ensure shellfish populations, the state and municipalities have implemented relay, transplant, and seeding programs. These efforts are largely dependent on state funding, which has diminished in recent years. For example, reseeding areas with shellfish is both popular with municipalities and effective. In 2008, $90,000 a year was going to Barnstable County to purchase seed that was then distributed to the municipalities on Cape Cod. This funding was cut in half in 2009, and eliminated in 2010. Currently, the cost to purchase shellfish for relay through DMF is $13 to $18 per bag. While these costs may seem modest, municipalities typically have insufficient funds to make large purchases. Some towns, like Bourne, fund these efforts through a revolving fund supported by the sale of commercial shellfish licenses, although the number of these licenses sold continues to decline (Figure 49).

Other impediments to sound shellfish management at the local level include lack of consistent and reliable catch data and lack of state oversight for management planning. Currently, municipal shellfish officers collect data on commercial and recreational harvest, but methods vary from town to town, and some towns do not re-



Data courtesy of the Massachusetts Division of Marine Fisheries.

Figure 48. Map of permanent, rainfall, or seasonal conditionally closed shellfish beds in Buzzards Bay as of July 1, 2013.

port this data. Information is often based on personal observations or estimations, reducing its reliability. Few municipalities have implemented post-season survey questionnaires. This catch data is important and can be used to evaluate trends, set quotas, establish economic value, and assist in predicting future populations.

Major Issues

Increased state funding is necessary to carry out the Shellfish Sanitation Program and to continue providing the appropriate level of technical and financial assistance to local communities to enhance resource productivity and improve shellfish management. To further increase closure areas defined as rainfall conditional requires appreciable local and state monitoring efforts, for which there are no funds.

While many shellfish beds have been opened during the past 20 years because of remediation of stormwater inputs, and application of rainfall conditional closures, summer seasonal closure areas have expanded in terms of area and duration in many parts of Buzzards Bay. This pattern appears driven by increased development and boating activity along the coast. This pattern will only be reversed with more aggressive pollution reduction efforts.

As noted in Chapter 3 Characterization of Pollution Sources, use of fecal coliform bacteria as indicators of public health risk has raised serious questions. While this indicator has provided reasonable protection from bacterial pathogens, it has not been shown to correlate well with the occurrence of viral pathogens. Despite this, re-

Table 20. Shellfish permit fees in Buzzards Bay municipalities (data from 2011).

Municipality	Commercial	Recreational: Resident	Recreational: Non-Resident	Temporary Non-Resident	Senior	Online regulations	Phone Recording
Bourne (1)	$625	$35	$175		$10 at 65	yes	759-0621 x2
Dartmouth	$225	$25	$75		free at 65	no	NA
Fairhaven	$260	$30	$135		free at 65	Yes, Shellfish Quahog Dredging	NA
Falmouth	$300	$25	$80		$5 at 65	no	495-7334
Marion, Rochester, & Mattapoisett (5)	$250	$25	$120	$25 (30 days)	free at 70	no	NA
Mattapoisett (3)	$100-$200	$25	$125		free at 65	no	NA
New Bedford (4)	$225	$12	$50		$3 at 59	no	NA
Wareham (2)	$700	$30	$120	$30 (2 weeks)	$15 at 65	yes	NA
Westport	$100	$25	$100	$50 (14 day)	$10 at 65	yes	NA

(1) Commercial fee for Masters License, quahog $250, clam $250, scallop $250, apprentice $100.

(2) Commercial fee for Masters License, quahog $300, scallop $300, oyster $300 clam $300, eel $150.

(3) Quahog: $200 with boat, $100 with no boat.

(4) Quahog only taking allowed, commercial price for full year.

(5) $250 for all species if purchased by 3/31, $150 per species if purchased after 3/31.

search has not yet provided a more cost-effective indicator that meets practical management needs.

The sale of commercial and recreational shellfish permits has been an important source of revenue for Buzzards Bay municipalities for decades (municipal fees shown in Table 20). Some towns place fees from commercial licenses, and occasionally from recreational licenses, in a fund to finance local shellfish restoration and propagation efforts. The loss of shellfish resources due to either overfishing, loss of shellfish habitat, disease, predation, competition by invasives, or other unknown variables has diminished overall harvest amounts in Massachusetts, and the sale of permits. While recreational shellfishing has diminished somewhat since the 1970s and 1980s in most communities, the continued decline in shellfisheries is most clearly expressed in the purchase of commercial licenses. For most Buzzards Bay communities, the trends of the Town of Bourne, shown in Figure 49, are most typical. Exceptions to these trends can be found in the City of New Bedford, and the Town of Fairhaven, after large shellfish resource areas were reopened for the first time after decades.

State funding for local seeding, relay, and propagation programs has continued to decline, and this pattern needs to be reversed to ensure a sustainable fishery in Buzzards Bay. Some municipalities have met some of their shellfish propagation needs through the establishment of municipal aquaculture programs. These efforts require the purchase of "upwellers[77]" to raise larval shellfish to an appropriate size for transplant, and require adequate local funding of staff to manage such efforts. Some of these programs have been started with grant funds, but long-term implementation of these efforts requires sustained local funding for staff, an expenditure often difficult to pass through town meetings.

Management Approaches

This action plan focuses principally on improving the management of shellfish beds, expanding propagation and relay efforts, and collecting additional water quality data, especially bacterial concentrations, in upstream pollution discharges. Most actions will need to be undertaken by DMF or municipalities, but successful collaborations could involve citizens groups and the Buzzards Bay NEP. When needed, towns could assist DMF with their water quality-monitoring testing in support of all sanitary surveys. Typically, the shellfish constable and health agent have the greatest capacity to assist in these efforts, and some towns have provided this support to DMF in the past.

[77] An upweller is a floating shellfish seed culturing-device that consists of seed containers, called silos, attached to a float-like apparatus attached to a pier or raft. The young shellfish are placed in the silos, and a wave driven pump system brings a continual flow of water over the shellfish.

To reduce the size and duration of shellfish bed closures, water quality collection should focus on better defining problems identified in sanitary survey reports. In a practical sense, priorities must be established based not only on closures, but also on whether there are shellfish resources in the closed areas. In general, DMF could encourage Buzzards Bay towns to work cooperatively to maintain or expand rainfall conditionally approved shellfish areas. This approach generally requires local action to eliminate pollution discharges.

Municipal collaboration with DMF can also help prioritize pollution sources most likely to result in openings of new shellfish areas if remediated. This approach is only practical where the most problematic discharges are identified and solutions implemented by the town. It is essential that boards of health take enforcement action to eliminate illicit discharges or failing septic systems identified by DMF's sanitary surveys. In the case of stormwater discharges, stormwater committees tasked to develop stormwater management plans to comply with federal stormwater discharge permits (EPA's "MS4 NPDES" program), should utilize the DMF sanitary surveys to help the town set priorities for stormwater treatment. DMF sanitary surveys should be posted on line to facilitate the exchange of information contained in those reports.

Broader actions that meet the goals of restoring habitat and water quality by reducing stormwater discharges and nitrogen loading can be found in the Managing Stormwater Runoff and Managing Nitrogen sensitive Embayments action plans. The most important are those municipal actions to meet any adopted bacteria TMDLs and Phase II stormwater permits.

A separate set of efforts are required to create or improve shellfish habitat. Creating new shellfish habitat, such as establishing oyster beds by the addition of shell to the bottom to create suitable habitat, not only creates additional shellfish resources that can be harvested by commercial and recreational fisherman, but the filter feeding of shellfish can help ameliorate the impacts of nitrogen pollution.

Financial Approaches

Existing state and local staff may not be able to accomplish all the elements of this action plan, so the towns would need to increase funding, especially for those efforts that support the Shellfish Sanitation Survey Program.

Funding for shellfish seeding and propagation programs has diminished greatly in recent years. Local funding through town meeting (or through the city council in New Bedford) or the legislature would be needed, but this would only occur if shellfish propagation were a higher priority for both the Commonwealth and municipalities. Some towns have established dedicated funds with shellfish permit revenues to implement local shell-

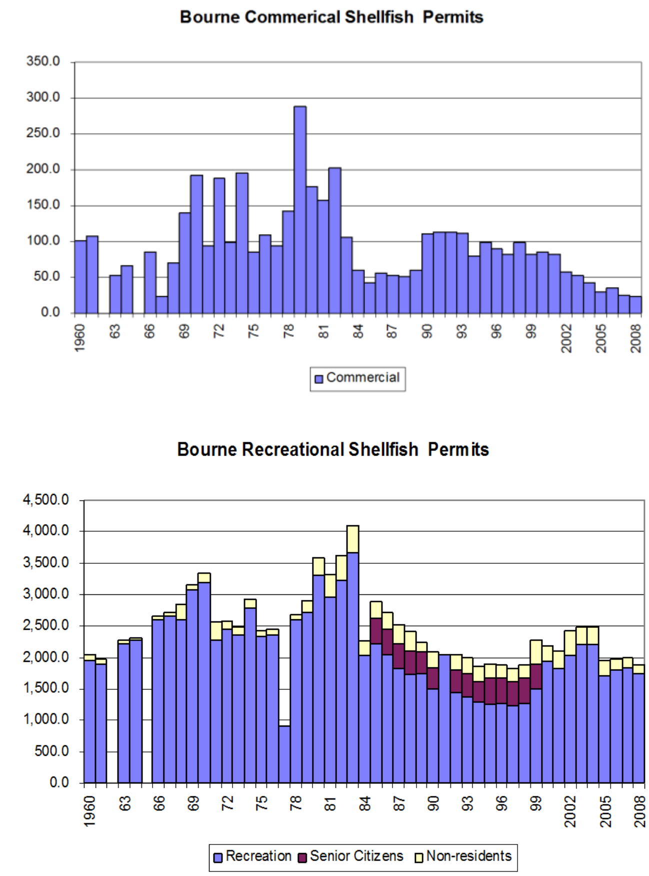


Figure 49. Chart showing a fifty-year record of shellfish permits in the Town of Bourne.

Top: commercial permits. Bottom: recreational permits of various types.

fish seeding and propagation programs, and this is a good model for other communities. These programs, and pilot efforts to establish shellfish aquaculture in coastal bays, may get a boost because increasing shellfish biomass is being viewed as a possible strategy to ameliorate the impacts of nitrogen pollution in coastal waters.

Various state and federal grant programs, or pollution trust programs that manage fines or court settlements, may provide grants for shellfish enhancement efforts. These programs generally do not support seeding programs because they are a temporary solution to increasing shellfish abundance. Instead, these programs are more likely to fund proposals that create longer term solutions, such as creating shellfish habitat (e.g. creating an oyster reef), or programs that expand local efforts to seed areas in a sustained way, such as funding for municipal upwellers.

The costs of water quality monitoring could either be appropriated at the local or state level (with funding provided by town meeting and the legislature respectively). Federal programs to assess water quality, such as EPA's

604(b) program, are a viable funding source for both watershed wide programs and subwatershed pilots.

Once upstream problems are identified, improving water quality will depend on the type and size of the pollution source. Stormwater treatment solutions can be expensive, and these are addressed in the Managing Stormwater Runoff action plan.

The best outcomes will be achieved by use of sanitary surveys, upstream source identification, and exchange and coordination of information between municipal health agents, Phase II stormwater coordinators, shellfish officers, and conservation agents.

The success of these efforts can be tracked by enumerating the number of illicit and illegal discharges eliminated, the number of stormwater discharges eliminated or treated, and ultimately the size and duration of shellfish bed closures.

Monitoring Progress

To evaluate progress towards the goals of this action plan will require tracking acres of shellfish beds closed particularly during the summer, acre-days closed on an annual basis, and commercial shellfish catch.

Action Plan 3 Managing Stormwater Runoff and Promoting LID

Problem

Thousands of stormwater pipes and overland flows discharge contaminated runoff into Buzzards Bay and its tributaries. Connected to these pipes are tens of thousands of catch basins and hundreds of miles of pipes that convey numerous allowed and illicit pollution discharges. New development adds stormwater to this discharge network. These stormwater discharges pose many threats to the environment, not the least of which is the closure of shellfish beds and swimming beaches in Buzzards Bay. Federal permit programs that may require compliance with daily load limits for bacteria, and other requirements for municipal stormwater programs, could cost more than a $1 billion in the coming decades. These efforts, while costly and politically challenging, will dramatically reduce shellfish bed closures in Buzzards Bay and restore habitat in many areas to conditions not seen for decades[78].

The ongoing development and redevelopment of land in the Buzzards Bay watershed must be better managed and reprogrammed to minimize new impacts and mitigate existing problems caused by stormwater discharges. This new approach, called low impact development (LID), can restore hydrological balances in watersheds and reduce water quality impairments.

Goals

Goal 3.1. Prevent new or increased untreated stormwater flows to Buzzards Bay and contributing watershed areas that would adversely affect shellfishing areas, swimming beaches, water quality, and wetlands.

Goal 3.2. Correct existing stormwater runoff flows to Buzzards Bay and contributing watershed areas that are adversely affecting shellfishing areas, swimming beaches, water quality, and wetlands, or exceeding watershed total pollutant load limits.

Goal 3.3. Maintain and restore natural hydrologic conditions to provide base flow conditions to streams, wetlands, and estuaries.

Goal 3.4. To encourage low impact development (LID) techniques in new development and redevelopment, in order to minimize impacts from stormwater.

Objectives

Objective 3.1. To adopt and implement local and state stormwater LID laws and regulations.

Objective 3.2. To implement effective stormwater pollution remediation projects that include proper design, construction, operation, and maintenance.

Objective 3.3. To provide guidance and incentives for LID that reduces and re-uses stormwater runoff, and reduces the need for structural practices.

Objective 3.4. To improve compliance with federal, state, and local stormwater regulations and meet watershed total pollutant load limits.

Approaches

LID approaches are best implemented through local bylaws and ordinances that regulate subdivisions, and commercial development, through new municipal stormwater permit programs, and will require additional training of regulatory and technical assistance staff.

The elimination of water quality impairments caused by existing stormwater discharges is a major undertaking that will require actions and expenditures by all levels of government. EPA must enforce compliance with the Buzzards Bay pathogen TMDL through MS4 stormwater permits. DEP must upgrade state stormwater policy to include treatment standards for nitrogen and bacteria, and EEA must promote policies and regulations that foster low impact development techniques. The largest burden rests with municipalities, which will need to develop and implement meaningful stormwater management programs for themselves and the private sector supported by sound local laws, regulations, and policies.

Costs and Financing

LID approaches have modest costs for government to implement, and some approaches can even reduce development and long-term maintenance costs borne by residents. The most daunting costs will be to treat existing discharges causing degradation and to implement municipal stormwater programs that support these goals. This effort will likely cost more than $1 billion over several decades. The costs will likely be met through federal and state SRF loan programs, or through local financing like stormwater utilities.

Measuring Success

LID and stormwater goals will be tracked principally by programmatic actions such as the adoption of necessary laws and regulations. More importantly, documenting compliance with EPA stormwater permits and stormwater TMDLs including constructing stormwater treatment systems, or eliminating stormwater discharges, and implementing good housekeeping programs will be key measures. A key measure of success will be improvements to water quality, as evidenced by reductions in the extent or duration of shellfish closures.

[78] The success of these efforts will also partly depend on actions contained in Action Plan 1 Managing Nitrogen Sensitive Embayments, because of relationship between bacterial and nutrient discharges.

Background

Runoff from rainfall and snowmelt carries natural and human-derived pollutants into wetlands, lakes, streams, estuaries, and groundwater, which can affect water quality, habitat, and living resources. Pollutants associated with stormwater runoff may include bacteria, road salt, nutrients, pesticides, metals, and organic contaminants such as hydrocarbons. Stormwater also conveys sediments, atmospheric fallout, and other particles that cause siltation of aquatic and wetland habitats, increased turbidity, and declining water quality. Such sediment particles often serve as carriers of metals and organic contaminants that adsorb to particles.[79]

Stormwater also contributes floatable debris, resulting in littered shorelines and impacts on marine animals due to ingestion and entanglement. Stormwater pollutants can lead to swimming beach closures, loss of habitat and resources, and changes in species composition and diversity.

In coastal areas, excessive stormwater pollutants (primarily bacteria) can also result in shellfish bed closures. Chronic runoff of polluted stormwater to sensitive resources can result in aesthetic as well as economic impacts, such as those associated with the loss of commercial and recreational fisheries.

In the Buzzards Bay watershed, like other urbanized areas, water from melting snow and rain flowing off streets, parking lots, roofs, lawns, golf courses, agricultural land, and other pervious and impervious areas, carries contaminants to the bay and contributing streams, groundwater, and wetlands in the watershed. This stormwater enters surface waters via storm drain systems, including catch basins, pipes, road cuts, and via other overland flow.

Thousands of stormwater pipes like the one in Figure 50 discharge contaminated runoff in Buzzards Bay and its tributaries. The Buzzards Bay NEP's 2003 *Atlas of Stormwater Discharges in the Buzzards Bay Watershed* documented more than 2,000 pipes and nearly 600 road cuts that discharge to Buzzards Bay or to streams and wetlands near the coast in eight towns[80]. Table 21 and the map in Figure 51 summarize and show the locations of these discharges.

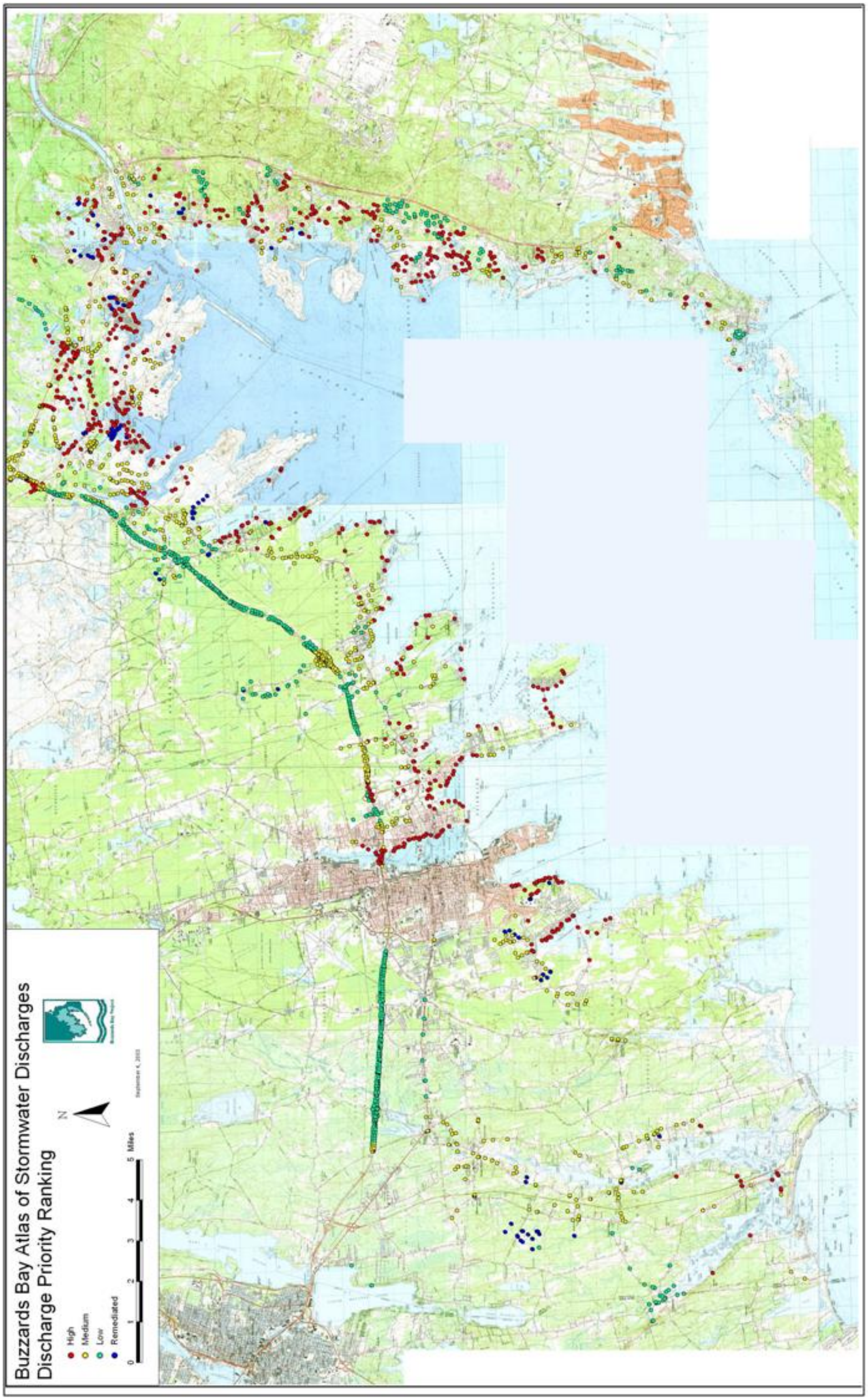
The atlas also mapped more than 12,000 catch basins, most of which were linked to the more than 2,600 discharges cited in Table 21. The actual number of catch basins associated with each discharge varied greatly, but most appeared to have only one or two catch basins draining various lengths of contributing roads and other impervious surfaces. More than 375 miles of road and pipe connected to these mapped discharges. The extent of water quality impairments in Buzzards Bay has been documented to a considerable degree in the Massachusetts DEP's Section 303(d) list. Twenty-two of the roughly 32 major Buzzards Bay embayments are listed as impaired due to fecal coliform bacteria (Figure 52).

Photo by Joe Costa.

Figure 50. A stormwater discharge pipe in Onset Bay.

[79] Good sources of general information on problems caused by stormwater pollution and management solutions are available from the Center for Watershed Protection website (www.cwp.org) and the U.S. EPA stormwater website cfpub.epa.gov/npdes/stormwater/swbasicinfo.cfm. For low impact development strategies in Massachusetts, the EEA website www.mass.gov/eea/waste-mgnt-recycling/water-resources/preserving-water-resources/partners-and-agencies/ should be reviewed.

[80] The study did not include the City of New Bedford, the Town of Acushnet, or the Town of Gosnold, part of the Elizabeth Island Chain. A description of this project is provided in subsequent pages of this action plan.



From Buzzards Bay NEP (2003).

Figure 51. Overview map of stormwater discharges documented in the *Atlas of Stormwater Discharges in the Buzzards Bay Watershed.*

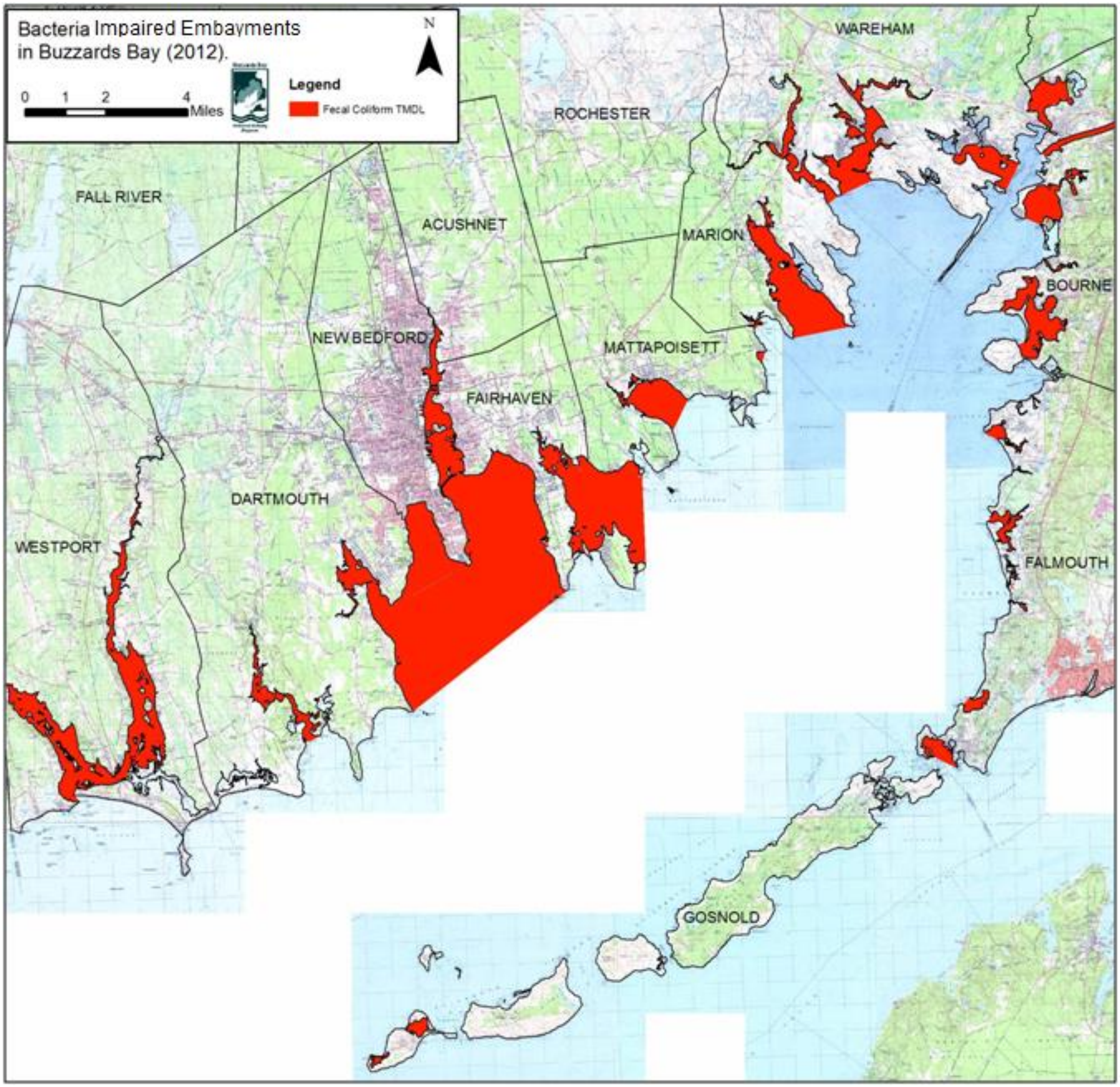


Figure 52. Buzzards Bay waters impaired by fecal coliform bacteria and having a TMDL.

Based on DEP's *Massachusetts Year 2012 Integrated List of Waters, Proposed Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act,* and a companion MassGIS coverage.

Further evidence of the scale of the problems caused by stormwater, or where stormwater is a contributing factor is illustrated by the distribution of shellfish bed closures in Buzzards Bay (see Figure 48 in Action Plan 2) and the temporary closures of swimming beaches in both fresh and salt water in the watershed. While some of these closures are related to municipal wastewater facility discharges, in most cases stormwater, conveying pollutants from various nonpoint sources, is the principal cause of the impairment.

Numerous studies in Massachusetts and nationwide have consistently pointed to stormwater as a major source of fecal coliform bacteria contributing to closures of swimming beaches and shellfish areas. Any stormwater pipe near a swimming beach represents a potential health risk and often contributes to floatable debris on beaches. On rare occasions, illegal sanitary hookups from septic systems to stormwater pipes have been found. However, many other "nonpoint" sources contribute to elevated fecal coliform levels in stormwater. These nonpoint sources include wildlife droppings, pet

Table 21. Summary of discharges by town showing numbers of basins tied to treatment system.

Municipality	Pipes	Road cuts	Total	UA Total(1)
Bourne	169	62	231	220
Dartmouth	255	168	423	412
Fairhaven	224	25	249	185
Falmouth	202	40	242	242
Marion	227	53	280	167
Mattapoisett	276	42	318	172
Wareham	592	118	710	513
Westport	88	85	173	12
Grand Total	2,033	593	2,626	1,923

(1) Taken from 2003 Buzzards Bay Atlas of Stormwater Discharges. "UA Total" equals number of discharges mapped in the National Pollutant Discharge Elimination System Stormwater Phase II urbanized areas. This permit program is further described in the background section of this action plan.

waste, overland run-off of manure from farms, and breakout from failed septic systems.

Every three years the Massachusetts Division of Marine Fisheries (DMF) completes sanitary surveys for shellfish areas in Buzzards Bay. These surveys contain a wealth of information on existing stormwater drains that are sources of fecal coliform bacteria and are causing or threatening to cause the closure of shellfish beds, as well as streams and rivers that have consistently elevated levels of coliforms. This information is in reports provided to all Buzzards Bay communities, and provides an excellent summary of potential pollution sources. However, due to limited funding, actual stormwater discharges during runoff events from pipes are usually not monitored for fecal coliforms, nor are upstream pollution sources identified in the rivers and streams contributing to high fecal coliform loads.

Prior to the late 1990s, the responsibility for controlling new storm drains was regulated largely at the local level through subdivision regulations and wetlands bylaws. Unfortunately, local regulations were inconsistent from one community to the next, and for the most part, municipalities did not adequately address management of the rate, volume, and quality of stormwater discharges. Management of all three parameters is now recognized as essential for improving or protecting water quality. In the late 1990s, however, the regulatory landscape expanded with additional state and federal authority to better address stormwater discharges to wetlands and surface waters. These changes coincided with increased local awareness and sophistication by local government pertaining to stormwater issues.

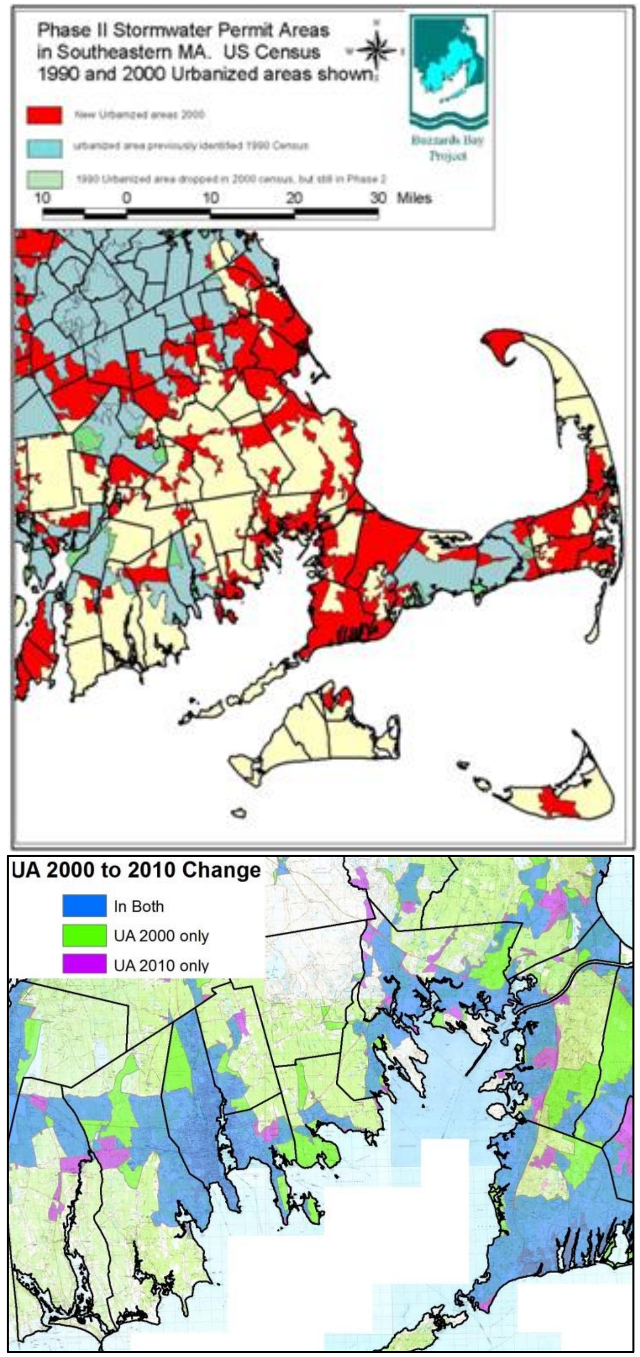


Figure 53. Top: Urbanized Areas (UAs) defined by the 2000 U.S. Census as compared to 1990. Bottom: Changes between the 2000 and 2010 urbanized areas.

As shown, the change in the definition of urbanized areas by the U.S. Census in 2000 resulted in a dramatic change in the jurisdictional area on the EPA NPDES Phase II Program for Municipal Small Storm Sewer Systems (MS4s). These changes in urbanized areas were more modest with the release of the 2010 Census, but still included some important new areas.

First, in 1990, implementation of Phase I of the National Pollution Discharge Elimination System (NPDES) program required the permitting of stormwater discharges from medium and large municipalities (municipalities with a population of 100,000 or more) to waters of the U.S. In 1996, the Massachusetts Department of Environmental Protection (DEP) adopted Stormwater Standards and Policy, to be implemented primarily in association with the Wetlands Protection Act. This new policy prohibited “untreated stormwater discharges” to waters of the Commonwealth, required water quality treatment for runoff of up to 1-inch from impervious surfaces, identified appropriate “best management practices” (BMPs), required recharge of stormwater to balance the hydrologic budget and required operation and maintenance plans for stormwater facilities.

In 2008, DEP again updated the policies that met many of the goals identified in the Buzzards Bay CCMP. These new standards however, do not fully address water quality limits to waters that have bacteria or nitrogen TMDLs, thus additional revisions will be required as implementation of TMDLs commences by all levels of government.

In December 1999, EPA published the “Phase II Final Rule” for the NPDES program in the Federal Register. This rule expanded the coverage of the stormwater permit program to include stormwater discharges from, “certain regulated small municipal separate storm sewer systems (MS4s); and construction activities disturbing between 1 and 5 acres of land (i.e., small construction activities).” The rule also revised “he ’no exposure’ exclusion and the temporary exemption for certain industrial activities.”In plain English, the rule required municipalities located within “urbanized areas”, as defined by the U.S. Census Bureau (Figure 53) to submit permit applications (Notices of Intent) by 2003 for their municipally owned stormwater discharges ("MS4s"), as well as “industrial facilities", waste transfer stations, landfills, and sewage treatment plants (separate from the wastewater discharge permit). Developers altering as little as 1 acre of land were also required to comply with the Phase II NPDES program beginning in 2003.

Perhaps even more significant than the adoption of the Phase II rule was the fact that the U.S. Census Bureau redefined “urbanized areas” for the 2000 Census (Figure 53, top). This redefinition greatly expanded the geographic extent of the federal definition of urbanized areas, particularly in the northeast U.S. Because the U.S. EPA had used the U.S. Census urbanized maps as the jurisdictional boundary for the Phase II program, the geographic area covered by the program now included at least a portion of nearly every municipality in eastern Massachusetts, including every Buzzards Bay watershed community. The urbanized areas defined by the U.S. Census changed again in 2010 (Figure 53, bottom), but the changes were less dramatic than the previous change.

While the geographic extent of the Phase II program may not seem appreciable for some municipalities, those areas covered essentially represent the existing moderately developed areas in each community, and more importantly triggers the requirement for management and regulatory actions in the municipalities as required in their permit.

Another regulatory program that has been moving forward in recent years is the DEP program to develop Total Maximum Daily Loads (TMDLs) in accordance with the Federal Clean Water Act to address pollutant loading to impaired water bodies throughout the state. Of particular relevance in Buzzards Bay is the recently published final Pathogen TMDL for the Buzzards Bay Watershed, developed jointly by DEP, U.S. EPA Region 1, and ENSR International. This TMDL has established a limit in the discharge concentration equivalent to the regulatory threshold for impaired waters. Thus, for stormwater discharges to waters closed to shellfishing, stormwater concentrations cannot exceed 14 fecal coliform per 100 ml. Adoption of this TMDL by the DEP has important implications for municipalities in addressing stormwater and pathogen sources, as well as for individual landowners with existing discharges. Various federal permits, such as those issued by the NPDES permit program, may require meeting the prescribed TMDL loading allocations, and associated water quality discharge standards. These TMDLs may also be implemented through other state regulatory mechanisms.

The Coastal Pollutant Remediation Grant Program at the MA CZM office has evolved into a positive funding mechanism for the remediation of nonpoint source pollution in Buzzards Bay and other coastal MA areas. For several years, the Buzzards Bay NEP had received funding through MA CZM from the MA legislature to address nonpoint pollution in the watershed. The Buzzards Bay NEP used this money to fund specific projects through a mini-grant program. This program was so successful that MA CZM adopted the program for the entire coastal zone in Massachusetts. These grants have been successful in fostering public education and addressing nonpoint pollution from roadways and other land uses through implementation of innovative stormwater practices. This program continues to this day.

Most development projects are designed and built using conventional development approaches, subdivision layouts and structural practices that encourage sprawl by maximizing road widths, parking areas and other impervious areas, and involve indiscriminate clearing and grading. The increase in impervious cover combined with soil compaction and removal of protective vegetation causes stormwater runoff to accelerate over land rather than infiltrate into the ground. The result is reduced groundwater recharge, increased flooding, increased downstream erosion, and other negative impacts on water resources, wetlands, and habitat. Cumulatively, these projects can add significant impacts to receiving waters including reduction of groundwater recharge and increased pollution such as nutrients and bacteria.

Photo credit: Modified from the Low Impact Development Center.

Figure 54. Conventional versus low impact development.

Although a significant portion of the Buzzards Bay watershed remains undeveloped, historically developed areas, including the industrial and port areas of New Bedford, Fairhaven, and Acushnet, and residential areas such as Wareham and Bourne, tend to reflect older zoning and development practices. Less densely developed or undeveloped areas of the Buzzards Bay watershed tend to be located further from coastal areas. Southeastern Massachusetts is favorably viewed as being within commuting distance of Boston and Providence, creating the need for new housing and businesses. Redevelopment in attractive coastal areas is continuing, along with new development inland. Some of the largest tracts of undeveloped land remaining in southeastern Massachusetts, comprising 6,000 acres of primarily forests and cranberries, are currently being planned for development.

Low-impact development (LID, Figure 54) offers an alternative approach in land development, an opportunity to develop land in a way that results in low impacts, and in some aspects, positive impacts. LID involves careful site planning and parcel level management strategies, including site and stormwater design techniques that infiltrate, filter, store, evaporate, and detain runoff close to the source of origin. This strategy helps to achieve the goals of mimicking a site's pre-development hydrology, protecting native vegetation, maintaining natural water budgets capable of sustaining sensitive water resources, and keeping pollutants out of the stormwater stream before they can negatively affect downstream water resources.

As discussed by the Puget Sound Action Team (www.psp.wa.gov), LID is based on the premise that nature knows how to manage water and stormwater runoff best. Forests and other natural land covers are extremely effective in recharging groundwater. In these areas, most of the rainfall infiltrates into the ground, is absorbed by vegetation, or evaporates to the atmosphere with very little stormwater runoff generated. Development activities that clear forests and other natural areas, and replace them with impervious surfaces and storm drainpipes, alter the natural hydrology. These "hard" surfaces no longer allow rainfall to soak into the ground, resulting in an increase in surface runoff.

To counteract the effects of conventional development, stormwater storage facilities are often used to reduce flooding and treat stormwater-related pollution. These structures, however, are often maintenance intensive, unsightly, and costly to install. Rather than collecting and conveying stormwater runoff through storm drain pipes or other conveyances to a centralized stormwater facility, LID-minimizes the use of impervious surfaces and incorporates natural vegetation and small-scale treatment systems to treat and infiltrate stormwater runoff. This involves strategic placement of linked lot-level controls that address specific pollutants and stormwater travel times in drainage networks, flow rate, and volume issues.

Low impact development is defined by the Commonwealth's Executive Office of Energy and Environmental Affairs Smart Growth Toolkit as "an approach to environmentally friendly land use planning. It includes a suite of landscaping and design techniques that attempt to maintain the natural, pre-developed ability of a site to manage rainfall. LID techniques capture water onsite, filter it through vegetation, and let it soak into the ground where it can recharge the local water table rather than being lost as surface runoff. An important LID principle includes the idea that stormwater is not merely a waste product to be disposed of, but rather that rainwater is a resource."

Site planning using the LID approach starts with identifying critical environmental resource areas on, adjacent to, and down gradient of the site. Such resource areas can include drinking water protection areas, sensitive wildlife habitats, and buffers to wetlands, streams, and estuaries. House sites and roads are then planned providing the maximum buffers to these resource areas. The site design reflects the site's natural runoff patterns, soil types, sensitive areas, and other key features and relies on those features to dictate the development pattern, rather than forcing a pre-conceived design upon an unwilling landscape. Refer to Action Plan 4: Improving Land Management and Smart Growth for more detailed discussion of site planning and design tools.

In LID developments, buildings are often clustered to protect natural areas by preserving open space. LID designs incorporate narrower roads and use permeable pavement for parking lots, driveways, and other impervious surfaces. Runoff from remaining impervious surfaces, such as rooftops, can be directed onto vegetated areas with porous soils. Roof gardens use soil and plants to absorb and evaporate water and slow runoff. Rooftop runoff can also be collected and reused. The proximity of the development to other developed areas (including village centers) can provide reduced costs associated with shared (neighborhood) wastewater treatment systems.

Some of the key goals of LID are as follows:

- Integrate stormwater management early in site planning activities;
- Mimic natural hydrologic functions;
- Focus on prevention rather than mitigation;
- Emphasize simple, nonstructural, low technology, and low cost methods;
- Manage stormwater as close to the source as possible;
- Distribute small-scale practices throughout the landscape;
- Rely on natural features and processes; and
- Create a multifunctional landscape.

The minimization of impervious areas is a key LID feature and directly ties into the protective goals of maintaining natural site hydrology, allowing for adequate groundwater recharge, and reducing pollution and erosion from stormwater runoff. Other common LID techniques include:

- Green rooftops that store and transpire precipitation before it can leave the rooftop surface;
- Rain gardens, rain barrels, cisterns, and other rainwater storage technologies that capture and store runoff for later use immediately after the runoff has exited roofs, driveways, or other impervious areas;
- Bioretention areas, constructed wetlands, and vegetated swales that transport, capture, store, infiltrate, and treat larger volumes of runoff while reducing the reliance on maintenance-intensive hard structures for stormwater management; and
- Better parking lot design, which divides large expanses of pavement into smaller sections where runoff can be managed and infiltrated in smaller quantities.

Table 22. Four key criteria for managing stormwater: "Reduce Runoff, Slow It Down, Spread It Out, Soak It In"

1. Peak rate flood control: The large, infrequent storms (e.g., 2, 10, 25 and 100-year) must be managed to avoid flooding and erosion impacts.

2. Channel protection: The bank-full event (1-year storm) must be managed to balance pre- and post-development runoff rates to avoid affecting stream banks and channels.

3. Recharge to groundwater: The goal of this criterion is to maintain the water balance at a site and within a watershed to the natural (pre-development) annual volume of recharge to groundwater after development occurs (in the post-development condition). Annual recharge (infiltration) depends on rainfall, runoff, and evapotranspiration during each rainfall event during a given year (See Figure 55), and simply put, these volumes are influenced by the combination of hydrologic soil groups (ability of a soil to infiltrate water), ground cover, and climate. For the Buzzards Bay watershed as a whole, the annual recharge volume is approximately 20 – 24 inches per year across the entire watershed. In order to get this volume of water back into the ground, the site designer must size stormwater infiltration practices to capture and infiltrate the first 0.6 inches of runoff from impervious surfaces. This will result in a cumulative total annual recharge volume approximating the natural annual recharge volume.

4. Water quality: The Massachusetts Stormwater Standards and Policy, established by DEP, requires that the first 0.5-inch (or 1.0-inch in critical areas) be effectively treated. This is based upon the so-called "first flush" principle where most pollutants are transported by smaller rainstorms during the first portion of larger events. While this is true for suspended solids, this principle is not directly applicable for bacteria and nitrogen. Therefore, the larger 1.0-inch design event is more applicable for the Buzzards Bay watershed.

An integration of LID principles and management practices allows for stormwater to be delayed (increased time of concentration) and infiltrated onsite, thereby reducing runoff volume and downstream flood damage (peak runoff control), and improving downstream water quality. The infiltration of stormwater provided by LID practices can result in more groundwater recharge than may have occurred under pre-development conditions, which in turn can help offset increasing water supply demand from other locations in the watershed. Finally, the hydrologic benefits of LID are also accompanied by an aesthetically pleasing landscape and neighborhood layout that manages stormwater more economically and with lower maintenance requirements than is generally the case with traditional stormwater management practices.

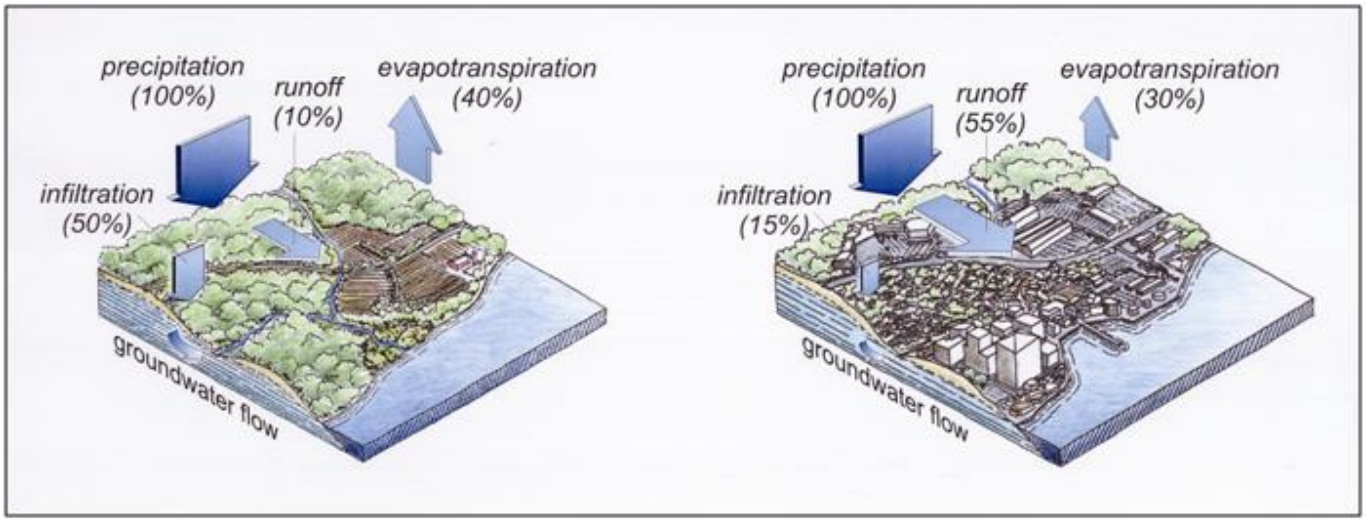


Figure 55. Graphical representation of degree of runoff in lightly developed watersheds as compared to urbanized watersheds.

Stormwater Management Design

Table 22 articulates some key principles of stormwater management design. Stormwater management is best accomplished as part of a holistic, integrated water management approach. Stormwater should not be viewed simply as problematic floodwaters that must be disposed, or only as a pollution source. Instead, stormwater should be considered a valuable resource part of the hydrologic cycle. This is recognized in those stormwater regulations that require stormwater to be recharged into the environment to approximate predevelopment hydrologic conditions. To achieve such a goal, stormwater runoff volumes, rates, and quality need to be managed to mimic natural conditions and pathways. Such actions can lead to the restoration of surface waters and wetlands.

Treated stormwater runoff from impervious surfaces can be “re-used” as an irrigation source, as an alternative non-potable water (non-drinking water) supply source and for groundwater recharge and base flow augmentation. From this standpoint, treated stormwater is a “resource” and not a ’wastewater” to be disposed of. Stormwater runoff from rooftops can be collected in rain barrels or cisterns and used for the irrigation of gardens and landscaped areas, reducing the need to use municipal drinking water for these purposes. It can also be infiltrated into the subsurface to recharge the groundwater system to restore drinking water supplies in some watersheds and to maintain critical (natural) freshwater base flow that may alleviate the impacts of withdrawal rates to streams, wetlands, and estuaries. Stormwater runoff can be managed to prevent water quality degradation of downstream resources.

An increase in impervious surfaces resulting from development decreases vegetation (Figure 55, as shown on right) and shifts the water balance from a more natural state (as shown on left), causing a significant increase in the volume of runoff and a decrease in infiltration and evaporation as a percentage of precipitation.

However, to balance the water budget for a watershed, stormwater recharge should also compensate for “consumptive” drinking water use by residences. These are primarily related to lawn and landscape irrigation, which result in water losses via additional evapotranspiration and runoff. This could be accomplished by either promoting the use of rainwater storage structures (e.g., rain barrels/cisterns) as an alternative irrigation source or by increasing the stormwater management recharge requirement from 0.6 inches to 1.0 inches of runoff. A broad range of best management practices (BMPs) has been developed to manage stormwater runoff. While some of these BMPs have been shown to be effective at removing at least 80% of the total suspended solids (TSS), the minimum required state and federal standard, only certain management practices are effective at treating fecal coliforms and nitrogen (two of the critical pollutants of concern for Buzzards Bay). These BMPs that treat both nitrogen and fecal coliforms are:

1. Filtration practices: sand filters, organic filters and infiltration systems (with proper pre-treatment) that trap bacteria.

2. Vegetated practices: bioretention areas, rain gardens, vegetated swales, and constructed wetlands that provide for nutrient uptake and/or nitrification-denitrification processes.

The proper design, construction, operation, and maintenance of all new stormwater BMPs are critical to their successful functioning. Without these elements, stormwater facilities provide only a false sense of security--they may appear to work because there is no flooding, but they may reduce little pollutant load in the stormwater that passes through them. Effective stormwater management also means that existing stormwater BMPs should be repaired, rebuilt, or retrofitted as needed, if they are observed to be malfunctioning, improperly sized, or otherwise failing to meet the objectives of stormwater management. Sometimes water quality testing is needed to evaluate system effectiveness.

Accomplishments in Addressing Existing Stormwater Discharges

By far, the greatest amount of federal and state financial resources associated with Buzzards Bay NEP implementation efforts and technical assistance has been spent on the remediation of existing stormwater discharges. A key first step in remediation is locating the discharges and source areas.

In the 1990s, the Buzzards Bay NEP began gathering this type of information for municipalities. The seeds of the project began when the Buzzards Bay Action Committee, implemented a Buzzards Bay NEP funded catch basin and discharge pipe mapping project, using interns from the Massachusetts Maritime Academy. This information was eventually refined and improved upon by Buzzards Bay NEP staff with funding from the Massachusetts Highway Department, and in 2001, the Buzzards Bay NEP published an *Atlas of Stormwater Discharges in the Buzzards Bay Watershed* to serve as a tool for guiding remediation projects, as well as an educational tool[81] (see watershed overview map in Figure 51).

These discharges contribute to shellfish bed closures and water quality degradation throughout the bay watershed. A recent CZM project completed in 2006 evaluated the effectiveness of stormwater BMPs that were constructed using CPR funding and found that while these facilities have tremendous potential for pollutant remediation, maintenance was lacking at many facilities, compromising the effectiveness of these BMPs. The Buzzards Bay NEP staff continues to help local officials in the identification of funding sources and the development of successful projects. This allows the Buzzards Bay NEP and local communities to leverage estuary program funds far beyond their limits. The Buzzards Bay NEP currently estimates the cost of remediating discharges to impaired waters in order to comply with bacterial TMDLs and to implement municipal MS4 stormwater programs will exceed $1 billion dollars and take decades to achieve.

The Buzzards Bay NEP has been greatly assisted in this work through a partnership with the USDA Natural Resources Conservation Service in which NRCS staff works with the Buzzards Bay NEP in design and review of various forms of stormwater remediation facilities. These projects include such varied forms of stormwater BMPs as traditional stormwater infiltration structures, innovative constructed wetland systems, improved agricultural management practices, and urban sewer/stormwater cross connection remediation.

Improved Management of Stormwater in New Development

Preventing new untreated discharges to surface waters was one of the most important goals outlined in the 1991 Buzzards Bay CCMP. It was common sense considering the high cost of remediating existing discharges; it is simply true that an ounce of prevention is worth a pound of cure. At the time of completion of the 1991 Buzzards Bay CCMP, all of the towns surrounding Buzzards Bay had regulations on the books addressing the construction of new stormwater conveyance systems to control flooding or stormwater volume, consistent with state and federal flood control and roadway engineering standards. The stormwater drainage design was generally focused on addressing the site being drained rather than addressing any downstream impacts from stormwater runoff, and/or impacts on the hydrologic budget. Often these rules required that stormwater be delivered as quickly and as directly as possible to the nearest water body or wetland with little or no attention to the quality of the stormwater and its effect on water resources and shellfish habitat. Only if both stormwater quantity and quality are addressed can a town expect to prevent new problems with shellfish bed closures and water quality degradation. Another problem the Buzzards Bay NEP observed was that requirements among town boards were not consistent and sometimes even contradictory.

To address these problems, the Buzzards Bay NEP developed in 1996 a model regulation to manage stormwater ("Unified Rules and Regulations for Stormwater Management for use by Planning Boards, Boards of Health, and Conservation Commissions"). The Buzzards Bay NEP provided technical assistance and educational outreach to communities interested in adopting these standards. In the spring of 2006, the Buzzards Bay NEP published a revised set of unified standards to incorporate low impact development techniques, recharge, and more effective water quality and channel erosion protection measures. To date, these standards have been adopted by Acushnet (Stormwater Board), Rochester (Planning Board Subdivision Rules and Regulations), Marion (Planning Board Subdivision Rules and Regulations, Plan and Site Review), Fairhaven (Planning Board Subdivision Rules and Regulations), Westport (Planning Board and Board of Health), and Falmouth (Conservation Commission Rules and Regulations). Some of these towns subsequently revised the regulations to better meet their needs.

Major Issues

There appears to be a general lack of public knowledge and recognition of the importance of stormwater management and the impacts from poorly man-

[81] This project was financed by the Buzzards Bay NEP through its EPA funded Municipal Grant Program, by the Massachusetts Department of Environmental Protection through the federal Nonpoint Source Pollution (Clean Water Act Section 319) Program, and by the Massachusetts Office of Coastal Zone Management's (CZM) Coastal Pollutant Remediation (CPR) Program.

aged stormwater runoff on surrounding properties and downstream resources. Additionally, stormwater runoff is still generally viewed as a waste that should be disposed of rather than a resource that is integral to the water budget in terms of groundwater recharge and natural stream flows. This makes it difficult to implement local regulatory changes to address stormwater management, and it limits the support for making stormwater improvements within a community. In addition, stormwater management design for permitting purposes requires engineering skills and more recently, site planning skills. Therefore, it is becoming increasingly necessary to incorporate technical review and expertise on behalf of the local boards and commissions in the local permit process. Education of the public, local boards and commissions, municipal employees, as well as engineers and site planners, on matters of stormwater management and BMP design, is critical to ensure that stormwater management programs improve water quality.

Local stormwater management regulations and standards, NPDES Phase II permitting, and the DEP Stormwater Policy generally focus on new development and redevelopment, but do not focus on stormwater impacts from existing developments. Implementation of management measures to address water quality improvements through retrofits to existing development is generally not receiving much attention. However, with the adoption of the pathogen TMDL for Buzzards Bay, and the expected reissuance of MS4 NPDES permits expected in 2013[82], communities will need to begin new efforts to reduce stormwater from existing development, and bring these discharges into compliance with the stormwater discharge standards.

Implementation of an effective and comprehensive stormwater management program can be expensive. Despite recent economic problems, appreciable new areas will be developed in the next decade throughout the Buzzards Bay watershed, together with the evolution of more technical stormwater and water quality regulations, coordination and implementation of a stormwater management program in any given community will likely be expensive. Communities need to consider innovative mechanisms and models to fund a stormwater program, including technical oversight and engineering review, enforcement, and maintenance of stormwater practices.

The management solutions for controlling stormwater discharges range from simple to complex, inexpensive to costly, and can involve different levels of government as well as private landowners. In developed areas, structural controls may be expensive to implement and land for retention basins may be either prohibitively expensive or not available at all. The costs of installing stormwater BMPs are usually borne by the municipality and its residents, but benefits accrue to all users of the municipality's water resource. These benefits can include restored recreational opportunities, maintenance of land values due to the aesthetic appearance of receiving waters, and, of greatest relevance here, restored, or continued shellfishing opportunities.

Any town that is contemplating the construction of stormwater treatment facilities must consider all facets of the issue, including land acquisition, installation techniques, cost, treatment effectiveness, and maintenance requirements. Sampling data may be needed to determine the relative impact of each drain on water quality degradation. Before targeting a particular storm drain for action, the town should ensure that the problem is not emanating from septic systems or other illicit discharges that are "cross-connecting" with the drain.

The NPDES Phase II Program requires that communities (MS4s) covered by the program prepare and implement a stormwater management plan in accordance with a five-year schedule each community sets in an initial Notice of Intent. While U.S. EPA and DEP require that each MS4 file an annual report to provide an update on progress, and the reports are posted on the internet, there has been little other enforcement to ensure that communities are following the stormwater plan tasks and schedules[83]. At the same time, most communities are understaffed to meet all the responsibilities outlined in their NOIs. Communities need technical assistance to work efficiently and effectively to meet the Phase II NPDES requirements, and to address other water quality efforts such as the need for municipalities to implement programs to meet the pathogen TMDL for Buzzards Bay.

The Massachusetts Department of Transportation (Mass DOT, formerly, MassHighway) has, as one of its primary concerns, the construction and maintenance of safe roads. Until recently, this typically included the removal of stormwater from those roads as quickly as possible. Accordingly, resource protection and water quality considerations must be balanced with the Mass DOT primary mission of building safe roads. In January 2006 Mass DOT released an updated manual for the design of state roads, this manual, entitled *Project Development and Design Guidebook* features more emphasis on design flexibility, streamlined procedures, and improved collaboration between Mass DOT and the cities and towns it serves. Mass DOT also developed a *Stormwater Handbook for Roads and Bridges* (May 2004) and is required to meet NPDES Stormwater Phase II permit requirements for the storm sewer systems from the roads and facilities operated by Mass DOT. These new guidance manuals coupled with the regulatory requirement of Phase II will help foster a climate where Buzzards Bay towns will work collaboratively with Mass DOT to en-

[82] "EPA is expected to renotice the draft permit in the fall of 2012.

[83] After a hiatus, in 2011 and 2012, EPA issued letters of compliance and fines to more than two dozen municipalities, including two Buzzards Bay communities, for their failure to submit annual MS4 permit reports.

sure that water quality and quantity impacts are evaluated in a comprehensive manner for road and bridge planning, design and construction projects. The activities of town DPWs should receive the same attention.

Transportation planning should avoid siting new traffic corridors or hubs near sensitive receiving waters, and an alternatives analysis should identify sites that pose minimal or least impact due to stormwater runoff. Existing corridors/hubs near sensitive resources should be remediated.

Stormwater runoff from more than one town may be contributing to water quality degradation or shellfish bed closures in a specific embayment. Each contributing town must implement similar and equitable stormwater controls in order for the affected resource to be fully protected.

Most stormwater outfalls in Buzzards Bay are primarily wet weather discharges only. Those that have continuous dry weather flows might be an indication of illegal cross connections with sewer lines or septic systems. More likely, these dry weather discharges are a reflection of outdated and decrepit pipe systems that allow groundwater infiltration. In some communities, the discharge of sump pumps from basements is responsible for large portions of dry weather flow.

Federal implementation of the Phase II requirements cover all applicable areas of a regulated community, whereas state implementation of the DEP Stormwater Policy only covers activities within the jurisdiction of the Wetlands Protection Act (i.e., within a regulated resource area and/or a buffer to a regulated resource area). Municipalities implementing the Phase II program requirements will have the flexibility to implement a stormwater program across the entire municipal limits either in accordance with the provisions of the DEP Stormwater Policy or to a greater level as offered by the Buzzards Bay NEP Model Stormwater Bylaw, updated in the spring of 2011.

Currently, the state's stormwater management policy requires 80% TSS removal. Most commercial BMPs that meet this standard do little to remove fecal coliforms or nitrogen, which are impairing 22 Buzzards Bay embayments (303(d) listed). DEP needs to work cooperatively with U.S. EPA, EEA, and CZM to revise its 2008 Stormwater Standards and Policy to better address volume, quality, and rate of stormwater discharges. More specifically, the standards must require BMPs and performance standards that reduce fecal coliforms and other pollutants (such as nitrogen) in order to meet new TMDLs. DEP formed a Stormwater Advisory Committee that made some progress on this task, and made several recommendations to strengthen the recharge criteria and methods, incorporate new provisions for LID and redevelopment projects, and provide additional guidelines on BMP pollutant removal effectives. However, most of the recommended changes have not yet been implemented. The adoption of new standards will minimize environmental degradation, help to restore impaired waters, and reduce other ecological impacts of stormwater discharges, and improve the long-term success of the MS4 NPDES program.

Climate Change Adaptation

An increase in the average global temperature will likely lead to an overall increase in global precipitation, although some areas will likely receive less rain than today, and other areas will receive more rain (IPCC, 2007). For the northeast U.S., models predict a 7-14% increase of annual precipitation by the year 2100, mostly the result of increased rainfall in cooler months (EEA, 2011, Frumhoff et al., 2007). Furthermore, the frequency of larger rainfall events may also increase, as may storm intensity. Because stormwater collection and treatment systems may have lifespans over many decades, towns may wish to employ or require treatment designs to accommodate higher and more intense rainfall events. For stormwater treatment systems very close to shore, groundwater levels may raise as sea level rises. Infiltration systems near shore should be designed to accommodate at least a 1-foot rise in sea level.

Management Problems

Most elements of EPA's TMDL and MS4 stormwater permit program makes sense from a conceptual framework; however, the capacity of municipalities to comply with these programs seems to have been exceeded, both financially, and politically. The state's approach of gradually strengthening stormwater treatment requirements has helped, but has not kept pace with what is required to improve water quality and open shellfish beds or remove other impairments.

There are not enough State Revolving Fund (SRF) dollars to meet all current needs for required wastewater upgrades. To address seriously municipal stormwater needs and wastewater compliance with nitrogen TMDLs (Action Plan 1), SRF annual funding will need to increase many fold. In the end, because these are loans, municipalities can only maintain a certain debt load. U.S. EPA and DEP may eventually need to implement a debt-forgiveness program where individual municipal burdens are too great to sustain.

Eliminating water quality impairments caused by stormwater discharges is a major undertaking that will require actions and expenditures by all levels of government. EPA must ensure that towns meet the Buzzards Bay pathogen TMDL though improved compliance with municipal MS4 NPDES stormwater permits. At the same time, the federal government must not cut nonpoint pollution grants for municipalities to reduce pollutants to their stormwater networks, and must increase funding to the state revolving loan program to help municipalities. DEP must upgrade state stormwater policy to include treatment standards for nitrogen and bacteria, and EEA must promote policies and regulations that foster low impact development techniques. The largest burden rests with municipalities, which will need to develop and implement meaningful stormwater management programs for themselves and the private sector supported by sound local laws, regulations, and policies.

As the Buzzards Bay watershed becomes increasingly developed, environmental impacts will also increase unless proactive measures are undertaken now. Conventional development may offer quick profits because the methods are well known and have been widely utilized; however, conventional development may not be the best way to protect sensitive resources. LID represents a sustainable approach to development that minimizes or eliminates impacts of development on water resources and habitat associated with Buzzards Bay. The key challenge is to encourage developers, planners, engineers and the public to utilize LID and other smart growth development approaches as the preferred alternative to conventional development.

A significant obstacle to the acceptance of LID principles is the perception that conventional development may be less expensive than LID and other methods of sustainable development. According to the Natural Resources Defense Council (www.nrdc.org/water), LID can often cost less than conventional stormwater management systems from both an installation and maintenance standpoint. LID design promotes reduced road surfaces and encourages less infrastructure underground (stormdrain pipes, catch basins, manholes). In addition, the associated vegetation also offers human quality of life benefits by greening the neighborhood, contributing to livability and aesthetics. This "greening" can enhance property values and marketability, and provide wildlife habitat along with pollution reduction and decreased flooding. Instituting change throughout the planning and development community will require showing that conventional development will cost Buzzards Bay communities more, in terms of environmental degradation and quality of life impacts, than the cost of changing over to sustainable development approaches. Figure 56 shows how the Buzzards Bay NEP sought to communicate these ideas a workshop series on LID.

Management Approaches

To address the stormwater problems identified in this action plan, a dual approach of setting higher stormwater treatment standards for new development and redevelopment, and for implementing an aggressive program to treat existing discharges that are causing water quality and habitat impairments is needed.

Stormwater Management Standards and Goals

With respect to stormwater treatment standards, DEP must work cooperatively with U.S. EPA, EEA and CZM to revise its 2008 Stormwater Standards and Policy to better address volume, quality, and rate of stormwater discharges, and to require reductions in fecal coliforms and other pollutants (such as nitrogen) to meet new TMDLs. This is an essential ingredient for towns to meet bacteria and nitrogen TMDLs, because many discharges are beyond their control. DEP may need to reconvene its Stormwater Advisory Committee to address this problem. The state's stormwater guidance must be updated to include the latest data on bacteria and nutrient removal by different types of BMPs. State and federal agencies, and regional planning entities like the Cape Cod Commission and SRPEDD, and the Buzzards Bay NEP can support these updates with training workshops, circuit riders, technical assistance staff, and GIS products. The Cape Cod Commission could also incorporate more stringent fecal coliform and nitrogen loading standards in their regulatory reviews of the stormwater management facilities associated with projects under their review.

USDA must update stormwater calculation programs like TR55 to include runoff coefficients for specific LID practices, with input from the EPA. This will set standards for commercial software packages and enable applicants to adopt certain LID approaches.

EPA's enforcement of existing MS4, MSGP, and Construction stormwater permits in the NPDES program has been inadequate. Currently two employees are working with 207 Massachusetts municipalities to address nonpoint source pollution, including local program review, permit compliance, and technical assistance. This level of support is not adequate to ensure the success of the program. The program is understaffed, and the agency must commit additional resources to the effort. Unless EPA takes action to ensure better compliance and tracking of these programs, little progress will be made. Even simple letter writing campaigns to notify industries not in compliance with the MSGP requirements can be an effective tool to promote action to implement stormwater remediation projects.

The state legislature should avoid exempting road and bridge projects from state wetlands permitting. The legislature continues this practice in the belief that it will streamline the permitting process, but it does nothing to streamline the federal permit process, and large projects often take considerable time, many times exempt from any local appeal process. Denying conservation commission involvement may just alienate the town. Although in these cases Mass DOT will still voluntarily meet with Conservation Commissions to resolve wetland issues, this does not always occur for exempted projects. Elimination of these exemptions will help Buzzards Bay communities to better protect sensitive wetlands from stormwater runoff from roads, and ensure that local needs are addressed.

With respect to restoring existing impairments to water quality and habitat, as defined under their MS4 per-

Figure 56. Posters developed by the Buzzards Bay NEP for a LID workshop.

mits, each Buzzards Bay community will need to implement best management and good housekeeping practices for stormwater networks. The highest priority should be given to stormwater networks contributing to shellfish bed closures or other impacts to wetlands, water quality, or other natural resources identified in bacteria TMDLs and MS4 permit stormwater plans. DPWs will be the lead in this effort, but most towns have established a stormwater management committee to help coordinate municipal board action and bylaw development, consistent with the town's stormwater management plan. It will be vital for conservation commissions, boards of health, and planning boards to adopt consistent stormwater regulations and policies, and that stormwater bylaws address projects not typically under review by municipalities like approval not required (ANR) projects.

Local Implementation

Most of the responsibility and costs for new stormwater management standards and requirements will fall to municipalities because the vast majority of stormwater discharges are associated with municipally owned stormwater drainage networks. There are considerable flexibilities in how municipalities might regulate and finance their expanded stormwater program obligations. For example, municipalities could establish a stormwater authority as authorized under the MGL Chapter 40, Section 1A and Chapter 83, Section 16. Alternatively, they could just expand existing programs and finance such efforts out of the general tax revenue base.

Whatever local management structure is implemented, an important process to support local stormwater management will be the continued development and expansion of GIS databases that map all stormwater discharges, catch basins, and drainage networks, BMPs, and maintenance (e.g., catch basin cleaning schedules) in existing stormwater networks. Currently few municipalities utilize GIS based stormwater management systems to track maintenance and repair of stormwater networks, despite the fact that the size of stormwater networks requires a computer-based management approach. Those municipalities may not have adopted these database management approaches because of startup costs and training requirements.

Because local government has the greatest control over development and redevelopment, each Buzzards Bay municipality must adopt LID principles in their subdivision regulations and site plan review laws and regulations, or town-wide stormwater general bylaws. Because many kinds of development and redevelopment are not reviewed through these types of permits, a good general stormwater bylaw or ordinance will be a more comprehensive solution. Board of health and conservation commission regulations for stormwater treatment should be consistent with these other town requirements. In some cases, town meetings must approve new bylaws; in others, town boards already have authority to adopt regulations.

These LID laws and regulations should maximize infiltration of stormwater runoff to the greatest extent possible with a goal of capturing 95% of the stormwater volume. These local requirements could even contain an incentive (credit) system to encourage developers to minimize impacts by reducing impervious areas, disconnecting rooftops and driveways from street drainage, and maintaining naturally vegetated buffers to wetlands, streams, and marine waters.

Key state and local staff and municipal boards should become familiar with LID and other sustainable development practices, and should attend training workshops where applicable.

At least half the Buzzards Bay communities have participated in workshops and formally considered whether LID bylaws are appropriate in their town. Several towns are now adopting some LID measures in their regulations. At the state level, MEPA has been imposing new stormwater requirements on projects meeting the state project review threshold, and in 2010, the federal government, in an effort to lead by example, is requiring that 95% of stormwater be treated on site for any new or redeveloped federal properties.

The Buzzards Bay NEP should continue to promote adoption of municipal bylaws and regulations that support the principles of LID. Workshops should be coordinated with the BBAC. This is a high priority and should be a core element of the Buzzards Bay NEP's technical assistance program to manage stormwater. The Buzzards Bay NEP should work with BBAC and Buzzards Bay municipalities to assist with the adoption and implementation of the LID bylaws and unified stormwater regulations among town boards. Watershed protection groups will need to advocate for and support the passage of bylaws and regulations.

Once these local regulations are adopted, the Buzzards Bay NEP should continue to provide training in implementation of these regulations and the review of plans and stormwater calculations for compliance with these new local regulations, and to identify when professional engineering reviews are required.

State Responsibilities

At the state level, DEP is the most important agency in setting policy and requirements requiring LID techniques, particularly for projects that come before conservation commissions. While the state has initiated many important changes in the stormwater policies and regulations, more needs to be done to foster LID principles. A key need is to expand stormwater treatment requirements beyond the 80% TSS performance standard for stormwater discharges to impaired bathing beaches and shellfish areas, and ensure BMPs are put in place that remove bacteria as well.

MEPA should require the submission of an LID alternatives analysis for commercial and residential projects that meet MEPA thresholds (for land, rare species, wetlands, water, wastewater, transportation, and ACEC) for EIRs. These LID principles need to be more formally incorporated into the MEPA Regulations at 301 CMR 11.00. The MEPA office and EEA could have a Task Force to develop these recommendations for an LID alternatives analysis. The MEPA office should add changes to their website that promote LID as part of a pre-project planning process, and MEPA should distribute appropriate guidance materials that encourage LID strategies prior to project submissions.

Agricultural Runoff

NRCS should continue their ongoing program to assist farmers to implement best management practices on agricultural lands in the Buzzards Bay area. In many Buzzards Bay watersheds, stormwater runoff from agricultural lands remains an important contributor to water quality and habitat degradation, and these impacts can be overcome. Presently there is inadequate follow up to ensure that farmers are adhering to their farm plans. Specifically, recommendations that are more detailed should be developed to minimize loading from nitrogen and phosphorous from fertilizers and fecal coliform where manure is used as a fertilizer. NRCS should work with DEP to develop updated guidance on understanding the exemptions and responsibilities afforded to agriculture under the MA Wetlands Protection Act. This information could be used to incorporate agriculture issues under the MA Stormwater Policy. Adequate staff and funding is needed to ensure that farmers have the resources and guidance to implement their farm plans.

Education and Training

Education and outreach is one of the most essential requirements for the success of this action plan. Currently there is general understanding and appreciation among decision makers of the problems with conventional development and the need for LID, and there is growing support for action. The main obstacle remains the inertia of politicians and regulators to enact changes that may be viewed as burdensome to the private sector.

Effective outreach and information about LID techniques and approaches need to be provided to a wide audience. The recipients of this training include municipal staff and boards involved in policy and permitting of development. This includes planning boards, building inspectors, conservation commissions, zoning boards, boards of health, and others. Outreach should be provided to non-governmental entities, including developers, builders, engineering firms, homeowners and trade associations, and the public.

The Buzzards Bay NEP should continue to promote the adoption of its model municipal stormwater regulations to help towns adopt LID principles, and better comply with municipal MS4 stormwater permits and bacteria TMDLs. This is a core mission of the Buzzards Bay NEP, an essential step for municipalities to implement stormwater management plans in support of their MS4 permits, and to meet bacteria TMDLs. This means the municipalities must adopt regulations and standards that exceed the minimum standards under the state's Wetland Protection Act stormwater policies. The Buzzards Bay NEP will work with the BBAC to conduct periodic meetings and workshops on stormwater issues to create a forum to exchange approaches and ideas among watershed municipalities.

There are costs to government in implementing new stormwater performance standards, and there are real and sometimes perceived cost to the private sector creates that can create political obstacles to implementation. Sometimes incorrectly perceived costs can be overcome through outreach and education of the benefits of a program. All levels of government have a responsibility in this outreach and education, and non-governmental organizations like the Buzzards Bay Coalition can play an important role. Training workshops, outreach materials, demonstration projects, school and university projects, and media involvement are all parts of this communication strategy.

MA CZM could reestablish an LID Working Group to develop new strategies to reach out to coastal communities and educate this wide range of participants. CZM has provided leadership and guidance to coastal communities, and can reach out to them to promote LID techniques.

Regional planning and regulatory agencies like SRPEDD and the Cape Cod Commission should update their own regulations, or policies to meet LID principles, and continue to provide LID training, outreach, and education to municipalities and developers as well. The Cape Cod Commission should review its Regional Policy Plan and apply LID standards to projects under their regulatory review.

Trade associations that should be targeted in outreach efforts include the Cape Cod Homebuilders Association, Massachusetts Homebuilders Association, Massachusetts Association of Municipal Employees, American Planning Association, American Society of Civil Engineers, and other development and planning organizations. DEP, EEA, CZM, and Buzzards Bay NEP could provide "Train-the-Trainer" workshops to train association staff to ensure that the industry can provide LID training to their members.

The U.S. EPA should continue to promote LID through funding and partnership building, as part of nation-wide smart growth initiatives, and to encourage LID principles through in their regulatory programs. In Massachusetts, LID techniques should be encouraged through the EPA's MS4 stormwater permit program.

As noted in the stormwater action plan, NRCS, with input from the EPA, should incorporate LID hydrology into the TR-55 stormwater loading model used by engineers and regulators. This is important because TR55 and similar models are used by consultants and engineering firms as the basis of evaluating stormwater discharges for conformance to government stormwater regulations, it is essential that the program be updated to give proper runoff coefficients to LID BMPs to ensure those BMPs are given adequate consideration. NRCS can then develop the revised model using existing peer-reviewed data and design characteristics. Training and outreach by NRCS, EPA, local state agencies and LID experts will then be needed to teach engineers and reviewers how to use this model. EPA is an essential facilitator of this effort. Development of this model should be undertaken with assistance from engineering associations and research institutes to ensure its proper application to BMP designs and function. The effort could also be used to define the set of user-specified variables that will be needed in the model when incorporating LID BMPs in varied environments. Training and outreach will be needed in order to teach practitioners how to use this software.

Financial Approaches

The actual costs for changes to government regulations, laws, and policies are negligible. Some of these changes will increase initial development costs; others will reduce those costs. The costs of providing training will vary, but using private contractors, could range between $5K to $20K annually depending on workshop schedules, speakers fees and expenses, rental fees for facility, etc. Alternatively, existing government staff and agencies could shoulder these responsibilities.

Financing stormwater remediation to remove existing water quality impairments in Buzzards Bay is the most significant obstacle hindering implementing this action plan. Exacerbating the problem, EPA has continued to limit the use of 319 nonpoint source grant funds, and the state revolving loan program, often touted as a financial solution for municipal stormwater solutions, is becoming increasingly burdened with municipal needs of sewer expansion and wastewater facility upgrades to meet nitrogen TMDLs.

The cost to Buzzards Bay towns to remediate existing discharges to comply with bacteria TMDLs and stormwater MS4 permits may exceed $1 billion dollars and take decades to achieve. All regional governmental organizations must provide towns with needed technical assistance to help comply with these water quality mandates. U.S. EPA, EEA, CZM and DEP, must commit additional funds to leverage local stormwater remediation projects. These programs should focus on watersheds of impaired embayments, including Phase II urbanized areas. A level of funding of $2 million annually directed to Buzzards Bay watershed can leverage continued progress to remediate important existing discharges. The state legislature and Congress must set aside these funds. However, the real burden of achieving these goals will fall to municipalities and the private sector. Government leverages private action at the time of permitting for development or redevelopment of projects. Remediation of existing municipal stormwater networks may require innovative approaches like stormwater utilities. Municipalities could utilize the State Clean Water Revolving Fund (SRF) loans to finance improvements to municipal stormwater networks. Unfortunately, the SRF program is overburdened with projects to upgrade wastewater facilities, so Congress would need to expand funding for the program. To save money on the cost of stormwater treatment projects, municipalities will need to coordinate stormwater remediation projects with road reconstruction and sewer expansion projects. Some of these actions will occur automatically if the state and federal governments change the performance standards in regulations defining stormwater treatment.

The costs to government to manage impacts from new development and redevelopment are negligible because government can adopt new performance standards that only incrementally add costs to development. Existing municipal and agency staff can develop and implement these new stormwater treatment standards mostly using existing staff, so the cost to government is negligible. Some municipalities have already adopted new bylaws with Buzzards Bay NEP assistance, and the level of technical assistance offered by the program will be defined by available funding.

Many of the elements of this action plan can be achieved by the passage of laws and promulgation of regulations. Because of the costs of stormwater treatment, and the perceptions of costs to the private sector, adoption of new laws and regulations can be challenging politically. The most daunting costs will be to ensure that municipal stormwater discharges meet bacteria TMDLs. Because of the large number of discharge pipes, and the costs to design and implement solutions for a single discharge pipe, the cost of meeting the bacteria TMDL will likely cost at least $1 billion and take decades.

To fund local stormwater restoration efforts, some municipalities have been considering adopting stormwater utilities. Potential funding for such an approach could be authorized under MGL Chapter 83, Section 16 ("Charge for use of sewers"). Municipalities may create such a stormwater management utility to raise fees to manage stormwater facilities that serve multiple residents and/or commercial properties. Such a stormwater utility is analogous to a sewer utility, and may include LID measures. A "water pollution abatement" district needs to be defined first, under MGL Chapter 40, Section 1A. Other funding sources include EEA Smart Growth Technical Assistance Grants and CZM CPR and NPS Grants.

The Buzzards Bay NEP should continue its grant program to support Buzzards Bay communities in eliminating or treating stormwater discharges. The Buzzards Bay NEP has particularly focused on helping communities adopt stormwater designs and site plans that can be used to obtain funding from other grant programs that have more funding for stormwater treatment construction, such as DEP's 319 grant program and CZM's CPR program. Municipalities can use funding from these programs to fund demonstration projects on municipal properties so that they can lead by example.

Monitoring Progress

Many of the actions needed to implement this action plan are programmatic, so success of programs can be measured by the adoption of embayment stormwater plans, the level of compliance with NPDES permit programs, and the adoption of new local regulations. Other tracking involves enumeration of the number of discharges treated, illicit discharges removed, and the percentage that have stormwater treatment solutions installed. The ultimate measure of success for this action plan will be number of acres of shellfish beds opened, or decreases in the number of beach days closed. Many of these elements can be evaluated through the MS4 permit process, and through the update and review of stormwater

With respect to meeting the goals of LID, workshops, adoption of bylaws and regulations, and meeting certain performance standards are measures easy to track. The long-term costs and benefits to the environment will take years to track and will be harder to measure, but the expected outcome will be less impacts of new development, and possible water quality improvements when the landscape is redeveloped and stormwater discharges are reduced through new stormwater treatment requirements.

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Action Plan 4 Improving Land Use Management and Promoting Smart Growth

Problem

Past building and development practices, coupled with poorly planned local zoning and development requirements, have resulted in sprawl, increased pollution discharges, and many other unintentional injurious effects to the environment. Whereas the Promoting LID action plan focuses principally on stormwater management and restoring the natural hydrology of sites, "Smart Growth" and similar growth management principles address the broader and indirect environmental impacts of growth and sprawl. Smart growth strategies include planning, zoning, protection of open space, preserving natural landscapes, encouraging village centers, and promoting clustering of development and other actions that cannot be directly addressed through conventional environmental regulations. Implementation of these plans, practices, and policies will not only benefit the environment, but also save government infrastructure construction and maintenance, and ultimately benefit the public with reduced government tax burdens.

Goal

Goal 4.1. To improve land use management through the use of smart growth strategies in the Buzzards Bay watershed to maintain and improve the natural resources and ecology of Buzzards Bay.

Objectives

Objective 4.1. To encourage smart growth techniques in less developed Buzzards Bay watershed communities to preserve open space, revitalize urban and village centers, focus development on growth centers, and protect natural resources and the environment.

Objective 4.2. To improve local zoning, subdivision, health, and wetlands regulations to manage future growth in a way that protects the environment of Buzzards Bay and its watershed.

Objective 4.3. Promote sustainable agriculture that does not adversely affect water quality.

Approaches

Municipalities have a responsibility for regulating and managing the impacts of future growth to minimize potential environmental impacts. Besides project specific permitting requirements, tools available to municipalities include master plans, open space plans, industrial and economic incentive zones, zoning, clustering of development rules, parking space regulations, and decisions about the placement of public infrastructure and public facilities, are all tools that shape and define future patterns of development. How these tools are used also effect the cumulative impacts of growth on the environment. One of the biggest local challenges, however, is simply defining the goals for the preferred patterns of development and redevelopment. Once the goals are better defined, these tools can be used more effectively and in a complimentary way.

The first step is to evaluate local regulations that need to be reexamined. Regulatory strategies may include revisions to zoning bylaws, general bylaws, and local wetland regulations. However, a vision of smart growth strategies and goals must be included in long-term planning documents like municipal master plans, open space plans, and municipal stormwater plans[84].

Each municipality must decide which smart growth techniques work best for them, and implement those that optimally protect their critical resources and minimize growth impacts on water quality and habitat special to their community. Certain techniques, like cluster zoning, should be universally adopted. Other techniques are more town-specific. The transfer of development rights (TDRs) is a technique underutilized by rural municipalities. For the TDR process to work as desired, municipalities must identify sensitive resource areas (sending areas) and growth centers (receiving areas). Defining the sending and receiving areas can be informed by science (e.g. receiving areas should not adversely affect another area), but assigning these areas may require political and economic considerations.

Other levels of government need to support municipalities through technical and financial assistance programs. Where appropriate, state, and federal government must also change regulations and laws governing new growth and redevelopment to both support smart growth principles, and to lead by example. Regional planning and regulatory agencies, the Buzzards Bay NEP, and state agencies all have important roles to play through training, education, and in the review of projects that meet certain state and regional thresholds.

Costs and Financing

Many of the necessary regulatory changes to implement this action plan have negligible cost to government. More importantly, some smart growth approaches (like clustering of development) also reduce costs to developers and tax burdens to residents because of lesser infrastructure maintenance costs.

Measuring Success

This action plan requires tracking of programmatic measures such as adoption of laws and regulations that achieve the goals of this action plan. This action plan attempts to lessen numerous effects of new development; no one environmental outcome can be tracked directly.

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[84] See Action Plan 3 Managing Stormwater Runoff and Promoting LID.

Background

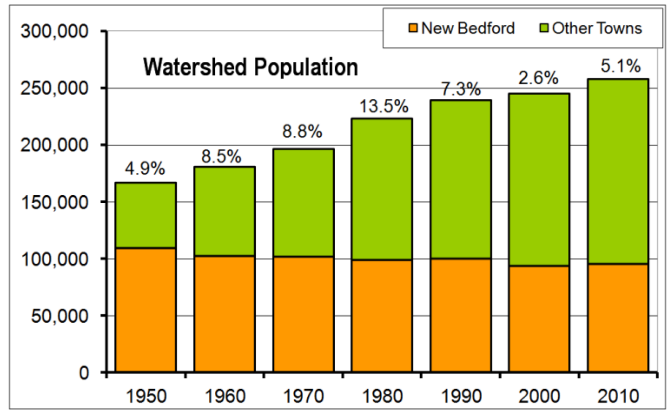
Land Use in Buzzards Bay

The central Buzzards Bay ecosystem is relatively healthy. With the exception of waters around New Bedford, and around some of the more eutrophic embayments, the water quality and living resources in the central bay have not yet experienced the degree of stress associated with other coastal areas such as Chesapeake Bay, Narragansett Bay, and Long Island Sound. However, the ability of the Buzzards Bay environment to sustain its many beneficial uses is threatened as growth in the area continues to accelerate.

Population in the watershed has increased from approximately 150,000 to 250,000 in the past fifty years (Figure 57). During this period population declined in urban areas (such as New Bedford), with continued sprawl into the countryside, requiring longer commutes to jobs and schools. Buildout analyses in the member communities demonstrate the potential for continued growth. A study by the Woods Hole Research Center of growth patterns in southeastern Massachusetts concluded that adoption of smart growth principles could appreciably reduce the loss of natural landscapes due to development over the next thirty years (Figure 58).

This relationship between development and population increase reflects the development of land programmed for subdivision by the Buzzards Bay communities through their zoning bylaws. Expansion of the second-home market and the increasing willingness of homebuyers to pay higher prices to live near the coast are creating economic pressure to convert rural or agricultural land to residential development. In addition, seasonal seaside homes are now commonly converted to year-round residences. These trends are demonstrated in land use statistics for Massachusetts that show that between 1950 and 1990, population in Massachusetts increased by 28%, but developed land increased by 188%[85].

In the Buzzards Bay watershed, changes in subsequent years are more nuanced because of population declines in New Bedford, and dramatic increases in population in more rural communities after 1985, as illustrated by Figure 59. Between 1970 and 1985, the rate of population growth paralleled increases in land development. However, between 1985 and 1999, a period of a great development boom, the rate of land development far outpaced population growth. Between 1971 and 1985, every new person in the watershed resulted in 5,500 sq. ft of new residential development, whereas between 1985 and 1999, every new person added to the watershed resulted in the creation of 11,300 square feet of residential area. For the entire period, population increased 40%, whereas the area covered by residential land use increased nearly 60%.



Data from the U.S. Census.

Figure 57. Watershed population changes - City of New Bedford (orange) versus watershed towns (green).
The net percent increase in population between decades is shown.

These more recently less densely developed areas of the watershed are contributing a disproportionately high pollutant load to the Buzzards Bay ecosystem because the road surface area per house also increases in sprawl areas. These loads are the result of not only increased runoff from roads, but larger lawns, driveways, and other sources. These increased pollutant loads impact coastal ecosystems by increasing discharges of bacteria, viruses, heavy metals, hydrocarbons, and nutrients through pathways to the bay.

The Alliance for the Chesapeake Bay (1989), in its white paper on growth management, reinforced the need for greater control and predicted that growth management would become the watchword of the 90s. The Alliance further indicated that managing growth is essential to protecting natural resources and those regulations, financial resources, and pollution-control devices are of limited value. More recently, the U.S. EPA and the Commonwealth of Massachusetts have become proponents of "Smart Growth" as the planning tool for this first decade of the new millennium, and beyond.

> *"Smart Growth" is well-planned development that benefits the community, protects open space and farmland, keeps housing affordable, provides more transportation choices, and preserves the natural environment.*

Smart growth provides an opportunity to foster quality development that provides both economic and environmental benefits to a community and a region. It directs growth into village centers that have appropriate wastewater treatment infrastructure, broader transportation choices, and more diverse (and affordable) housing opportunities. It also preserves and protects critical environmental resources, agricultural areas and open space.

[85] EEA Smart Growth website at: www.mass.gov/eea/state-parks-beaches/land-use-and-management/land-conservation/ma-smart-growth-smart-energy-toolkit.html. Last accessed October 11, 2013.

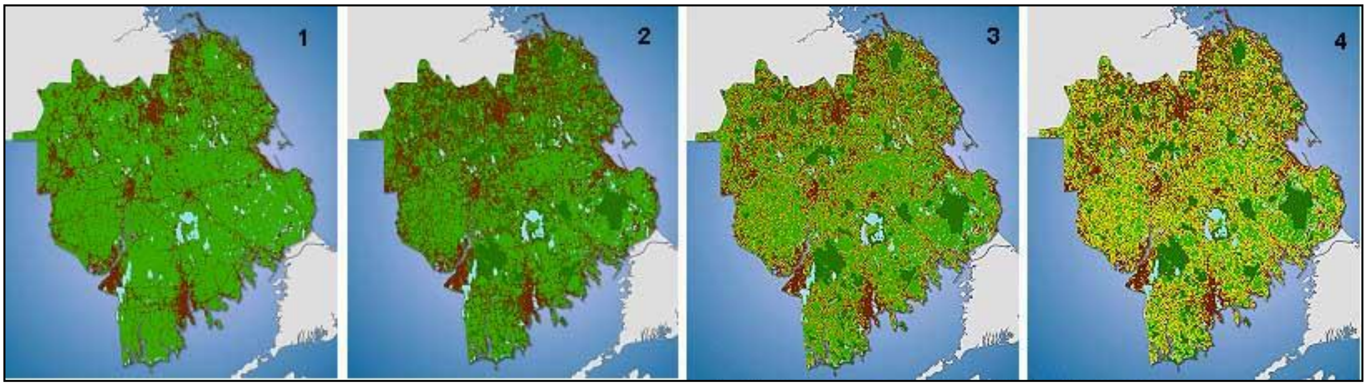


Figure 58. Expected development patterns in Southeastern Massachusetts, with and without smart growth techniques adopted.

The above panels show (1) development as of 1971, (2) development as of 1999 (3) development over 30 years with a smart growth scenario, and (4) development with unmanaged growth after 30 years. In the Smart Growth scenario, land altered by development increases by 20%, whereas in the unmanaged development scenario, developed areas expand by 34%. Graphics and data taken from a Woods Hole Research Center study posted at www.whrc.org/mapping/semass/landcover.html. Last accessed October 11, 2013.

Other action plans in this Buzzards Bay CCMP address specific types of pollution sources or sensitive habitats, or contain specific recommendations for reducing pollutant loads and protecting areas of special concern. These individual action plan recommendations alone are not sufficiently protective; inherent in each set of recommendations is an understanding that a holistic approach to water quality protection is needed. The cornerstone of such an approach is land use planning for growth management and more specifically, smart growth.

Developing a Local Land-Use Plan

The underlying assumption of growth management is that there are limits to the amount of unmanaged growth that an area can withstand without serious harm to public health, safety, regional economy, or the environment. Environmental systems, and specifically coastal embayments, reach limits at which they can no longer absorb the impacts from additional development without degradation or impairment of uses. This is known as the "carrying capacity." Of specific concern in Buzzards Bay are the localized embayments where the greatest amount of human activity (swimming, fishing, and boating) takes place. Aggressive land use management and planning can ensure that the water quality of an embayment is protected, particularly when drainage basins contain appreciable amounts of developable land.

A key component of local land use planning is the identification of critical areas for protection. Escalating growth patterns place stress on these critical resource areas, and the stress is often proportional to growth. Identification of these areas will provide communities with a planning tool to begin answering questions of

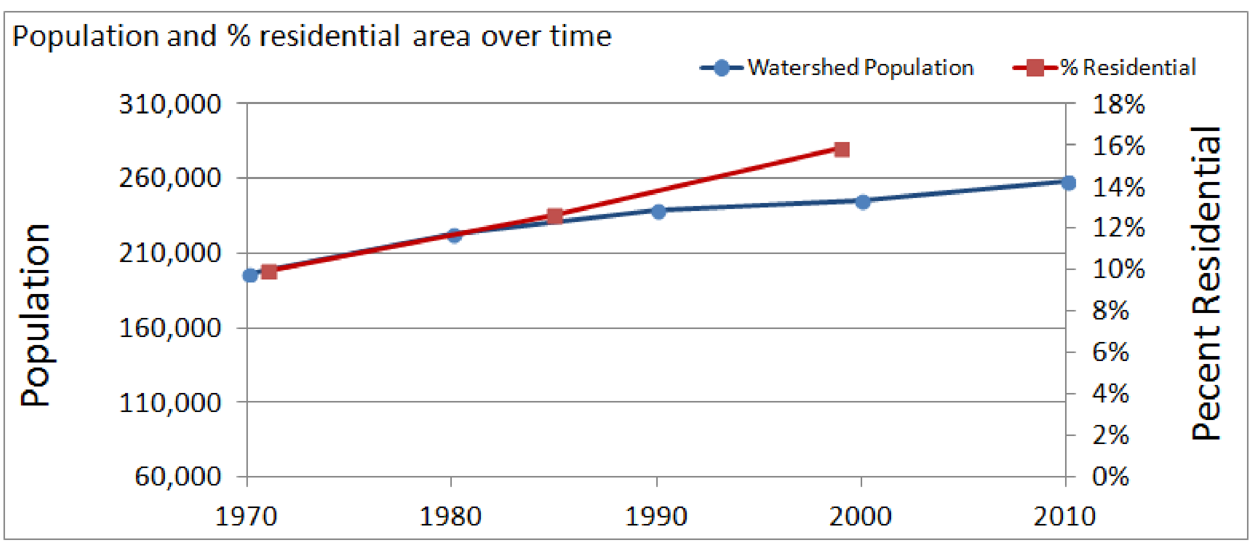


Figure 59. Population trends in the Buzzards Bay watershed versus changes in residential land use.

Land use data from MassGIS (residential land use categories only) and population data only for principal municipalities within the watershed (entire town). Prepared by the Buzzards Bay NEP. Land use methodologies changed after 1999 and are not comparable.

where to allow development, how best to design development, how much of it can occur, and how best to regulate potentially detrimental future land uses.

Equally important is the identification of growth centers, areas that can accommodate growth, where appropriate infrastructure (including wastewater treatment) and environmentally sensitive design standards can be provided. These growth centers can then absorb the vested rights of landowners in the region by re-directing (or transferring) them from more critically sensitive areas. They can also provide better diversity of housing types (including affordable), a range of transportation options (transit, cycling, and pedestrian) and a good quality lifestyle. The resulting form of development (more compact village centers surrounded by protected open spaces) can also provide opportunities for the reduction of carbon emissions, leading to minimization of the "greenhouse" affects and sea level rise.

Important agriculture areas must also be delineated. Cranberry and other agriculture have been an important part of the landscape in southeastern Massachusetts and Cape Cod for well over one hundred years. This unique environment plays an increasingly important role in the preservation of open space, in providing opportunities for water conservation and in providing wildlife habitat.

Although, 13,000 acres are in actual production (USDA NASS 2012 statistics), cranberry growers own and manage nearly 62,000 acres of related ponds, bogs, wetlands, and upland forest. As the region becomes more developed, this land takes on more and more importance. For example, A.D. Makepeace Company, a large cranberry grower and the largest private landowner in Massachusetts, is poised to develop a sizeable portion of their land. The development of this area will change much of the landscape in the upper watershed, and should utilize some of the planning and design methods described below to minimize the impacts of the development on water quality and quantity, and habitat and the environment. This project is in the planning stages, and Buzzards Bay NEP expects it will continue to take shape on paper and on the ground over the next several years.

Tools & Techniques

The validity of local government regulation is predicated on the broad concept of police power: the power of government to regulate for the advancement and protection of the health, safety, economy, and welfare of the inhabitants of the community. In the Buzzards Bay area, this broad authority has typically been limited to zoning techniques such as dimensional requirements including lot size, setbacks, and lot coverage.

A handful of communities have expanded their zoning regulations to focus on the protection of water quality, and a smaller number have given the protection of Buzzards Bay water quality a high priority in their zoning codes and subdivision rules and health regulations.

Smart growth provides a new approach to land use planning that recognizes vested land values and development rights of current landowners, and re-directs (and re-designs) this growth in patterns that are more sensitive to environmental constraints. The following regulatory and non-regulatory techniques represent a sampling of those methods that the Buzzards Bay watershed communities could adopt to provide added protection from the pressures of growth and development by offering alternative designs and techniques.

Regulatory Techniques

Overlay Ground/Surface Water Protection Districts

A groundwater or surface water overlay protection district clearly identifies and recognizes critical water resources and protects these resources through regulatory restrictions. These ordinances (cities) and bylaws (towns), while varying in their approach toward resource protection (i.e., prohibition of various uses versus special permitting and/or performance criteria), are similar in their goals of defining a resource by mapping boundaries and enacting specific legislation for land uses and development within these boundaries. Whenever possible, stormwater should be contained and treated on-site.

Overlay Smart Growth Zoning District

Many communities in the Buzzards Bay watershed and throughout Massachusetts are faced with a shortage of affordable housing units. Communities that do not meet the minimum requirements for availability of affordable housing can be faced with proposed affordable housing projects that are allowed to bypass certain local zoning regulations through a comprehensive permit application process, under MGL Chapter 40B. As a result, high-density projects can be proposed in areas that may not be best suited for this level of development.

One mechanism to pre-plan and provide incentives for creation of affordable housing and open-market housing is to develop a Smart Growth Overlay Zoning District (authorized by MGL Chapter 40R; see slide from the Smart Growth Toolkit in Figure 60). Within the district, development must meet a set of design standards created by the municipality, but development can occur by right, easing the comprehensive permitting requirements for the developer in comparison to Chapter 40B developments (which are often contentious and end up in court). Chapter 40R allows a municipality to designate areas where mixed use and residential growth should occur in the town, in accordance with a land use plan, and then provide an incentive in the form of a simpler permit process. Such a district can relieve development pressures in more environmentally constrained areas through a transfer of development rights process (described below).

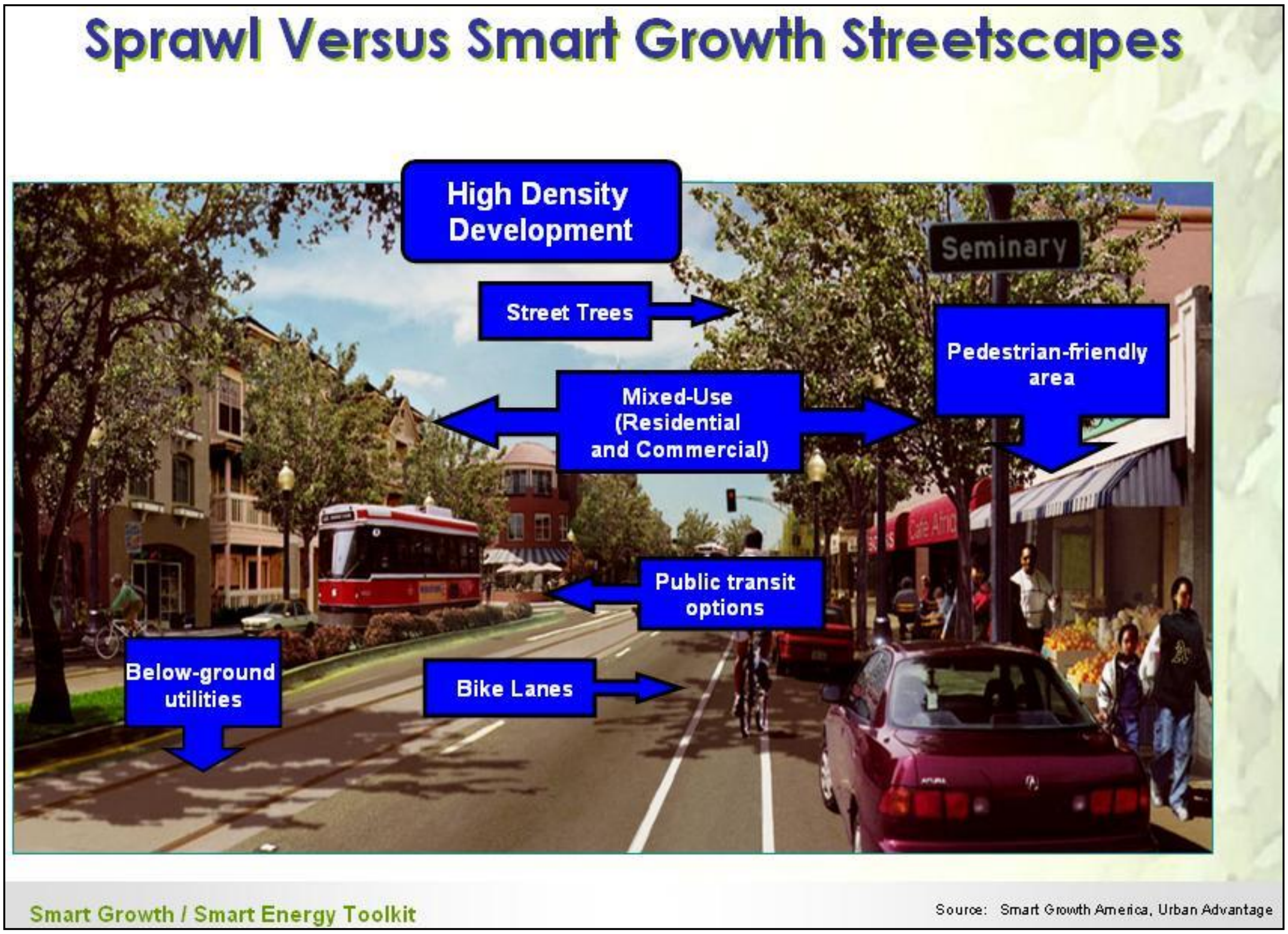


Figure 60. Slide from a smart growth presentation developed by the Massachusetts EEA.

In addition, and perhaps its biggest selling point to the public, state approval of a Chapter 40R Overlay District results in an incentive payment to the community's general fund, commensurate with the number of units the district allows. The municipality may receive additional payments of $3,000 per unit as each new residential unit receives a building permit, as long as one unit is built within three years. This program has only been employed by a handful of communities in the Buzzards Bay watershed to date; for example, Plymouth recently passed a Chapter 40R district (at Cordage Park, although this is outside the Buzzards Bay watershed), and Dartmouth adopted a 40R district at Lincoln Park.

Surface Water Buffer

Stormwater runoff is a major component of nonpoint-source pollution in surface water and contains pathogens, nutrients, and contaminants associated with road runoff. Studies have shown that undisturbed lands are generally more permeable and, as a result, allow higher levels of stormwater percolation and natural treatment of associated contaminants. Municipalities can require that undisturbed vegetative upland buffers be maintained adjacent to and within a defined buffer area (e.g., 100 feet or more) of surface waters in order to promote natural stormwater treatment.

<u>Performance Standards</u>

Performance standards are based on the assumption that any given resource has a critical limit (carrying capacity) beyond which the resource deteriorates to unacceptable levels. Performance controls assume that most uses are allowable within a designated area--if the use or uses will not overload natural or manmade resources. To apply this concept to Buzzards Bay, the critical limits of nitrogen sensitive embayments must be determined. Once determined, each development project within the drainage basin would be allowed to contribute a defined percentage of nitrogen, relative to the capacity of the embayment.

Because many estuaries currently exceed TMDLs for nitrogen, existing nitrogen sources must be reduced and new development must be held to a de facto net zero standard. Net zero wastewater nitrogen loading for new development can be achieved through sewering, by offsetting new development by sewering other parts of the same watershed, or by installing advanced nitrogen removal systems in a sufficient number of systems to offset new inputs. Reducing existing nitrogen sources will generally require sewering, but in some cases, decentralized treatment options may be an alternative.

This approach may provide the only comprehensive mechanism for equitably protecting Buzzards Bay embayments from increasing additions of nitrogen. Each embayment's ability to assimilate nitrogen is limited, but establishing a program for each watershed that is based upon performance regulations is an exciting and imaginative mechanism for protecting and restoring water quality.

Cluster Design

Cluster zoning is an alternative to the standard grid-style subdivision. In a cluster development, smaller building lots are allowed, with resulting land savings set aside in contiguous areas of open space. Clustering can be done at the same density that could be obtained in a grid system or with greater density "bonuses." Typically, cluster development allows shorter streets, reduced construction, and maintenance costs. It provides tremendous flexibility for both the developer and municipality, and often allows for greater creativity in the division of large land parcels. Among other benefits, large open spaces may serve as buffers.

Open Space Residential Design

Open Space Residential Design (OSRD) is similar to cluster design, but generally is a partnership process between the developer and the town. It requires a larger portion of land to be set aside as open space, offers more flexible incentives, and establishes a design process to be followed. OSRD design process starts with identifying areas of the site with conservation value, such as water resources, wetlands, and habitat areas. Placing residential units on the site to avoid these areas, aligning roads and walkways to conform to the natural topography of the site, and drawing lot lines around the units allows residents the best opportunity to enjoy these resource areas. The conservation value of the open space conserved through this technique is often greater than through traditional cluster subdivisions.

Transfer of Development Rights

Transfer of Development Rights (TDR) is a regulatory strategy that harnesses private market forces to accomplish two smart growth objectives. First, open space is permanently protected for water supply, agricultural, habitat, recreational, or other purposes via the transfer of some or all of the development that would otherwise have occurred in these sensitive places to locations that are more suitable. Second, other locations, such as city and town centers or vacant and underutilized properties, become more vibrant and successful as the development potential from the protected resource areas is transferred to them. In essence, development rights are "transferred" from one district (the "sending district") to another (the "receiving district"). Communities using TDR are shifting development densities within the community to achieve both open space and economic goals.

Image from travelguideofamercia.com.

Figure 61. Onset Village is a traditional Buzzards Bay watershed village center.

Traditional Neighborhood Development

Traditional Neighborhood Development (TND), also known as "new urbanism", "neo-traditional" or village-style development, includes a variety of housing types, a mix of land uses, an active center, a walkable design, and often a transit option within a compact neighborhood scale area either as infill in an existing developed area or as a district scale project. Onset village (Figure 61) can be considered a traditional village center.

Transit Oriented Development

Transit Oriented Development (TOD) creates mixed-use, higher density communities that encourage people to live, work and shop near transit services and decrease their dependence on driving.

Low Impact Development

Low Impact Development (LID) is a more sustainable land development pattern that results from a site planning process that first identifies critical natural resources, and then determines appropriate building envelopes. LID also incorporates a range of best management practices (BMPs) that preserve the natural hydrology of the land. LID is described in much more detail in Action Plan 3. LID techniques can be incorporated in a variety of smart growth approaches listed here.

Subdivision Control

Subdivision regulations, as described in Massachusetts General Laws Chapter 41 Sections 81K- GG (the "Subdivision Control Law"), differ from zoning bylaws in that they focus less on land use and more on engineering concerns such as street design (grade, width, intersection angles), utility placement and traffic patterns of individual subdivisions. Protecting water resources via subdivision control can help limit the degree of imperviousness of the watershed, thereby controlling stormwater runoff.

Stormwater Management Requirements

Stormwater from subdivisions and commercial developments can be regulated through the use of local stormwater bylaws, as well as through local stormwater performance standards and design criteria that can be incorporated into the local subdivision regulations, local wetlands protection bylaw or site plan review process. A model stormwater bylaw has been developed for the Towns of Duxbury, Marshfield, and Plymouth using CZM grant funding.

Nitrogen Management Overlay Districts

Overlay districts such as the Buttermilk Bay Overlay District adopted separately in Bourne, Plymouth, and Wareham can be used to regulate the nitrogen impacts from development on coastal and groundwater resources. It is possible, for example, to determine the water quality impact of a 20-lot subdivision by calculating the nitrogen contribution from road and lawn runoff and septic systems. Planning boards can use this information to regulate subdivisions by limiting development size and placing restrictions and requirements on lawn size, fertilizer use, and wastewater treatment so that water quality will not be compromised. In cases where the project is located in an already-impaired subwatershed, positive-impact development can be required where off-site mitigation must be provided in exchange for development permits.

Board of Health Review

Section 81-U of the Subdivision Control Law requires that boards of health review all subdivision plans to ensure that they do not pose any public health concerns. When used appropriately, board of health review under Section 81-U can ensure that threats to water quality are minimized. Planning boards are constrained from approving subdivision plans that the board of health stipulates are not suitable for construction due to public health issues. This review authority vests considerable power in the board of health, but also has the effect of encouraging planning boards to work cooperatively with local health boards to ensure adequate protection of public health.

Board of Health Regulations

The development of health regulations, as provided for in the various sections of Massachusetts General Laws, Chapter 111, can be an extremely effective method of land use management. Although zoning bylaws and subdivision rules and regulations have limited ability to protect water resources, regulations adopted by boards of health can be powerful protective mechanisms. This is due in part to the fact that health regulations can be adopted very quickly, only requiring a majority vote of the board of health.

Because of the extensive protection afforded to land owners through zoning, many communities have opted for regulatory programs administered by boards of health. The urgency of adopting growth controls and the impressive powers that boards of health possess make these boards probably the most effective local institution upon which to base a strategy for land use management. The courts have consistently upheld these powers when they have been challenged, as long as the process is well conceived, logical in its approach, and does not totally deny the use of property. Several examples of effective board of health regulations are discussed below.

Dennis:

State law currently governs the siting and operation of septic systems, requiring setbacks from environmentally sensitive areas. Concerned about the rising number of variances being granted from these regulations, the Dennis Board of Health has defined environmentally sensitive areas to include:

- Land area (whether developed or not) that borders on and is within 100 feet of marshlands, tidal flats, coastal dunes, barrier beaches, coastal banks, coastal beaches and surface water.
- Land area containing subsurface water that is 6 feet or less below natural ground surface elevation.
- Existing or known future water supplies.
- Terrestrial and/or threatened or endangered species.

In environmentally sensitive areas, the Dennis Board of Health rarely grants variances from these septic system regulations.

Brewster:

Brewster requires a water quality report to be submitted to the board of health for all developments that will discharge greater than 2000 gallons per day (GPD) of wastewater. This regulation attempts to address large projects with heavy wastewater discharge flows that will not meet the state review threshold of greater than 10,000 GPD. Proposed projects with a density of less than one unit per two acres are exempt.

Information submitted to the Brewster Board of Health must demonstrate that no significant impact to water resources will occur because of the project. In addition, it must be demonstrated that the nutrient contribution of the proposed project, when added to the existing and potential nutrient level of other developments and acreage within the specific recharge or drainage area, will not result in nutrient levels that exceed the receiving water's critical eutrophic level.

Variances may be granted by the board of health, but the applicant must prove that sewage disposal will not adversely affect, among other uses, any shellfish, or recreational waters. The information required is extensive and amounts to a local environmental impact report.

Bourne:

The Bourne Board of Health prohibits the construction of septic systems in areas of shifting sands (coastal beaches, coastal dunes, barrier beaches, coastal banks). This is to prevent systems from being torn loose during storms and becoming health and safety hazards. In addition, in an attempt to discourage septic systems highly "mounded" above natural ground level in coastal areas, the board of health requires greater than 6 feet of separation between the original ground elevation and groundwater.

A duplicate regulation administered by the Sandwich Board of Health was recently challenged in court. The Superior Court of Barnstable found that the restrictions are a valid exercise of the town's police power to prevent the use of property in a manner that is detrimental to the public's interest. The court also found that the regulations were promulgated in response to identifiable local concerns regarding (1) the installation of septic systems as affecting the public health, and (2) maintenance and preservation of coastal areas.

Non-Regulatory Techniques:

District Improvement Financing/Tax Increment Financing

District Improvement Financing (DIF) and Tax Increment Financing (TIF) are economic tools that promote redevelopment by use of public/private partnerships. TIF offers tax breaks to developers, while DIF channels tax dollars into targeted redevelopment districts. Both of these programs can indirectly help to preserve open space and reduce the pattern of sprawl.

Donations of Land

Landowners can donate a piece of land (as part of a development project or an entire developable parcel) either to the community or to a nonprofit land-holding organization. Donating the land for preservation is advantageous to land owners because of a variety of tax savings. Donations eliminate estate or capital gains taxes and avoid real-estate taxes, insurance, and maintenance costs. The entire value of the donation can be deducted, over time, from federal income tax obligations.

Purchase of Land

Many communities are committed to the acquisition of selected parcels of land deemed so significant to the town's future that it may be willing to purchase them outright at market prices. These acquisition priorities include large tracts of undeveloped land, land within defined water resource areas, land containing unique or rare and endangered wildlife, and land with unique ecological character. There are four variations:

- Sale at fair market value: Sale at the price a buyer is willing to pay a seller to purchase a piece of property.
- Bargain sale: The sale of property below fair market value to a conservation organization or municipality. The difference between fair market value and the reduced price may qualify as a charitable deduction from income taxes.
- Installment sale: Sale that allows the seller to spread the income from the sale of property over several years, thus deferring and, in some cases, reducing income taxes. This allows the buyer greater flexibility in securing funds for acquisition.
- Sale with a reserved life estate: The transfer of property upon the death of the individual landowner. This option allows landowners to sell or donate now, but continue to use the property during their lifetimes or the lifetimes of other members of their immediate families. It also allows the use of tax benefits now and avoids inheritance tax requirements that can lead to the sale of property later.

Tax Deferments

One factor that often pressures individuals into selling their land is the property tax, because it taxes land based on the market price for development, regardless of the land's present use. All New England states currently provide for some degree of reduction in real-estate tax for lands used for conservation. In Massachusetts, open space for forest, agricultural, or recreational uses can receive from 75% to 90% reduction in real-estate taxes. Inheritance tax generally is 50% of value. In land-rich, cash-poor situations, this can lead to the need to sell property at the highest value to settle an estate.

Conservation Easements

An easement is a limited right to use or restrict land owned by someone else. Easements are either positive (rights-of-way) or negative (conservation, scenic) and may take a variety of forms. Negative easements can effectively assist a community in protecting land from development by restricting all or a portion of the property to open-space or limited development uses. The granting of a conservation easement does not involve the transfer of ownership of the land; instead, it means giving up certain development rights of the property. For example, a conservation restriction may limit the number of houses to be built upon a parcel, restrict development to specified types, or specify that portions of the parcel within sensitive areas will remain undeveloped in perpetuity.

Conservation Commission Policies

Local conservation commissions, in their role of implementing the Wetlands Protection Act, have significant land use responsibility. For example, they have the authority to protect critical wetland areas through local initiatives that assert their jurisdiction within the 100 foot buffer zone around wetlands. Conservation commissions can protect sensitive coastal wetlands by requiring strict standards within buffer areas. A buffer zone is extremely important for the protection of both wetland functions and wildlife habitat.

Neither state nor federal government has a setback requirement in its wetland regulations, but towns are permitted to adopt construction setbacks from wetlands. Some towns have adopted wetland setbacks of 25-50 feet and, in the case of Areas of Critical Environmental Concern, 100 ft. Others, such as Falmouth, have adopted regulations requiring new construction to provide at least 25 feet of vegetated buffer to the wetland. Most towns on Buzzards Bay however, do not have standard wetland setbacks, and thus must negotiate buffer zones on a case-by-case basis, and no automatic protection buffer exists.

Major Issues

The biggest challenge municipalities need to overcome is to rewrite laws and rules to better define what kind of new development and redevelopment the town wants, not to define only what is not allowed. Fundamental requirements like minimum road widths, parking space regulations, cluster development, transfer of development rights (TDRs), and changes in zoning need to be rethought to redefine the future character of communities to minimize per capita impacts associated with each new residential unit.

Among these, TDRs face the most obstacles, yet it is also one of the most powerful tools because it offers opportunities to link to and solve other problems such as managing nitrogen loading through trading.

A good summary of the obstacles and challenges offered by TDRs is provided by Hanley-Forde et al.[86] The authors note, "A TDR program, with its inherent goal of compensating landowners, is naturally more politically palatable than typical command and control zoning regulations. However, any kind of land use restriction generates controversy. Municipalities must build community support for the projects. Successful TDR programs cannot be created by the will of an agency. Political legitimacy must be built over time."

Management Approaches

Municipalities have the greatest capacity and responsibility for regulating and managing the impacts of future growth to minimize potential environmental impacts from that growth. Other levels of government need to support municipalities with technical and financial assistance programs, and where appropriate, must also change regulations and laws regulating new growth and redevelopment to both support smart growth principles, and to lead by example.

Regulatory strategies may include revisions to zoning bylaws, general bylaws, and local wetland regulations. However, a vision of smart growth strategies and goals must be included in long-term planning in documents like municipal master plans, open space plans, and municipal stormwater plans[87]. Municipalities, together with their partners need to educate the public of the benefits of smart growth techniques to help them encourage these ideas. Outreach should target developers as well.

Each municipality must decide which smart growth techniques work best for them, and implement those that best protect their critical resource areas and minimize growth impacts on water quality and habitat special to their community. Certain techniques, like cluster zoning, should be universally adopted. Others are more town-specific. These efforts must involve the public because residents must often vote to support these changes. Where resources cross municipal boundaries (e.g., water supply areas), municipalities must think of creative ways of collaborating with neighboring towns.

Transfer of Development Rights (TDRs) and cluster development approaches need to be more widely embraced by municipalities. These approaches should not be cobbled together with density bonus incentives that negate the benefits of the TDR process. For the TDR process to work as desired, municipalities must identify sensitive resource areas (sending areas) and growth centers (receiving areas). Defining these areas is informed by science, but boundaries must also incorporate political and economic concerns. The TDR approach can be adopted through both zoning and general bylaws. This process should include identify boundaries of village growth centers, revising zoning, and planning for appropriate wastewater infrastructure. Receiving areas should be able to accommodate sewering and wastewater treatment goals and recommendations in Action Plan 5 Managing Onsite Wastewater Disposal Systems.

When properly managed, agricultural lands can have less impact on the environment than the same land used for residential or commercial development. For these reasons, existing farms in areas with good agricultural soils should be preserved. Government can help preserve existing farms for continued agricultural uses through tax policies and regulations. In those areas with prime farmland soils, or soils of statewide importance (determined by USDA-NRCS), these can also be protected by the property owner for future generations through the state's Agricultural Preservation Restriction program. This approach is important because areas with good agricultural soils are in limited supply, and it would be unwise to direct growth to these areas through TDRs or other smart

[86] Hanly-Forde, J., G. Homsy, K. Lieberknecht, R. Stone, (no date) Transfer of Development Rights Programs. Using the Market for Compensation and Preservation (no date). At http://www.mildredwarner.org/gov-restructuring/privatization/tdr. Last accessed November 7, 2013.

[87] All Buzzards Bay municipalities have been issued a stormwater management permit by the U.S. EPA that requires the development and implementation of 5-year stormwater management plans as part of the NPDES MS4 stormwater discharge permit. See Action Plan 3 Managing Stormwater Runoff and Promoting LID.

growth approaches. Maps of prime farmland soils should be included in municipal open space plans. Towns and the USDA should work with farmers to enact APRs on these properties.

Municipalities can further protect agricultural lands with buffer zones using mandatory OSRD zoning or other appropriate land use techniques, including a required setback for residential structures of 200 feet from active cranberry bogs. These buffer zones protect residential areas from impacts of agricultural lands (e.g. human exposure from pesticide spray applications), and conversely minimize discharge of pollutants from development onto agricultural lands (e.g. runoff of pollutants).

The Commonwealth of Massachusetts should continue to provide assistance in the implementation of smart growth techniques by local government, and the adoption of those techniques by developers. EEA should be the lead, and the agency needs a continued commitment to this effort. For example, the agency's online Smart Growth Toolkit needs to be updated and better promoted, and training workshops should be held as has been done in the past. Populations have been leaving most cities to build new residences in neighboring towns, causing sprawl. EEA should fund projects through programs like PARCs[88] to both make cities more desirable and livable while at the same time mitigating existing environmental impacts. DEP can implement similar efforts on a statewide basis, and CZM can have parallel elements that focus on issues of development alongshore.

Regional planning or regulatory agencies (SRPEDD and the Cape Cod Commission respectively) should provide technical assistance to communities in promoting smart growth incentives and assist communities in the development of regulatory amendments. In the past, both agencies promoted model bylaw and performance standards, such as how to limit impervious area and nitrogen loading. These regional agencies should encourage towns to work together to develop inter-municipal resource management plans when watersheds or resources span municipal boundaries. Both regional agencies can provide important leadership and direction to the communities when they review state projects or development of regional impact, and it is important that comments on projects filed with the state MEPA office, include the protection of critical resource areas.

Both regional entities should help towns identify where growth centers should be located so that they are of sufficient size and density to make sewering and wastewater treatment with municipal or package wastewater treatment facilities economical over onsite wastewater systems. As a regulatory agency, the Cape Cod Commission is in a better position to work with municipalities to encourage the use of such "growth incentive zones" to establish village centers and TDR programs.

The Buzzards Bay NEP should work with municipalities to develop and implement model bylaws and local plans that incorporate smart growth techniques, such as transit oriented development and traditional neighborhood design as part of TDRs, nitrogen management overlay districts, and transfer of development rights. Specifically NEP staff can work with municipal staff and boards to develop policies, regulations, and bylaws for town meeting or board meetings where applicable. The Buzzards Bay NEP can prepare some of the necessary outreach materials and maps for municipalities and other partners.

The Buzzards Bay Action Committee can be a forum for the exchange of smart growth approaches, through meetings and workshops. Citizen groups must help educate the public and mobilize town meeting support for appropriate local legislation and regulations.

Only one Buzzards Bay town (Bourne) has a state-designated Area of Critical Environmental Concern (ACEC). The Town of Bourne could develop a management plan for the Back River and Pocasset River ACECs, and in that management plan, incorporate LID principles, or use the watershed as sending areas for a TDR process. The state could support such an effort through grants, and by mandating local and regional ACEC management plans as required by existing regulations.

The Buzzards Bay Coalition can play an important role in promoting smart growth through public outreach and education to residents about smart growth techniques, and by providing continuing credit courses for town officials.

Industry groups, like the Massachusetts and Cape Cod Homebuilders Associations should also promote smart growth techniques through training and other education programs. These associations appreciate and understand the benefits of LID and smart growth techniques, including potential financial savings they provide. They need to promote more actively these concepts to their membership and in support of local law and regulation change.

Financial Approaches

Many of the necessary regulatory changes to implement this action plan have negligible cost to government. More importantly, many smart growth approaches also reduce costs to developers and in the end, reduce tax burdens to residents because of lesser infrastructure costs.

Modest technical assistance and outreach programs by the state will cost a few hundred thousand dollars. State grants could assist with the development of open space and municipal master plans. The greatest cost, and

[88] The Parkland Acquisitions and Renovations for Communities grant program ($6.7 million in 2010) and the Gateway City Parks Program ($2.0 million in 2010) are two EEA grant programs focused on urban centers that can be used to leverage local action.

one largely hidden, is the cost to hire professionals to review the large and complex projects to ensure conformance with state and local laws. Often municipal boards already have authority to pass these costs on to the developer, but are often reticent to request the additional review for political reasons.

Monitoring Progress

Measuring the success of this action plan involves tracking the implementation of programmatic measures such as adoption of laws and regulations that achieve the goals of this action plan. Because this action plan attempts to lessen impacts of new development, no environmental outcomes can be tracked to define success. This is because broad measures would be needed to evaluate whether environmental degradation is occurring at a slower rate than without smart growth measures in place, and these environmental measures would need to separate out the effects of environmental restorations projects that may be occurring in the same watershed. Answering these questions is beyond the capabilities of current ecological models and approaches.

Action Plan 5 Managing Onsite Wastewater Disposal Systems

Problem

The preponderance of the use of conventional septic systems poses a threat to many embayments and freshwater ponds in the Buzzards Bay watershed. Failed and inadequate septic systems also remain a source of pathogens contributing to water quality impairments. The 1996 updates to Title 5 required that both new standards and the inspection and replacement of inadequate systems at time of property transfer. These regulations have eliminated many problem systems. However, many properties have not changed hands since 1995, and many inadequate systems remain in place. Moreover, local regulations need to be adopted to address special local environmental needs. This action plan addresses the need for improved and more effective designs for onsite wastewater treatment systems to meet the needs of protecting sensitive areas of Buzzards Bay.

The nutrient impacts of septic systems remain a significant problem, and controlling these eutrophication impacts are addressed in Action Plan 1 Managing Nitrogen Sensitive Embayments. While there will be a push to sewer many more areas in the Buzzards Bay watershed, homes in the less densely developed areas will continue to use onsite septic systems for years to come, and in some cases may need to be upgraded to nitrogen removing septic systems. The increased use of onsite wastewater systems with alternative designs will pose a management challenge for local and state government.

Goal

Goal 5.1. Prevent public health threats and environmental degradation from on-site wastewater disposal systems.

Objectives

Objective 5.1. Enforce the provisions contained in Title 5 regulations such as, siting and design, inspection and upgrades, training, maintenance, mapping and designation of nitrogen sensitive areas, etc.

Objective 5.2. Where special local conditions exist, encourage boards of health to adopt local regulations to ensure and/or improve environmental and public health protection.

Objective 5.3. Improve management and oversight by municipalities of onsite wastewater disposal systems.

Objective 5.4. In areas where advanced nutrient removal is required, encourage community scale alternative technology systems as a preference over individual alternative systems.

Approaches

To meet the goals of this action plan, installed or upgraded onsite systems must meet all state and local regulations. When appropriate, municipalities must adopt local regulations to meet special local needs to protect public health, safety, and the environment. Some of these local requirements could include more stringent setbacks, or accounting for sea level rise in nearshore areas by increasing separation to groundwater.

For watersheds of embayments listed as nitrogen impaired on the state impaired waters list, or where warranted by TMDL, or as part of local Comprehensive Water Management Plans (CWMPs) local government can require the use of nitrogen removal septic systems. Such an approach could include nitrogen discharge standards more stringent than the state specified minimum of 19 ppm. As an interim measure, towns could request that DEP designate nitrogen sensitive embayments pursuant to 310 CMR 15.000, Section 15.215(2).

Costs and Financing

Most of the solutions identified in this action plan have negligible costs to government, although some initiatives would increase the workload for staff, or new staff may be required. Some initiatives, like a regional online innovative system tracking system would likely cost less than $10,000 to create, and may cost $10,000 per town to annually staff thereafter. Management solutions that incorporate the use of innovative onsite treatment systems can add to the costs incurred by developers and property owners, but these costs will need to be evaluated and weighed against the costs of conventional sewering.

Measuring Success

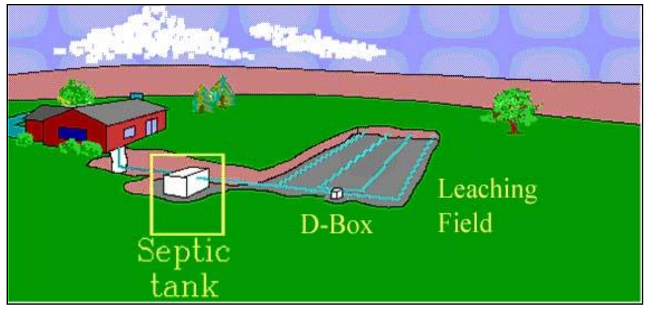
For this action plan, programmatic actions are the chief measure to track progress toward the goals of this action plan. Evaluating the effectiveness of local regulations is subjective, and each municipality must assess its needs and define the most effective regulatory solution.

Background

In the 1991 Buzzards Bay CCMP, on-site wastewater disposal systems (commonly referred to as "septic systems," Figure 62) were identified as a concern to human health and the environment for three primary reasons. First, failed systems were contributing to elevated fecal coliforms in surface waters (especially cesspools), and high densities of functioning systems threatened public health and public and private drinking water supplies. Second, nitrogen from these wastewater disposal systems was unregulated and was often the principal source of eutrophication to many embayments around Buzzards Bay. Third, Title 5 systems were being used as a de facto growth control and land protection tool by many municipalities, but this was an unwise and ineffective strategy, and towns needed to develop land use planning approaches (like zoning) to better manage growth. Twenty-one years later, while there have been many profound changes in the laws and regulations concerning onsite wastewater systems in Massachusetts (some of which were first proposed in the 1991 Buzzards Bay CCMP) these three concerns remain.

In the 1991 CCMP, it was estimated that 43% of the population was served by onsite systems. By 2000, that percentage appears to have grown to 48% of the population and 48% of the residential units served by onsite systems in the Buzzards Bay watershed[89]. This increase appeared to be the result of the fact that between 1990 and 2000, the population increased 8 to 18% in most Buzzards Bay municipalities, and most of this growth occurred in more suburban areas (often on one to two acre lots) outside the sewer service areas served by on-site wastewater systems.

In the 2000s, several communities (notably Wareham, Marion, and Mattapoisett) expanded sewering to densely developed former seasonal village areas. By the 2010 Census data, the percentage of units served by septic systems in the watershed has again declined to 45% percent of the estimated residential units (= 51,870 of 116,205 units), and 43% of the population (108,261 of 249,999 year-round residents in the watersheds)[90]. Maps of current sewer service areas in the watershed are shown in Figure 32 and Figure 63.



Graphic taken from an EPA-Purdue University slideshow about septic system design and installation, and modified by the Buzzards Bay NEP into an online slide show.

Figure 62. A conventional septic system in MA consists of a septic tank, distribution box, and a soil absorption system ("leaching field").

In Massachusetts, the Massachusetts Sanitary Code ("Title 5" or 314 C.M.R.15.00), first promulgated in 1978, established the minimum requirements for the subsurface disposal of sanitary sewage. These regulations established design standards (as opposed to performance standards) for the construction of septic systems. The most important of these design standards limiting the installation of septic systems has been the required setback distances from protected resources, especially the separation of the base of the system to groundwater (4 feet in most soils) and surface waters (50 feet). Another constraint limiting the use of septic systems was the allowable percolation rate of the soil absorption system, where until recently, percolation rates slower than 30 minutes per inch were not allowed.

Boards of health administer most of the elements of these regulations; however, the Massachusetts Department of Environmental Protection must approve any locally approved variances from the regulations. Title 5 represents a minimum standard for onsite wastewater disposal in Massachusetts. Local boards of health may promulgate their own more stringent regulations under Massachusetts Home Rule and Chapter 111, Section 31 of the Massachusetts General Laws, to meet local needs and better protect public health and the environment[91].

[89] The Buzzards Bay NEP has analyzed U.S. 2000 Census GIS data and clipped block information using watershed boundaries and sewered area boundaries developed by the Buzzards Bay NEP (further explanation of this approach is contained in Action Plan 1 Managing Nitrogen Sensitive Embayments. As of the 2000 census, 243,400 persons live in the Buzzards Bay watershed in 108,300 residential units. Of these, our best estimate is that 56,800 units were sewered, with a population of 126,100 persons, and 51,500 units on septic, serving a population of 117,300. This information is not based on parcel level information and should be considered approximate. It also does not include data from portions of Rhode Island included in the Westport River Drainage Basin. Part of the percent increase use of septic systems also results from a population decline in the City of New Bedford where most property is served by sewers.

[90] Buzzards Bay NEP analysis; see the additional detailed explanation of this calculation in Action Plan 1 Managing Nitrogen Sensitive Embayments. The growing discrepancy between the percentage of units (seasonal + vacant + occupied) and percentage of year round residents served by sewer appears to relate to the increased seasonal occupancy rates in some towns in the 2010 Census, notably in Bourne and Falmouth, and some population declines due to economic conditions.

[91] Chapter 111, Section 31, states, "Boards of health may make reasonable health regulations." However, this section also states that municipalities may adopt local regulations that relate to requirements for subsurface disposal of sanitary sewage as specified in the state environmental code. The state environmental code is defined in the 310 CMR 11.00 and 310 CMR 15.00 ("Title 5")

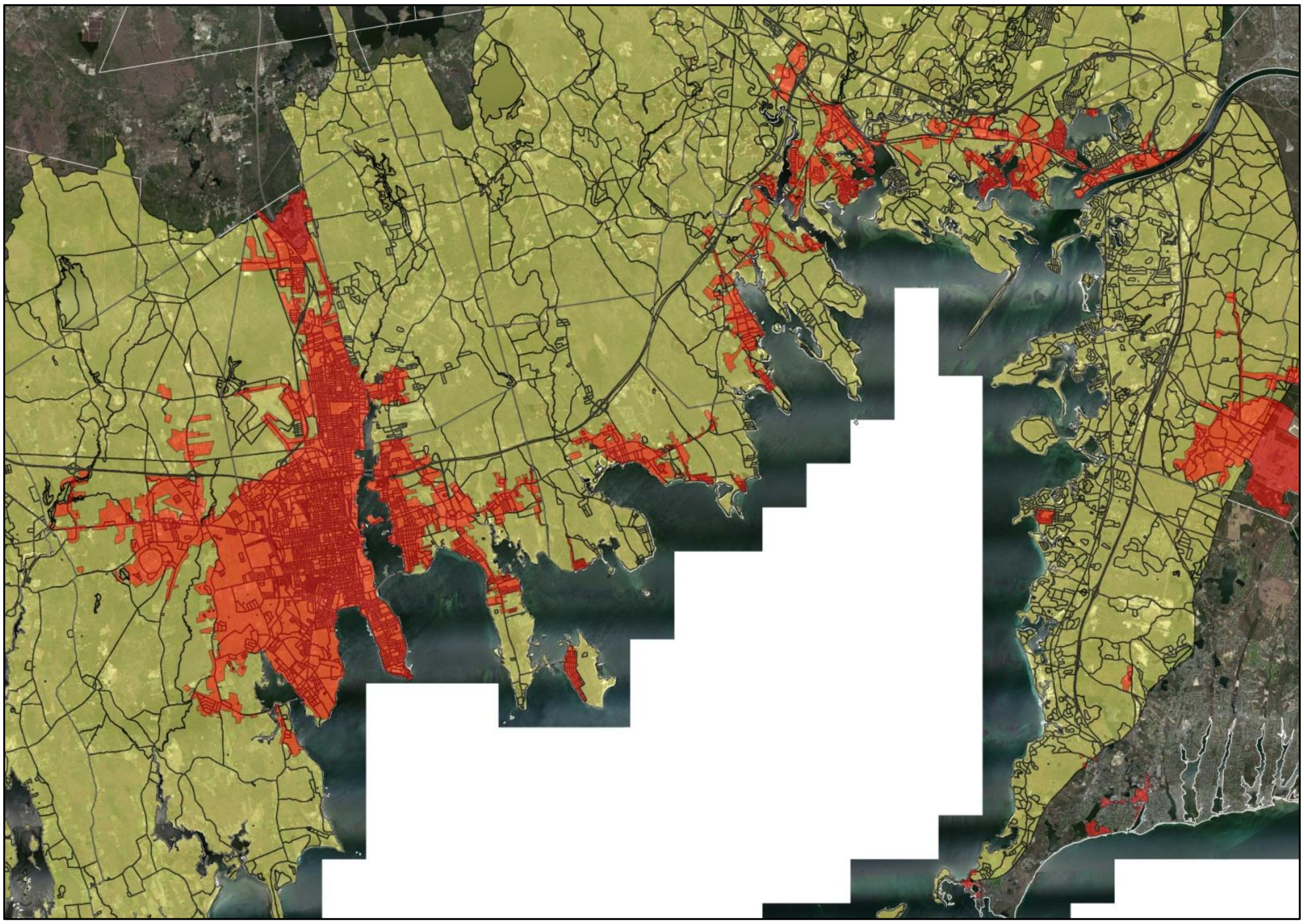


Figure 63. Aerial map (2008) of a portion of Buzzards Bay showing sewered areas (shaded red) and U.S. Census 2010 population blocks (shaded yellow) clipped to the watershed boundary.

These coverages were used to estimate units tied to sewer and septic systems as described by the methodology described in Action Plan 1 Managing Nitrogen Sensitive Embayments. The black lines show the boundaries of the yellow shaded of census blocks, and give a sense of the density of housing units in different parts of the watershed.

While there have been challenges to boards of health, the Massachusetts Supreme Court upheld the rights of the boards of health to enact more stringent local regulations.[92]

Since the inception of Title 5, the scientific understanding of the pathways and impacts of groundwater discharges has grown significantly. This new information, coupled with recommendations from documents like the 1991 Buzzards Bay CCMP, led to a rewrite of the Title 5 regulations (1995) and new rules and policies (1994 and 1996). These rewrites and amendments included many innovations, including recommendations contained in the 1991 Buzzards Bay CCMP. The most important changes to Title 5:

- Required onsite system inspections (and upgrades if necessary to comply with Title 5) whenever a property is transferred, or when there is a change in use or an expansion of the structure.

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regulations. Throughout 310 CMR 15.00 its purpose is clearly stated to "Protect Public Health and Safety and the Environment." For example, in Section 303, wastewater disposal systems "determined by the local Approving Authority or the Department, the system is failing to protect public health and safety and the environment…" Part (2) states: "Any system shall be upgraded upon the order of the Department or the local Approving Authority if either determines that a specific circumstance exists by which any system threatens public health, safety, welfare or the environment or causes or threatens to cause damage to property or creates a nuisance." It is well established that local boards of health can adopt more stringent standards than are allowed in 310 CMR 15.00.

A good explanation of the powers and authorities of the boards of health can be found in this Mass DPH publication: www.mass.gov/eohhs/docs/dph/emergency-prep/board-of-health-manual.pdf.

[92]Decision was in the case Tortorella versus the Board of Health of Bourne 39 Massachusetts Appeals Court 277. Retrieved from masscases.com/cases/app/39/39massappct277.html.

- Placed more emphasis on soils analysis when siting systems, including requiring the use of certified soils inspectors.
- Streamlined and revised the permitting of alternative and innovative onsite wastewater systems.
- Established discharge limits for nitrogen sensitive areas (440 gallons per day per acre for Zone 2 well recharge areas).

From the beginning, the Title 5 regulations attempted principally to control and limit the discharge of human pathogens in the environment. Scientists and managers generally believe these regulations protect human health from pathogenic bacteria. However, there has been on ongoing debate in the scientific community about how far viruses travel in different types of soils, and whether a four-foot separation to groundwater is adequate to address viruses, and how little separation should be allowed for innovative alternative septic systems.

The groundwater separation issue was partly addressed in the 1995 Title 5 rewrite, where a 5-foot separation was required for very fast percolating soils (<2 minutes per inch). Concerns about virus transfer to groundwater have prevented Massachusetts from adopting less than a 4-foot separation to groundwater for alternative advanced treatment septic system designs, except in remedial situations where there may be no alternative.

While the 1994, 1995, and 1996 changes to Title 5 were generally viewed as more protective of the environment and human health, in 2004 DEP again amended the regulations to allow Title 5 systems to be installed in tighter soils, with percolations as slow as 60 minutes per inch. This change was less popular with some communities because it allows the installation of septic systems in lots previously characterized as unbuildable.

Another interesting element of the Title 5 changes in the 1990s, was the fact that the new regulations allowed the use of alternative septic systems to provide enhanced treatment so that certain constraining standards could be waived (e.g., separation to groundwater and size of leaching fields). These alternatives were allowed, in particular, for the retrofit of existing homes and septic systems. Construction on new lots was constrained by requirements for sufficient reserve land in existence to allow for the construction of a conventional septic system should the alternative design septic system fail.

The outcome of all these changes was that Title 5's focus was the protection of public health and the environment, not growth control. These changes pressed municipalities to better utilize other tools, like local zoning bylaws and ordinances, to better plan future growth.

The debate in Massachusetts communities about the role of Title 5, and whether it is adequate to manage broader environmental impacts from septic systems continues today. Despite the pressures and guidance from the state, boards of health continue to adopted local regulations because they feel that Title 5 does not address all the needs of local communities to protect public health and the environment. This has resulted in a myriad of local health regulations in Massachusetts.

Developers, critical of these local health regulations, lobbied for changes in Chapter 111, and have been critical of the entire Home Rule authority in Massachusetts. These concerns were well articulated in a 2002 report discussing barriers to housing development in Massachusetts and are listed below[93].

Process Limitations – Many towns have enacted regulations limiting the time of year soil evaluations and percolation tests are observed.

Oversizing Requirements – Some towns have increased flow allowances as calculated per Title 5 by the use of multipliers, and redefining bedrooms.

Reserve Area Requirements – Some communities have enacted regulations that require expanding setbacks between primary and reserve areas, especially for trench systems, or have required the reserve area be cleared and graded when the primary area is built, or even to be actually constructed to address future fail-

Buzzards Bay Success Story:
SepTrack and Septic System Tracking

In the mid 1990s, the Buzzards Bay NEP took an important step to assist local boards of health in the upgrade of failing or poorly functioning septic systems and the proper long-term maintenance of septic systems through the development of SepTrack. SepTrack was a septic system tracking computer program conceived by the Buzzards Bay NEP and jointly developed with Kyran Research Associates through a contract with Massachusetts Coastal Zone Management.

SepTrack helped boards of health track the operation, maintenance and permitting of septic systems and other health related issues. To support the implementation of SepTrack, the Buzzards Bay NEP, through its municipal grant program, purchased computers for each area board of health. Finally, an intern was hired by the Buzzards Bay NEP to set up and install historic septic system information and current assessor's data in each of the bay towns.

In 1999, to address issues relating to Y2K, the Buzzards NEP paid for SepTrack databases and software upgrades for participating municipalities to ensure adequate operation and performance of the software beyond 2000.

Today, SepTrack is still used by some municipalities, while others have moved onto other database management systems. In 2004, the Town of Bourne hired a contractor to integrate the SepTrack database with a GIS software package to produce maps to track outdated or poorly functioning (frequently pumped) septic systems.

[93] Report of The Governor's Special Commission on Barriers to Housing Development. January 2002. archive.org/details/reportofgovernorss00mass.

ure.

Percolation Rate Limits – Some communities have limited maximum rates to 20 minutes per inch, or the previous 30 minutes per inch. Others disallow sites more rapid than 2 minutes per inch.

Limiting or Prohibiting Mounded Systems – Some communities limit or prohibit the construction of mounded disposal systems by preventing the use of fill to meet the required 4-foot separation to groundwater. Others municipalities require 4 or 6 feet of naturally occurring soils.

Limiting Innovative or Alternative Technology Systems - Some communities have local restrictions on the use of innovative or alternative Title 5 systems.

Prohibiting Shared or Community Systems - Some communities have local restrictions on the use of innovative or alternative Title 5 systems.

Despite the criticism against local health regulations by some sectors, they cannot be overturned without significant changes to state law, including a change in the state constitution to eliminate Home Rule. Because Home Rule is entrenched in so many aspects of municipal law in Massachusetts, and municipalities have resisted loosing such powers in the past, local board of health regulations will likely remain a fixture in the environmental regulatory landscape.

Previous accomplishments toward the 1991 Buzzards Bay CCMP

New regulations and policies by DEP, better local training, expertise, adoption of local health regulations, and increased public awareness have improved Title 5 enforcement and forced the replacement of failed or inadequate onsite wastewater systems. These actions have helped achieve many of the objectives and recommendations in the 1991 Buzzards Bay CCMP.

The establishment of septic system "betterment" programs has been one of the most important contributing factors leading to better septic system management. The current statewide betterment program can be traced to enabling legislation passed in 1995 that was developed by the Buzzards Bay Action Committee. This legislation enabled municipalities to float bonds to help individuals finance septic system upgrades through betterments using low interest long period loans. This work led DEP to establish a similar statewide program in 1997, funded through DEP, making it easier for municipalities to create the revolving accounts necessary to implement local betterments.

However, while betterment programs eliminated many of the financial obstacles preventing septic system upgrades by the homeowner, the single most important factor causing onsite septic system upgrades was the new state requirement adopted in the 1996 Title 5 regulations that required septic system inspections at the time of property transfer. This single regulatory change has resulted in a profound change in compliance with the Title 5 regulations. This is because failed septic systems became a potential financial liability for banks writing mortgages, and this financial risk ensured that lending institutions required compliance with Title 5.

Buzzards Bay Success Story: Massachusetts Alternative Septic System Test Center

In 1998, with a grant from the U.S. EPA, the Buzzards Bay NEP constructed the Massachusetts Alternative Septic System Test Center in partnership with Massachusetts DEP, and Barnstable County (Figure 64). Testing of technologies began in 1999, and in 2001, the first 6 fact sheets were issued of alternative septic system performance compared to a conventional system. In addition, in 2000, the Buzzards Bay NEP began testing for NSF International to establish national nitrogen testing protocols.

Today, the Test Center continues to test new technologies, has established a Research and Development program for vendors, holds training workshops, and has become one of the foremost facilities of its kind in the U.S.

In 2001, the Buzzards Bay NEP turned over the operation of the facility to Barnstable County. The Massachusetts Department of Environmental Protection has also agreed to continue to fund the Test Center and has placed more personnel and emphasis on the approval of alternative septic systems in Massachusetts. Today the Test Center has become nearly financially self-sustaining through grants and the collection of fees from vendors participating in the various testing programs.

Another contributor toward accomplishing many Buzzards Bay CCMP recommendations in this action plan was the fact the Buzzards Bay NEP, DEP, and other state agencies put a considerable amount of staff and financial support through grants to provide boards of health with many tools to help them adequately enforce the regulations. These tools include software for septic system tracking, grants for computers, and equipment, and training on interpreting soil profiles, and other aspects of the regulations. During a period in the 1990s, DEP also hired circuit riders to visit and assist boards of health.

Major Issues

The Title 5 regulations were originally developed to minimize the threat of pathogen discharges to people, groundwater, and surface waters, by minimizing the possible threat of either hydraulic failure of the systems (e.g. breakout of effluent because of a clogged or overwhelmed soil absorption leach field), or through the contamination of ground drinking water because of inadequate treatment of the effluent (filtration) by soils. Not until the 1990s were the cumulative impacts of nutrient (nitrogen and phosphorus) loading from septic systems considered, and the subsequent changes to the state Title 5 regulations have only addressed these latter problems in an imperfect and less than comprehensive way. In the

Figure 64. Photo of the Massachusetts Alternative Septic System Test Center.

The construction of the Massachusetts Alternative Septic System Test Center at the Massachusetts Military Reservation by the Buzzards Bay National Estuary Program, in partnership with Barnstable County Department of Health and the Environment and Massachusetts Department of Environmental Protection, was an important achievement toward implementing key goals and objectives contained in the 1991 Buzzards Bay CCMP onsite wastewater management action plan, including “to promote innovative technology that will reduce nitrogen."Today the facility is operated by Barnstable County Department of Health and the Environment.

two sections below, we address shortcomings and needs associated with both issues.

Pathogen treatment and hydraulic integrity

Three primary constraints govern the placement of a septic system:

1) the elevation of the site above groundwater,

2) the lateral distance between the leaching component of the facility and a point of water use (well, watercourse, surface waters, etc.), and

3) the suitability of the soils or sediments to receive and treat the liquid effluent from the wastewater disposal system.

Title 5 acknowledges the importance of the distance between wastewater discharges and depth of groundwater and the lateral intercepting points of human contact like drinking wells and surface waters. In Title 5 the first two constraints are addressed by the many setback requirements imposed by the regulations, the last constraint is addressed by soil evaluation and percolation test requirements. Debate continues as to whether the existing regulations are adequately or overly protective.

Pathogens in septic tank effluent are removed primarily through two mechanisms in the soil: physical retention or straining, and adsorption onto soil particles. The efficiency of these processes decreases as the moisture in the soil increases and drops drastically if the soil is saturated. For this reason, a minimum separation distance between the bottom of a leaching facility and groundwater has been adopted in most states. In Massachusetts, the minimum allowable distance is 4 ft. Vendors of some alternative technologies have argued that increased performance should allow for decreased separation to ground water. While the state has accepted these variances for remedial work, it has not been allowed for new construction because of uncertainties with viral transport.

The third major consideration in the placement of septic systems is the ability of the soils to allow infiltration of septic wastes. In Massachusetts, suitability is determined by examining a “deep observation hole” and performance of soil percolation tests that are witnessed by a representative of the local board of health. Today, a licensed soil evaluator must also determine the suitability of the site. The purpose of these evaluations is to determine and record the kinds of soil in the proposed leaching area, depth of groundwater elevation, and permeability of the soils. Many boards of health require that these test pits be dug when groundwater is at or near its maximum elevation.

Site evaluators perform percolation tests at the proposed disposal site to determine the ability of the soil to infiltrate wastewater. Under present Massachusetts regulation, any soils with receiving rates slower than 30 minutes per inch are deemed unsuitable for on-site wastewater disposal[94]. In general, the "faster" the soil, the smaller the surface area required for the leaching facility.

The contamination of surface waters from on-site wastewater disposal systems can occur in at least three ways. Perhaps the most obvious public health threat occurs when a system experiences overt failure. Failure occurs when soils can no longer receive septic tank effluent, and sewage levels rise or back-up in the system, often breaking out onto the surface of the ground. This process is often more noticeable during periods when soils are saturated or very wet from heavy rains. When a system is near shore, this sewage, which may contain both bacterial and viral pathogens, can be transported to surface waters via stormwater drainage systems or overland flow. In general, systems experiencing overt failures (pooling of sewage on the surface) are usually pumped out quickly by property owners, but these problems do not always lead to enforcement actions or septic system upgrades unless a complaint is lodged with the municipal boards of health. In some towns, because of the availability of septic system tracking programs, frequent pumpouts have triggered inspections by municipal health agents and resulted in boards of health requiring septic system repair or replacement.

Covert failures may play a more significant role in the pathogen contamination of some embayments surrounding Buzzards Bay. Many on-site systems installed before 1978 had little or no separation from groundwater. Sewage from these systems is discharged directly to the groundwater, without the benefit of filtration through unsaturated soil. These systems are often assumed to be functioning effectively because no visible wastewater appears on the ground surface, but in reality, they are adding pathogens directly to groundwater. Depending on the horizontal distance this contaminated groundwater flows before reaching surface waters, the potential for pathogens to reach coastal waters can be significant.

Another type of covert failure is the problem of overflow pipes. Before the enactment of Title 5, some property owners used these pipes as backups to prevent overt failure of systems. After Title 5 was enacted, these overflow pipes were sometimes illegally installed. These overflow pipes discharged wastewater directly into surface waters, connecting ditches, streams, or wetlands. Through health agent participation in sanitary surveys with the Division of Marine Fisheries, and through other local field evaluations, many of these illegal discharges have been identified and eliminated.

A similar problem has occurred in some municipalities with sewer systems. In some municipalities (Acushnet, Dartmouth, Fairhaven, and New Bedford), household sewer pipes were attached to stormwater pipes instead of municipal sewer lines as was the case. During the late 1990s and 2000s, these communities rented, purchased, or borrowed pipe "creeper cameras" to conduct surveys to identify these illicit connections. Dozens of illicit connections have been identified and eliminated because of these efforts. Today, some overflow pipes undoubtedly still exist, and they need to be eliminated.

The possibility of viral pathogens entering Buzzards Bay from properly designed and installed on-site systems remains a concern, but is the subject of much debate. Research suggests that, although fecal indicator organisms are filtered out adequately in the leaching component of on-site wastewater disposal systems, viruses may pass through the unsaturated soil layer, reach groundwater, and travel great distances. These viruses may be a public health threat to resource areas (aquifer, shellfish area, swimming beach). The presumption remains that the existing Title 5 setback requirements from on-site wastewater disposal systems to private wells, surface water bodies, and other areas are inadequate to provide protection against virus transport.

Cumulative Nutrient Impacts

A properly functioning septic system, installed pursuant to Title 5, is not designed to remove nutrients. A conventional septic system removes less than a third of the nitrogen contained in wastewater through processes in the tank and under the leaching field (Costa et al., 2002). In most MEP TMDL reports completed for Cape Cod, cumulatively septic systems in embayment watersheds typically account for 60 to 80% of controllable watershed loads reaching these estuaries.

In the 1980s and 1990s, state regulations, and many local wetland and health regulations, were amended with language asserting presumption concerning the protectiveness of Title 5. As outlined in the current section Title 5 section 15.003 (1), "in general, full compliance with the provisions of 310 CMR 15.000 is presumed by the Department to be protective of the public health, safety, welfare and the environment." Local wetland bylaws included similar language. In practice, this meant that if a board of health approved a septic system installation, a conservation commission could not reject the system under a wetlands bylaw if it was outside a resource area. This meant that the individual or cumulative impacts of septic systems on the environment could not be addressed through wetlands laws.

[94] This was revised down to 60 minutes per inch in 2004. This rule change made buildable more sites with "tight" soils.

In the 1991 Buzzards Bay CCMP, and in the early 1990s, the Buzzards Bay NEP and others encouraged DEP to amend the regulations to address the cumulative impacts of nutrient discharges from septic systems, limit the use of conventional septic systems in nitrogen sensitive areas, and encourage the permitting of alternative nitrogen removing system designs. In the 1995 to 1998 amendments to Title 5, DEP did address these issues, but only in partial ways. For example, DEP identified drinking water well recharge areas (Zone 2s) as nitrogen sensitive areas, but left open-ended what embayment watersheds were nitrogen sensitive. In these Zone 2 areas, septic systems were limited to 440 gallons per day per acre of conventional septic system effluent. This limit was established in order to prevent exceedance of a 5-ppm nitrate groundwater drinking water limit goal. However, by the 1990s it was already recognized that average groundwater nitrogen concentrations needed to be well below 5-ppm nitrate to protect coastal waters.

DEP never designated any nitrogen sensitive embayment watersheds pursuant to Title 5, and by the late 1990s and early 2000s, DEP made a policy decision that nitrogen discharges would best be established by watershed nitrogen TMDLs that would be recommended by the newly established Massachusetts Estuaries Project. However, even after TMDLs were adopted, the state did not designate any embayments as nitrogen sensitive, or establish any discharge limits per acre, as it was decided that these decisions would be best addressed by municipalities through the local Comprehensive Wastewater Management Plans. It is unclear if municipalities can petition the state to designate an embayment watershed as nitrogen sensitive, but to date, no community has made such a request.

Both the slowness in the completion of watershed nitrogen TMDL reports (see discussion in Action Plan 1 Managing Nitrogen Sensitive Embayments), and the cost of the scale of sewering needed to meet watershed nitrogen TMDLs, has prompted boards in one town (Wareham) to pass then later repeal an article at town meeting requiring nitrogen removing septic systems and no net increases in nitrogen loading for new construction[95]. Since the 1980s, the Town of Falmouth has required the use of nitrogen removal septic systems in locally defined nitrogen sensitive areas, but regulations of this type are fragmentary and do not systematically manage all existing and new sources in a way necessary to achieve a watershed TMDL.

An important criticism on the use of nitrogen removal alternative onsite wastewater systems as a widespread solution to meet watershed nitrogen TMDLs is the fact that Title 5 approved nitrogen reducing septic systems need only meet a 19 ppm standard on effluent discharge. Moreover, a long term study by Barnstable County (Rask et al., 2010; Heufelder et al.2010) found more than 30 percent of samples from these systems exceed the 19 ppm threshold (although it must be added that many systems did far better than 19 ppm, so the average concentration of all systems was close to 14 ppm).

These observations suggest that the use of alternative wastewater systems to meet TMDLS would only be practical if standards that are more stringent are required for onsite system discharges, and a more vigorous tracking and discharge compliance system put in place for hundreds or possibly thousands of onsite systems in a watershed. Currently some alternative technologies can match larger scale centralized nitrogen removal systems efficiencies and discharge 5 ppm nitrogen or less (Heufelder, 2010). Such systems cost $10,000 or more than other types of alternative systems that just meet the 19-ppm state minimum nitrogen discharge standard. Despite the higher costs and management obstacles, some communities on Cape Cod are studying this approach as a possible solution to TMDLs (Barnstable County Wastewater Cost Task Force, 2010).

With respect to phosphorus discharges from septic systems, these discharges primarily affect freshwater systems. Moreover, because of the nature of the iron rich soils in the region, most phosphorus in septic effluent tends to be bound to soil particles with a hundred or few hundred feet of discharges where the water table has aerobic (well oxygenated) conditions. Most regulations for onsite systems that limit phosphorus generally require a specific setback distance from surface waters or vegetated wetlands, and some managers have promoted a 300 feet setback rule of thumb[96]. Only a limited amount of research has been undertaken to evaluate the time to saturate soils with reactive phosphorus from septic plumes and some for example have question if these distances are adequate (Robertson, 2007).

Local Regulations

DEP wrote the Title 5 regulations as minimum standards of protection. In recognition of this fact, some boards of health have adopted supplements to the regulations that offer extra protection to public health and enhance environmental protection. Some coastal communities have been quite aggressive in formulating supplements, but others have made few changes. Most of the Title 5 setback supplements have been developed on a town-by-town basis with little understanding as to why a specific setback was selected.

Local boards of health possess enormous authority to protect public health and the environment. Various sections of Chapter 111 of Massachusetts General Laws

[95] See information posted at: buzzardsbay.org/wareham.htm. Eventually in 2013, the town's Board of Health enacted new regulations requiring all new construction within 500 feet of wetlands and surface waters, and certain retrofits, to use state approved nitrogen reducing onsite systems

[96] See, for example, the Barnstable County septic system training module 3 at: www.learntitle5.org/Module3.PDF.

directs boards of health to examine, and make regulations to protect the public health and safety from all nuisances and causes of sickness, and to destroy, remove, or prevent these nuisances as the case may require. Boards of health may also make other reasonable regulations that they believe are necessary to protect public health and safety. In addition, they have authority to prohibit activities that may result in a nuisance or are harmful to the inhabitants of the town. Some boards of health have used this authority extensively to protect public health and prohibit environmental degradation through far-reaching supplements to Title 5. These decisions have been invariably upheld when challenged in court as long as the regulation was administered fairly.

Management Approaches

Where existing onsite wastewater systems are installed, whether they are conventional passive "Title 5" systems, or an innovative system designed to address a particular environmental need or site limitation, these wastewater treatment systems must be designed, sited, installed, and maintained in a way to best protect the environment. To a large degree, changes in the state's Title 5 regulations managing onsite systems set municipalities on a long-term path to upgrade inadequate and failed septic systems that will achieve the goals of this management plan. To meet the broader goals of this action plan (separate from TMDL limits), where onsite systems are installed or upgraded, municipal regulators must better enforce provisions of the state regulations, and where appropriate, adopt regulations to address special local needs (such as TMDLs).

All boards of health should determine if special local conditions exist which warrant the adoption of local board of health regulations for protection of the environment or public health. While Title 5 represents a good minimum state standard, local regulations are sometimes needed. For example, in 1988, because of concerns of pathogen movement in glacial soils, the Town of Bourne Board of Health required a 150-ft setback requirement for all leaching facilities from a watercourse. The first step for any enhanced local regulation is the identification of local conditions or environmental issues that require a more strict local regulation. The Buzzards Bay NEP can work with local health boards to inventory current local regulations already adopted and the special conditions or issues that warranted these enhanced local regulations.

New TMDLs will result in the expansion of sewers in Buzzards Bay, and the elimination of existing and potential new systems, and will otherwise challenge the notion of the protectiveness of the Title 5 regulations. Where TMDLs are far off, as an interim measure, the state could also designate as nitrogen sensitive areas pursuant to [310 CMR 15.000](), Section 15.215(2). This approach could be applied to watersheds of waters on the 303(d) lists. This approach, however, would do little to mitigate existing discharges. Moreover, the 440 gallons per acre threshold for non-nitrogen removing systems is too high a standard to support most watershed TMDLs, where a far lower standard would be needed. Still, this approach could be also be part of a local strategy where the denser developed parts of the watershed will be sewered, and nitrogen removal onsites are the only financially practical solution in areas with large acre zoning. Such a requirement would impose nitrogen-loading limits for Chapter 40B projects, which are currently exempt from any local nitrogen regulations.

Where TMDLs have not yet been adopted, in watersheds to embayments with significant eutrophication problems, adopting other interim local regulations limiting nitrogen discharge from new homes can be considered. Installation of alternative design onsite systems with advanced nitrogen removal (e.g. < 10 ppm), or required shared community wastewater systems with advanced nitrogen removal, could be considered as an option if sewering these areas are not viable (e.g. areas zoned greater that one acre may be prohibitively expensive to sewer), or where sewering an area may be decades away. In these areas, shared or community scale alternative systems should be encouraged over individual alternative systems because of the economy of scale for operation, maintenance, and oversight costs.

If a municipality desires to require the use of nitrogen removal onsite systems as part of a local strategy to comply with a nitrogen TMDL, the health board could adopt local regulations that require nitrogen removal systems with performances superior to the state's minimum standard of 19 ppm. For such an approach to work, the municipality must implement a reporting program that builds upon and fortifies existing state requirements for operation and maintenance agreements and monitoring. Municipalities can take measures to ensure that all those reports submitted to the state, are also submitted to the municipality, and to ensure that deed restrictions identifying onsite systems are also recorded in the county deeds office as required by 310 CMR 15.287. Such regulations would also need to include mechanisms to ensure compliance with the local law. State testing and O&M requirements for alternative systems generally only apply to provisional or pilot systems undergoing state review or required under a state regulation. Locally required alternative systems with "general use" certification do not have this level of state oversight or required monitoring, so local monitoring requirements must be defined to meet local regulation needs.

Enhanced tracking and record keeping of alternative design systems is a burden on municipal staff time. The workload can be ameliorated by an online operator based self-reporting system where the licensed operator reports the information into a database. The online tracking software can generate alerts to health agents and property owners when O&M agreements lapse, or if systems are not properly reporting. This approach has been adopted by Barnstable County that has a full-time staff person overseeing the report or operation and monitoring of more than 3000 alternative design systems installed in 12 municipalities on Cape Cod.

Rather than each Buzzards Bay town outside of Barnstable County adopting its own alternative onsite tracking system, Buzzards Bay municipalities could adopt a regional web-based tracking program for innovative and alternative wastewater technologies and community systems to ensure their proper operation and maintenance. It may be appropriate for this effort to include a web-based system.

Municipalities could require designer certification for all innovative and alternative designs systems, and for all wastewater systems designed to accommodate greater than 2,000 gallons per day. This is important because municipal health agents do not have the necessary expertise to evaluate all the possible alternative septic system designs. Local regulations can also allow boards of health to hire outside expertise to review large, or innovative and alternative septic system designs at the proponent's expense. This may be an important solution in situations where the health agent is not a registered sanitarian, or the agent does not have the expertise to review infrequently encountered systems.

In nearshore areas that will be affected by sea level rise, a local regulation could require an increased separation to groundwater (5 feet instead of 4 feet) to account for a corresponding increase in groundwater potentially caused by sea level rise within the life of the system. State regulations now require the 5-foot setback for very fast soils that are common to some, but not all beach areas. Such a 5-foot setback to groundwater is consistent with a 1-foot sea level rise in the next 50 years, the practical maximum life expectancy for any onsite system.

Financial Approaches

Most of the solutions identified in this action plan have negligible costs to government, although some initiatives would increase the workload for staff, or new staff may be required. Some initiatives, like a regional online innovative system tracking system would likely cost less than $10,000 to create, and may cost $10,000 per town annually to staff thereafter. Management solutions that incorporate the use of innovative onsite treatment systems can add to the costs incurred by developers and property owners, but these costs will need to be evaluated and weighed against the costs of conventional sewering.

Monitoring Progress

For this action plan, programmatic actions are the chief measure to track progress toward the goals of this action plan. Some of those actions, like the type of local regulations needed, are subjective, and each municipality must assess its needs and the most effective solution. Long-term success will eventually contribute to improved water quality and habitat restoration.

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Action Plan 6 Managing Impacts from Boating, Marinas, and Moorings

Problem[97]

One of the significant accomplishments of the Buzzards Bay Action Committee, on behalf of the watershed municipalities, and with technical assistance from the Buzzards Bay NEP, was the designation of Buzzards Bay as a No Discharge Area for boat sewage in 2000, the first large area to be designated in Massachusetts. However, boats, boat moorings, and marinas can still adversely affect water quality and habitats of Buzzards Bay. These impacts are most pronounced where boat density is greatest or where there are sensitive resources. Boat use and maintenance, and the infrastructure to support those activities, all have potential impacts associated with the release of contaminants, and through physical alterations like propeller wash and anchor chain scour, and through shading of the bottom. Some harbors in Buzzards Bay have more than 1000 moorings. Mooring chains scour the bottom, remove eelgrass, and destroy habitat for benthic fauna. These chains, bouncing on the bottom with waves, resuspend bottom sediments greatly reducing water clarity that can shade out eelgrass beds over large areas and elevate bacteria levels. Some marinas have illicit discharges associated with boat cleaning operations, and 95% of the marinas in Buzzards Bay have not complied with EPA's Multi-Sector General Permit for managing stormwater discharges. Education is needed about the broader impacts associated with boats, moorings and marinas and how they can be minimized.

Goals

Goal 6.1. Eliminate the discharge of wastewater from all boats in Buzzards Bay.

Goal 6.2. Eliminate or minimize impacts of discharges from marina operations.

Goal 6.3. Eliminate adverse environmental impacts associated with mooring fields.

Objectives

Objective 6.1. To ensure there is an adequate number of pumpout facilities in Buzzards Bay.

Objective 6.2. To promote the use of pumpout facilities by educating boaters, making facilities more accessible, and enforcing the regulations.

Objective 6.3. Achieve full compliance of marinas with the Phase II stormwater and MSGP discharge permits.

Objective 6.4. Ensure compliance of marina power washing activities with applicable state and federal laws.

Objective 6.5. Deploy mooring systems that minimize environmental impacts to habitat and water quality.

Approaches

Goals can be achieved through education efforts, such as the distribution of newsletters, factsheets, and posting of notices or signs. Improved compliance by marinas with the MSGP stormwater permit program will require notification and enforcement by the U.S. EPA, with supporting technical assistance from DEP and CZM. Marina operators must also cease discharges associated with bottom cleaning operations on their properties that result in direct discharges.

Eventually most conventional mooring anchors should be replaced with helical anchors and elastic rodes. Requirements for mooring gear replacement to environmentally friendly types can be mandated through regulations or policies and could be phased in over time to minimize hardships. For example, the Town of Marion now requires helical anchor systems only on vessels over 25 feet (but elastic rodes are not yet required). Environmental moorings have an added benefit of increased boat densities, the same number of boats can be confined to a smaller area of the estuary. Municipalities can lead by example by replacing all municipal owned moorings with these environmentally beneficial mooring systems.

Costs and Financing

Many elements of this action plan require modest or negligible expenditures of public funds, as most relate to education, adoption of regulations, or better enforcement of existing regulations. Most of the necessary flyers and notices can be produced in-house by towns, and disseminated with mooring permits and through marinas.

The most expensive element of this action plan is born by boat owners, and that is the cost of the new mooring system. While these environmentally friendly mooring systems are somewhat higher in price to a conventional mooring system ($4-7,000), unless the mooring is new, this is an added cost. Mooring upgrades can be phased in over a period of years. Municipalities should pursue funding for municipal owned mooring replacements from habitat restoration programs.

Measuring Success

The success of this action plan will be documented principally with programmatic actions, the volume of boat waste collected, regulatory compliance, and the extent of use of environmentally friendly moorings.

[97] This action plan differs considerably from the boat sewage action plan in the 1991 CCMP. It only addresses physical impacts and pollutant discharges associated with boats, marinas, and mooring fields. Broader impacts associated with managing development of the waterfront, managing usages of the watersheet, and watersheet zoning are addressed in Action Plan 6 Managing Impacts from Boating, Marinas, and Moorings. Some boating impacts are also addressed in Action Plan 17 Preventing Oil Pollution.

Background[98]

During the summer, Buzzards Bay is home to more than 12,000 docked or moored boats[99]. During a peak summer holiday or boat event, with the addition of day launches, more than 15,000 vessels are in the bay. Based on boat registration data, perhaps 1,850 of these are commercial or government operated vessels (principally coastal or nearshore fishing boats, ferries and municipal craft), with the remainder being recreation vessels. More than 33 public and private marinas, 58 public boat ramps, 6,340 moorings, and more than 1,000 docks serve these vessels. The number of docks, moorings, and boats in Buzzards Bay continues to grow. In some harbors, mooring fields cover large areas and may exceed 1,000 anchorages (Figure 65).

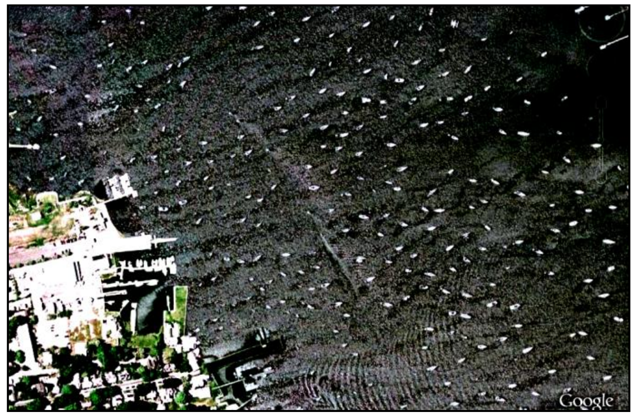

Figure 65. Oblique aerial photograph of a portion of a mooring field in Sippican Harbor, Marion, MA.

As illustrated by this aerial photograph, this harbor has one of the largest and densest mooring fields in Buzzards Bay

While boating is an important part of the recreational and commercial use of Buzzards Bay, the cumulative impacts of these activities together with impacts from the construction and maintenance of the supporting infrastructure, and other recreational activities like jet and water skiing, can affect the water quality, habitat, and living resources of Buzzards Bay. The illicit discharge of sanitary wastes was a concern identified in the 1991 Buzzards Bay CCMP. This concern led to the designation of Buzzards Bay as a No Discharge Area for boat sewage in 2000, the first large area to be designated in Massachusetts[100]. One of the most conspicuous boating impacts is the effects of propeller wash from the operation of boats at too high a speed in shallow areas. Certainly direct impacts occur when navigational channels are dredged or maintained. However, the cumulative impacts of less conspicuous activities have an important, if not greater, impact on water quality. These cumulative impacts result from varied boating activities including boat cleaning operations, illegal discharge of sanitary waste or contaminated bilge water, fueling spills and engine discharges, and general maintenance activities at public and private marinas. Shading by boats and docks can block sunlight from eelgrass and algae, changing bottom communities.

Besides these effects, more important are impacts from chain scour and sediment resuspension that are caused by traditional mooring systems. Traditional moorings systems consist of a large weight or anchor connected to a chain that drags on the bottom as the boat shifts with changing tide and wind direction and bounces up and down on the bottom with each wave. The chains scour the bottom destroying eelgrass and animal communities. They also suspend sediments causing increased turbidity, which causes eelgrass loss beyond the footprint of the mooring. Chain scour impacts can often be discerned from aerial photographs (Figure 66 middle).

This goal of this action plan is to minimize these impacts. Those impacts associated with fueling and hydrocarbon discharges are included in the *Reducing Oil Pollution* action plan.

Major Issues

There are several issues associated with pollution discharges and the operations of marinas[101]. Most marinas include impervious surfaces or town conveyance systems that discharge stormwater to surface waters. These marinas require a stormwater NPDES permit under the multi-sector general permit (MSGP) required for all “industrial” classified facilities with stormwater permits. Through this permit program, marina operators are required to implement best management practices to minimize stormwater volume and contaminants in the stormwater.

[98] Text from the *Massachusetts Clean Marina Guide* prepared by Steve McKenna and Robin Lacey of Massachusetts Coastal Zone Management provided the basis of large portions of this new action plan.

[99] This information is based on mooring and slip numbers provided by the towns. In 2006, the Massachusetts Division of Marine Fisheries reported that there were 23,231 boats registered to residents of Buzzards Bay watershed municipalities. Many owners trailer these boats to coastal waters. Owners of many larger recreational vessels register their boats in other states (like Delaware) for tax purposes, but moor them in Buzzards Bay. For these reasons boat registration data, while useful for capturing the public’s interest in boating is less useful for defining actual boat activity in Buzzards Bay. However, 1,769 of these registered vessels are registered as commercial vessels that are most likely used on Buzzards Bay a large amount of time each year.

[100] The application was submitted by the Buzzards Bay Action Committee on behalf of Buzzards Bay municipalities. The Buzzards Bay NEP 2000 press release is retrieved from: buzzardsbay.org/ndapress.htm.

[101] EPA defines a marina as any facility that contains 10 or more slips, piers where 10 or more boats may tie up, or any facility where a boat for hire is docked; boat maintenance or repair yards that are adjacent to the water; any federal, state, or local facility that involves recreational boat maintenance or repair that is on or adjacent to the water; public or commercial boat ramps; any residential or planned community marina with 10 or more slips; and any mooring field where 10 or more boats are moored.

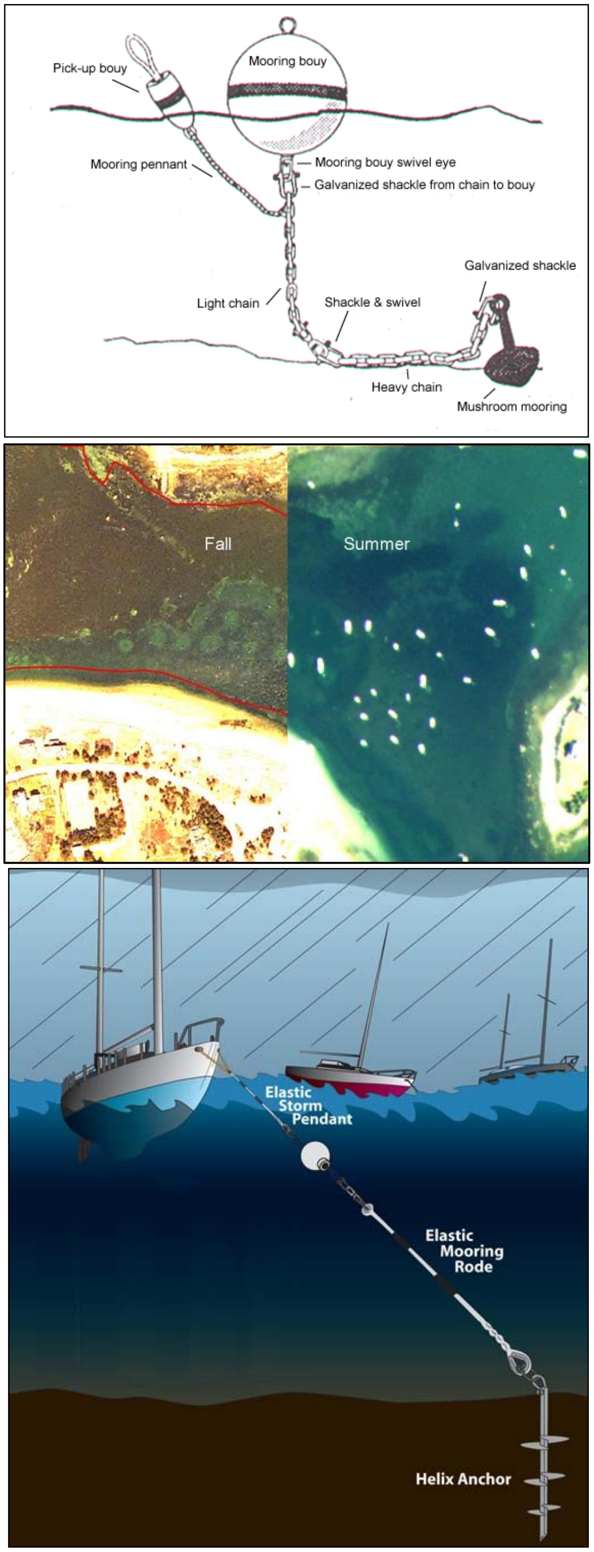

Figure 66. Impacts of traditional anchor systems and benefits of alternative systems.

Traditional moorings (top) have chains that scour the bottom destroying eelgrass beds (middle, mooring scars in West Falmouth Harbor) and suspending bottom sediments that make the water turbid, and shade out eelgrass beds and release nutrients. New anchoring systems consisting of elastic rodes and helical anchors (bottom) eliminate these problems, have only slightly higher costs, and have the additional benefit of allowing denser mooring fields. Graphic courtesy of boatmoorings.com.

Figure 67. Pressure washing at a marina with a water collection and treatment system.

It is believed that less than 5% of marinas in Massachusetts have complied with this EPA permit program.

Separate from the stormwater issues are discharges from power washing boats to remove debris and fouling organisms. Most boat bottoms have anti-fouling paints to prevent biological growth that can reduce boat speed and fuel economy. This bottom paint typically contains high concentrations of copper as its active ingredient.

Copper is a very effective deterrent to bottom fouling, however it is harmful to marine organisms. Even with a coat of bottom paint, most vessels need to have their hulls cleaned once a year to remove any biological growth. The most popular and efficient method is to power or pressure-wash the hull once the boat is hauled from the water using a high-pressure stream of water over the boat bottom while the boat is situated over a travel-lift well or on a boat ramp (Figure 67). The resulting wash water contains fouling organisms and paint chips, and is usually discharged directly into the surface waters or allowed to soak into the ground.

This wastewater, if not properly managed, may contaminate surface water and groundwater. It is also considered a contaminated discharge and requires either a EPA NPDES permit for a stormwater discharge to surface waters, or a DEP groundwater discharge permit from the state. Marina operators cannot discharge this flow to a septic system. These discharges require a wastewater recycling system, or a system to remove contaminates to permit authorized levels. As of 2005, only one marina in Massachusetts has obtained the necessary permits to discharge its power washing operation to a municipal sewer system. Most marinas have chosen to install a closed loop systems that does not require operational permits. Massachusetts CZM and the Buzzards Bay NEP have programs underway to educate marina operators about the need to comply with these permit programs.

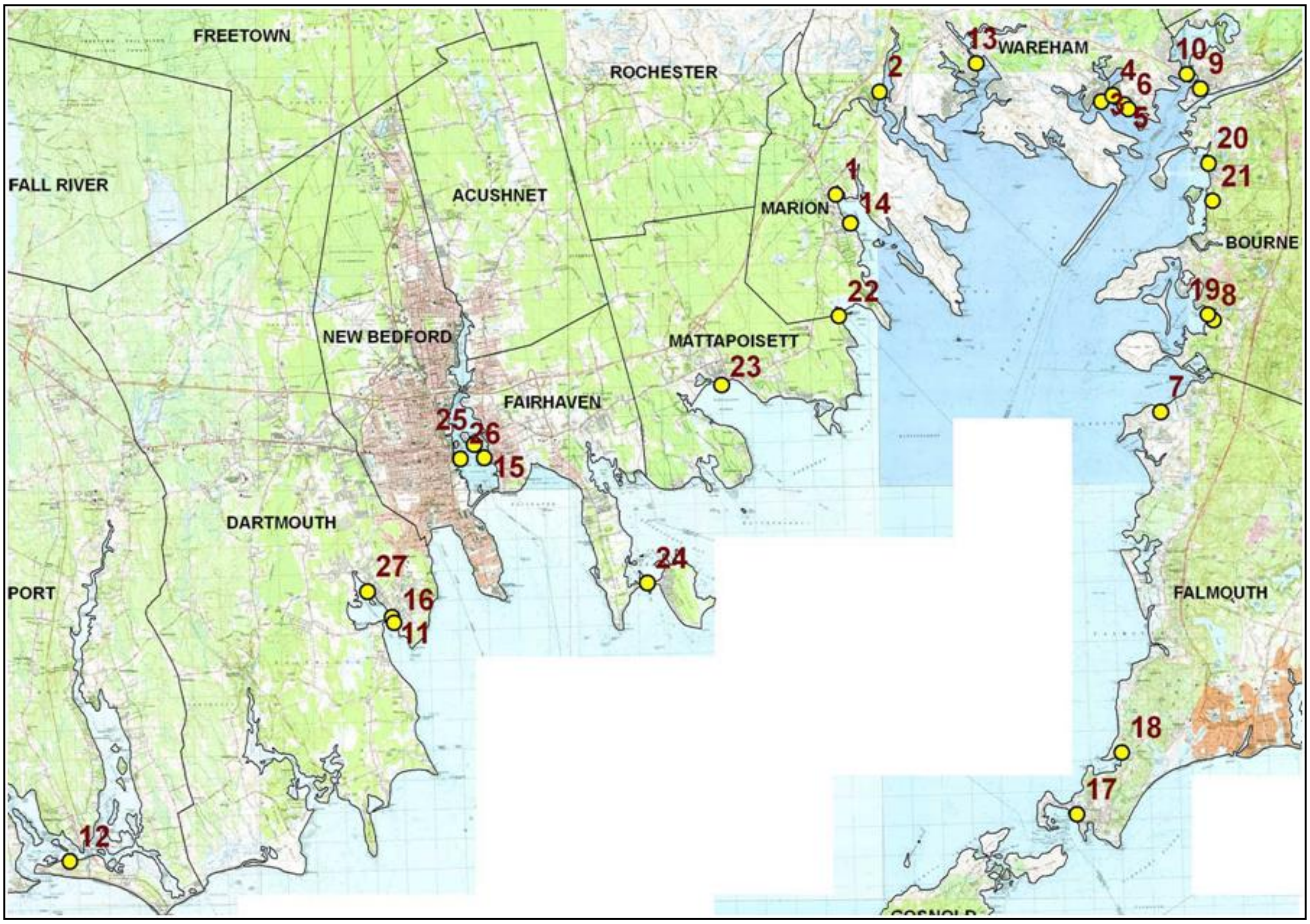

Figure 68. Location of boat pumpouts in Buzzards Bay.

Key: 1: Burr Brothers, 2 Wareham Boat Yard, 3: Onset Town Pier, 4: Stonebridge Marina, 5: Pt. Independence Yacht Club, 6: Onset Bay Marina, 7: Brewers Fiddler Cove, 8: Parker's Boat Yard, 9: Taylors Point Marina, 10: Continental Marina, 11: North Side Bridge Town Dock, 12: Westport Point-Town Dock, 13: Town Facility at Warr's, 14: Island Wharf, 15: Fairhaven Pumpout, 16: Davis and Tripps, 17: Woods Hole Marine, 18: Quisset Harbor Boatyard, 19: Kingman Marine, 2: Wareham Boat Yard, 20: Pocasset River - town op, 21: Monument Beach Marina, 22: Mattapoisett Boat Yard, 23: Mattapoisett Town Dock, 24: Earl's Marina, 25: Popes Island Marina, 26: State Pier Facility, 27: Padanaram Harbor Boat. Not shown: Coalition Bay Keeper serves Cuttyhunk Harbor on Gosnold.

Fueling spills at marinas remain a problematic issue, but these problems are addressed in Action Plan 17 Preventing Oil Pollutio.

Sanitary Waste Issues

Perhaps 1,000 or more of the moored boats in Buzzards Bay have installed marine heads (toilets)[102]. Some smaller vessels use portable heads. Discharges from these marine sanitary devices were an area of concern in the 1991 Buzzards Bay CCMP and were the focus of recommendations in the Boat Sewage action plan. Most of the recommendations in this action plan were fulfilled, including the 1994 designation of Buzzards Bay as a boat no sanitary wastewater discharge area (NDA). Although this action plan was a success, some additional recommendations have been developed to help improve compliance with the boat no discharge area designation.

When traveling in NDA waters, boaters with Type I or Type II MSDs must do one of the following: 1) close the seacock and remove the handle 2) fix the seacock in the closed position with a padlock or non-releasable wire-tie 3) lock the door to the space enclosing the toilet with a padlock or door handle key lock. Those with Type

[102] Boats of 65 feet or less must be serviced by one of three types of marine sanitation devices (MSDs). Type I and Type II MSDs macerate and disinfect waste with chlorine, formaldehyde or other disinfectants. The Type I MSD treats the waste to a level not to exceed 1000 fecal coliform/100 ml and the Type II MSD treats to a level not to exceed 200 fecal coliform/100 ml and 150 mg/l suspended solids. Type III MSDs are holding tanks to prevent discharge of sewage near shore. These systems typically use formaldehyde, alcohol, or both, primarily to deodorize waste while it is stored in the holding tank. Boats larger than 65 feet must use Type II or Type III MSDs. Types I and II MSDs are permitted under the FWPCAA to discharge into all coastal waters. Type III MSDs are fitted with piping to enable sewage discharge, but this discharge is prohibited in marine waters within 3 miles of shore or within the territorial sea, which includes all of Buzzards Bay.

III MSDs (holding tanks) must secure these in one of the following ways: 1) close each valve leading to an overboard discharge 2) padlock each valve in the closed position 3) use a non-releasable wire-tie to hold each valve leading to an overboard discharge in the closed position. The U.S. Coast Guard must approve the approach of securing MSDs within NDA waters.

Boater compliance and government enforcement of boat no discharge area designations remains problematic. As required in the NDA discharge designation, adequate pumpout facilities are found in Buzzards Bay (Figure 68), but certainly additional ones are needed for at least two harbors: Cuttyhunk, and West Falmouth. The Federal Water Pollution Control Act Amendments of 1972 (FWPCAA) authorized the Coast Guard to regulate marine head discharges from vessels with installed heads, and has the authority to enforce the no-discharge designations. However, the Coast Guard never had adequate personnel to achieve a high level of compliance with the law. Changes in laws and regulations now enable the Commonwealth of Massachusetts with enforcing the restrictions of NDAs. In the 2008, the Massachusetts legislature amended Chapters 21A and 90B of the General Laws to allow for fines of up to $2,000 for discharge violations in NDAs.[103] These amendments now give the authority to issue the fine to the Director of the Massachusetts Environmental Police and all that serve under him, which includes environmental police officers, harbormasters, fish and game wardens and police officers.

Marine heads installed on boats of 65 feet or less must be serviced by one of three types of marine sanitation devices (MSDs). Type I and Type II MSDs macerate and disinfect waste with chlorine, formaldehyde or other disinfectants. The Type I MSD treats the waste to a level not to exceed 1000 fecal coliform/100 ml and the Type II MSD treats to a level not to exceed 200 fecal coliform/100 ml and 150 mg/l suspended solids. Type III MSDs are holding tanks to prevent discharge of sewage near shore. These systems typically use formaldehyde, alcohol, or both, primarily to deodorize waste while it is stored in the holding tank. Boats larger than 65 feet must use Type II or Type III MSDs. Types I and II MSDs are permitted under the FWPCAA to discharge into all coastal waters. Type III MSDs are fitted with piping to enable sewage discharge, but this discharge is prohibited in marine waters within 3 miles of shore or within the territorial sea, which includes all of Buzzards Bay. Nonetheless, it is widely believed that discharge near-shore and in harbors does occur. Several harbormasters and boat dealers believe that Type I and Type II systems are not widely sold today and that most new boats are installed with Type III MSDs.

[103] See Chapter 495 of the Acts of 2008.

Mooring Field Issues

As noted above, dense and expansive mooring fields degrade water quality and bottom habitat of Buzzards Bay. Some harbors, like Apponagansett Bay and Sippican Harbor have more than 1,500 boats on moorings and slips. Conventional mooring blocks may have a bottom area of 16 square feet or more. Chains attached to mooring weights scour eelgrass from the bottom. These chains also bounce up and down off the bottom resuspending bottom sediments, greatly reducing water clarity that in turn can shade out eelgrass beds and elevate bacterial levels.

One solution to this problem is to install alternative mooring systems that have less environmental impacts, and where possible divert demand for new moorings to more compact marina facilities. Alternative mooring systems include helical anchors twisted into the bottom connected to boats by elastic cords. This mooring system is pragmatic for Buzzards Bay because the tidal range is less than 4 feet and the generally dense layer of fine sediments found in our embayments. Some Massachusetts communities, like the Town of Marion already require helical anchors.[104] Similar systems have already been installed in major U.S. harbors including Santa Monica.

Other Management Issues

Problems associated with houseboats and other waterfront management issues, as well as issues associated with dredging, and the beneficial use of dredged materials, are discussed in Action Plan 15 Managing Coastal Watersheets, Tidelands, and the Waterfront. Some boating impacts are also addressed in Action Plan 17 Preventing Oil Pollutio.

Management Approaches

Each town should determine whether it has sufficient pumpout facilities. For example, the Town of Gosnold, which is potentially served by the Coalition’s Baykeeper vessel, has sought funding to build a facility at its docks. Other towns should maintain and review sewage pumpout records of boats, and query boat owners to ascertain whether they have an adequate number of pumpout facilities to serve recreational boaters. Such tracking can also be used to evaluate the effectiveness of NDA designations and evaluate outreach efforts. Funds remain available from various state and federal sources to meet municipal needs, and local record keeping and boating activity can help direct state and federal funds to where there is the greatest need.

If local officials do not believe that compliance with the Buzzards Bay NDA is adequate, harbormasters could

[104] Owners of vessels longer than 25 feet must meet the 2002-approved requirement to install helical anchors. As of 2011 there were 1570 moorings in the Town of Marion of which approximately 1200 had helical moorings. Elastic rodes are not required by the Marion regulations.

implement programs such as seal heads of tank valves while in harbor, or place dye tablets in the heads, and where appropriate, issue non-criminal citations for failure to secure the MSD, and criminal fines for actual discharges.

With respect to mooring upgrades, towns should consider adopting regulations or implement programs to replace conventional mooring systems with those that are less injurious to the environment, such as those with a helical anchor and elastic cord systems. In most cases, such a program would need to be phased in. The use of these innovative mooring systems is needed most in shallow and sensitive environmental areas, such as bays with eelgrass or fine mud bottoms. Municipalities could lead by example by using these anchor systems for their own moorings.

With respect to discharges associated with marinas, municipalities, the U.S. EPA and the Buzzards Bay NEP should provide informational materials, and guidance to improve compliance of marinas with their MSGP NPDES stormwater permit program. Current compliance rates of marinas with the MSGP stormwater NPDES permit program are low. DEP and CZM should also work with marina operators to ensure that pressure washing and boat-cleaning operations do not discharge to surface waters. The Buzzards Bay NEP could offer marinas free planning and technical assistance for stormwater management. The EPA has also previously expressed an interest in conducting a joint educational mailing with the Buzzards Bay NEP to address these issues. Even with a robust technical assistance program, compliance with certain regulatory programs may take years without some enforcement action by state and federal agencies. In some cases, businesses might require private or public (SRF) loans to meet pollution discharge limits.

Financial Approaches

Many elements of this action plan require modest or negligible expenditures of public funds, as most relate to education, adoption of regulations, or better enforcement of existing regulations. Most of the necessary flyers and notices can be produced in-house by towns, and disseminated with mooring permits and through marinas. There will be a more substantial cost for private entities to comply with state and federal pollution discharge regulations, and this will need to be met by private or public (SRF) loans.

The most cumulatively expensive element of this action plan is born by boat owners, and that is the cost of the new mooring system. While these environmentally friendly mooring systems are somewhat higher in price ($4-7,000) to a conventional mooring system ($2-4,000 for comparable vessels), unless the mooring is new, this is an appreciable added cost for replacements. Such mooring upgrades, however, can be phased in over a period of years as moorings ownerships are transferred. Municipalities should pursue funding for municipal owned mooring replacements from habitat restoration programs.

Monitoring Progress

The success of this action plan will be documented principally with programmatic actions, the volume of boat waste collected, regulatory compliance, and the extent of use of environmentally friendly moorings. Long-term benefits can be documented by recovery of eelgrass beds in those areas where eelgrass is adversely affected by conventional moorings.

Table 23. Boats registered in Buzzards Bay municipalities. Data from Massachusetts Environmental Police as of 2008.

Municipality/Boat Size:	**<16'**	**16'-25'**	**26'-39'**	**40'-65'**	**Over 65'**	**all Boats**	**est. MSDs[2]**
Westport	659	789	109	6	0	1,563	218
Dartmouth	496	603	116	3	0	1,218	182
New Bedford	726	571	66	10	0	1,373	157
Acushnet	196	106	9	0	0	311	26
Fairhaven	409	511	184	11	0	1,115	205
Mattapoisett	371	341	127		0	839	132
Marion	479	353	119	12	1	964	143
Wareham	809	1,112	194	6	0	2,121	325
Bourne	922	1,290	307	12	1	2,532	425
Falmouth[1] (BB only)	369	533	119	5	0	1,026	171
Gosnold	30	61	10	0	0	101	17
Totals	5,466	6,270	1,360	65	2	13,163	2,001

[1] For this table, 25% of boats registered in Falmouth were assumed to be on Buzzards Bay.

[2] The actual number is not known. For this table, the numbers of MSDs were estimated based on these assumptions: 20% of boats in the 16-25' range, 50% in the 26-39 foot range, and 100% for boats 40 feet and over.

Table 24. Moorings and slips in Buzzards Bay embayments and towns data collected from various source circa 2004-2006.

Town	Bay	Moorings	Slips	Combined
Bourne	Buttermilk Bay	162	299	461
	Canal: Gray Gables	29	3	32
	Hen Cove	232	6	238
	Phinneys Harbor	327	70	397
	Pocasset Harbor	201	8	209
	Pocasset River	88	63	151
	Red Brook Harbor	546	278	824
	Squeteague Harbor	70	11	81
	Wings Cove	23	1	24
Bourne Summary		1678	739	2417
Dartmouth	Apponagansett Bay	810	270	1080
	Clarks Cove	30	30	60
	Little River	10	0	10
	Slocums River	30	0	30
Dartmouth Summary		880	300	1180
Fairhaven	East Cove, West Island	22	0	22
	Little Bay	10	0	10
	Nasketucket Bay	60	85	145
	Nasketucket Bay-Seaview Ave	13	0	13
	New Bedford Inner Harbor	213	409	622
Fairhaven Summary		318	494	812
Falmouth	Fiddlers Cove	0	120	120
	Megansett	138	0	138
	Quissett Harbor	240	0	240
	Rands Canal	15	0	15
	West Falmouth Harbor	348	0	348
	Wild Harbor	109	0	109
Falmouth Summary		850	120	970
Gosnold	Cuttyhunk Harbor	135	46	181
	Cuttyhunk Pond	61	0	61
	Hadley Harbor	18	0	18
	Robinson’s Hole/Nash. Harbor	4	0	4
Gosnold Summary		218	46	264
Marion	Aucoot Cove	17	0	17
	Blankenship Cove	48	0	48
	Hammets Cove	85	0	85
	Planting Island Cove	90	0	90
	Sippican Harbor	260	56	316
	Sippican Harbor- Old Landing	0	100	100
	Sippican Harbor-Inner Harbor	732	0	732
	Sippican Harbor-Jobs Cove	24	0	24
	Weweantic River	71	0	71
	Wings Cove	90	0	90
Marion Summary		1417	156	1573
Mattapoisett	Aucoot Cove	100	0	100
	Brandt Island Cove	12	75	87
	Mattapoisett Harbor	694	9	703
	Pt. Connett	45	0	45
Mattapoisett Summary		851	84	935
New Bedford	Clarks Cove	90	30	120
	New Bedford Inner Harbor	105	995	1100
	New Bedford Outer Harbor	90	10	100
New Bedford Summary		285	1035	1320
Wareham	Butlers Cove	35	0	35
	Buttermilk	0	86	86
	Buttermilk Bay	30	0	30
	Onset Bay	370	350	720
	Onset Bay-Broad Cove	35	0	35
	Onset Bay-Stonebridge	0	60	60
	Onset Bay-Sunset Cove	40	0	40
	Wareham River	376	116	492
	Weweantic River	30	28	58
Wareham Summary		916	640	1556
Westport	East Branch	100	130	230
	West Branch	30	30	60
	Westport Harbor	500	440	940
Westport Summary		630	600	1230
Total Bay Summary		8043	4214	12257

Action Plan 7 Protecting and Restoring Wetlands

Problem

Marine and freshwater wetlands continue to be lost and degraded. Although the rate of loss has diminished greatly in recent years, reductions in future wetland losses and wetland habitat degradation will only be achieved through increased local training and enforcement, education of property owners, and the adoption of local wetland regulations to address shortcomings of state and federal laws.

The management of stormwater discharges has become an increased responsibility of conservation commissions. These stormwater treatment requirements must be strengthened to better achieve water quality goals (like open shellfish beds), and conservation commissions need to better coordinate with other boards to ensure comprehensive and consistent town-wide stormwater management requirements.

Additional efforts are needed to restore existing degraded wetlands and remedy past wetland violations. This requires a more robust enforcement approach and additional public funding for restoration projects.

This action plan principally relates to the enforcement of existing laws and regulations, and the need to adopt municipal laws and regulations that address local needs and conditions. Additional issues relating to wetlands protection and restoration can be found in many other action plans in this Buzzards Bay CCMP[105].

Goal

Goal 7.1 Long-term increase of high-quality wetlands in Buzzards Bay and its surrounding watershed.

Objectives

Objective 7.1. To protect existing wetlands.

Objective 7.2. To encourage restoration of degraded wetlands.

Objective 7.3. To improve enforcement of wetlands laws.

Objective 7.4. To upgrade the effectiveness of local conservation commissions to protect wetlands.

Objective 7.5. To create new wetlands habitat, especially habitat that can be used by threatened, rare and endangered coastal species and anadromous and catadromous fish.

Approaches

Most of the action needed to achieve the goals of this action plan relate to improved enforcement of existing regulations, or the need to adopt municipal laws and regulations that supplement the minimum standards imposed by state and federal laws. Improved enforcement, monitoring wetland loss using aerial photography, and implementation of new local wetlands laws and regulations are the key actions. Continued training of municipal staff (conservation agents) and municipal conservation commission members will facilitate these actions. Wetlands regulations are among the most complex that are enforced locally, and there is a steep learning curve for municipal officials in their successful implementation. Because local conservation commissioners are volunteer appointees with little training in wetland science, it is important that state and regional agencies (like the Buzzards Bay NEP) provide training and support.

The two most challenging aspects of enforcing wetlands regulations are the accurate delineation of wetland boundaries, and the adequacy of stormwater treatment designs (which has a primary benefit to water quality). Municipal boards must carefully review these elements for accuracy and adequateness. These can be assured through improved training of commissioners and staff, utilization of free technical services (like the Buzzards Bay NEP), and for complex projects, hiring consultants, paid for by the applicant, as provided under state laws.

Municipalities can reduce future threats to wetlands by promoting open space acquisition and conservation restrictions on lands with appreciable wetland habitat, and by helping restore filled or impaired wetlands.

Costs and Financing

The cost of adoption of regulations is negligible to government, but the staff to implement and enforce additional regulations is an added cost. Most of the training courses are available at no or little cost. Other needed actions, like the restoration of wetlands, or the permanent protection of wetlands and habitat will only be achieved through additional government funding. For example, a funding level of $1 million per year could leverage the protection or restoration of many hundreds of acres annually.

Measuring Success

Most of the elements of this action plan can be addressed through tracking programmatic actions, like the adoption or update of bylaws and regulations. Some actions, like numbers of acres lost, restored, or protected are useful metrics, and are already being tracked by DEP or the Buzzards Bay NEP.

[105] Action Plan 8 Restoring Migratory Fish Passage, Action Plan 9 Protecting Bio-Diversity and Rare and Endangered Species Habitat, and Action Plan 12 Protecting Open Space have many goals, objectives, and suggested actions that compliment this action plan.

Background

Marine and freshwater wetlands are some of the world's most naturally productive areas, and they perform many functions that are useful to man. The Massachusetts Wetlands Protection Act, G.L. Chapter 131, section 40, officially recognizes that wetlands are crucial to the following interests:

Protection of public and private water supply

Protection of groundwater supply

Flood control

Prevention of storm damage

Prevention of pollution

Protection of land containing shellfish

Protection of fisheries

Protection of wildlife habitat.

Marine wetlands, especially salt marshes, eelgrass beds, and shellfish beds, together with other marine habitats, are fundamental for healthy coastal ecosystems. With respect to protecting marine and coastal resources, freshwater wetlands are important in removing nutrients and other pollution associated with upper watershed development. The need, as recognized by the legislature, to preserve freshwater and marine wetlands, is thus fundamental to any effort to protect either coastal or inland water quality and living resources. For these reasons, the protection and restoration of coastal and inland wetlands are a major focus of the Buzzards Bay National Estuary Program. A summary of wetland types in each watershed municipality is shown in Table 25.

In Massachusetts, since colonial times, an estimated 40-50% of the wetlands base has been lost, and wetlands continue to be destroyed and degraded at an unacceptable rate. Wetlands are still widespread in Buzzards Bay, although evidence of historic wetland loss is clearly evident in the greater New Bedford area (see Figure 69). A study conducted for the 1991 management plan estimated that between 1977 and 1986 alone, southeastern Massachusetts lost over 1300 acres of freshwater wetlands. The passage of the inland wetland protection regulations in 1983 improved this situation considerably. For example, as part of the Wetland Conservancy Program (described below), a comparison of wetlands on aerial photographs in about 1994 and then 2001, within the Buzzards Bay watershed, found that only 167 acres of wetlands were lost, comprising 306 sites. Many of these documented losses were illegal alterations. The study did not identify alterations less than 1/3 acre, and these are considered much more widespread via wetland encroachment on developed lots. These smaller encroachments may be cumulatively greater than other documented illegal fills, but these losses have not been well characterized. In any case, these statistics suggest that both enforcement and the current regulations for wetland protection still fall short of full protection.

Recent court rulings limiting federal jurisdiction regulating fill and discharges to wetlands

In 2001, in a decision in the case of Solid Waste Agency of Northern Cook County (SWANCC) versus the U. S. Army Corps of Engineers, the U.S. Supreme Court limited the scope of the Clean Water Act's jurisdiction by limiting the definition of "Waters of the United States." In the SWANCC decision, the Court invalidated the "Migratory Bird Rule" (the use of the wetlands by migratory birds crossing state lines) as the sole basis for applying federal wetland regulations to "isolated" and non-navigable waters and wetlands. The court's decision did not define which waters and wetlands were covered by federal regulations (33 CFR 328(a)(3)).

In 2004, the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers proposed but did not adopt new rules defining "Waters of the United States" to address this decision. The impacts on states of this ruling and the lack of clear new rules, is discussed by Christie and Hausmann (2003).

While the SWANCC decision eliminated some solitary adjacent isolated wetlands from federal protection, it did not directly affect adjacent or bordering vegetated wetlands along navigable waters of the U.S. However, in 2006, federal jurisdiction was further limited by the Supreme Court decision in Rapanos versus the United States. In one sense, Rapanos went beyond the idea of just "navigable waters" as being waters of the U.S. by including the concept of pollutant pathways. However, the Supreme Court also rejected that all bordering wetlands near navigable waters be automatically included under the jurisdiction of the Army Corps, and remanded the case back for review. That is, questionable cases will need to be decided on a case-by-case basis until the law and regulations are clarified.

Because of the Rapanos decision, new cases are making their way to the Supreme Court to clarify further the definition of jurisdictional wetlands under the Clean Water Act. In a local case, a Carver, MA cranberry grower appealed a $75,000 fine and a $1.1 million restoration cost for destroying 50 acres of wetlands to build a cranberry bog. The grower asserted that the Army Corps had no jurisdiction over the destroyed wetlands. In 2005, the U.S. First District judge rejected this assertion. However, in October 2006, the first U.S. Circuit Court of Appeals sent the case back to U.S. District Judge for further consideration in light of the Rapanos decision.

Because the authority of the federal government in protecting wetlands has diminished in recent years, two actions should occur. First, the U.S. Congress should clarify and strengthen the language of the Clean Water Act to protect wetlands. Second, state and local government should adopt laws necessary to protect the values and functions of wetlands from discharges and fill where jurisdiction is lost by federal agencies.

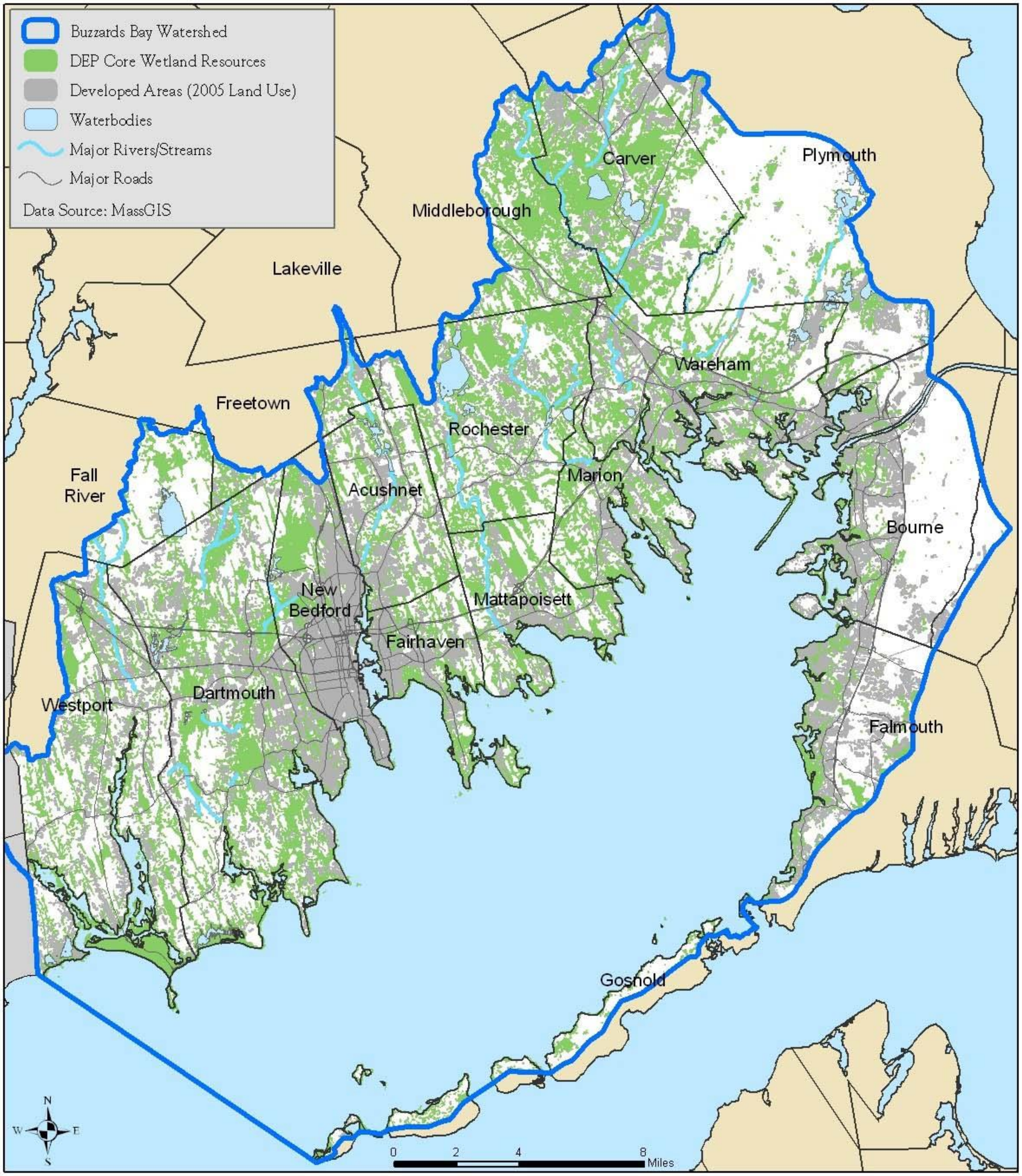

Figure 69. Core vegetated wetlands in the Buzzards Bay watershed.

(Wetland Conservancy Program data from MassGIS.)

Table 25. Summary of wetlands in the Buzzards Bay watershed.

Summary from the Buzzards Bay NEP based on MassGIS 1991 wetland coverage clipped to Buzzards Bay NEP 2006 adopted watershed. Excludes marine open waters, watershed area in Rhode Island, and a small area of unclassified lands. Not shown but included in column totals are lands in Lakeville, Sandwich, Kingston, and Freetown.

Wetland Habitat Type	**ACUSHNET**	**BOURNE**	**CARVER**	**DARTMOUTH**	**FAIRHAVEN**	**FALL RIVER**	**FALMOUTH**	**GOSNOLD**	**MARION**	**MATTAPOISETT**	**MIDDLEBOROUGH**	**NEW BEDFORD**	**PLYMOUTH**	**ROCHESTER**	**WAREHAM**	**WESTPORT**	**Total in category**	**percent of all wetlands in the watershed**
BARRIER BEACH SYSTEM		49		65	94		28	21	47	86					36	455	880	1.5%
BARRIER BEACH-COASTAL BEACH		20		81	8		53	66							9	121	358	0.6%
BARRIER BEACH-COASTAL DUNE		9		94	12		77	31							9	200	432	0.7%
BARRIER BEACH-DEEP MARSH																2	2	0.0%
BARRIER BEACH-MARSH		2					2									12	15	0.0%
BARRIER BEACH-SALT MARSH																0	0	0.0%
BARRIER BEACH-SHRUB SWAMP							2									5	7	0.0%
BARRIER BEACH-WOODED SWAMP DECIDUOUS																2	2	0.0%
BOG		10	129	4			1	0			44	26	39	1	21		276	0.5%
COASTAL BANK BLUFF OR SEA CLIFF	0	73		20	7		15	15	10	7		25	0		44	14	232	0.4%
COASTAL BEACH	2	123		100	64		94	157	71	56		36			148	44	896	1.5%
COASTAL DUNE		88		37	30		35	35	6	18		5			90	19	363	0.6%
CRANBERRY BOG	66	134	2,952	57			24		163	66	745	13	567	1,083	1,591		7,594	12.8%
DEEP MARSH	139	42	416	70	5	9	5	5	34	3	208	8	175	218	296	7	1,685	2.8%
OPEN WATER	157	175	1,223	483	22	578	299	182	44	47	108	102	1,688	1,207	1,138	193	7,675	13.0%
ROCKY INTERTIDAL SHORE		21		45	31		36	85	21	29		14			9	47	337	0.6%
SALT MARSH	29	360		1,142	607		245	26	419	402		4	1		886	987	5,107	8.6%
SHALLOW MARSH MEADOW OR FEN	134	29	252	243	140	3	58	15	77	32	36	144	60	210	186	212	1,844	3.1%
SHRUB SWAMP	111	109	674	242	51	10	80	104	119	95	268	82	107	470	294	83	2,947	5.0%
TIDAL FLAT	1	39		93	34		43	49	26	20		1			2	249	557	0.9%
WOODED SWAMP CONIFEROUS	17	6	342	211	1	83	7	2	31	131	67	265	55	264	65	15	1,579	2.7%
WOODED SWAMP DECIDUOUS	1,060	86	692	4,385	570	335	68	85	1,029	1,189	1,079	773	39	2,147	435	3,052	17,251	29.1%
WOODED SWAMP MIXED TREES	637	18	897	1,478	100	475	10	0	551	729	1,567	662	71	1,311	261	171	9,159	15.5%
Total Wetlands	2,352	1,393	7,577	8,852	1,776	1,492	1,182	877	2,648	2,911	4,124	2,160	2,802	6,910	5,521	5,889	59,200	
UPLAND	9,710	20,255	13,571	30,950	6,239	5,326	11,177	7,175	6,438	8,350	6,647	10,283	22,523	14,220	18,348	22,881	217,926	
PERCENT WETLAND	19.5	6.4	35.8	22.2	22.2	21.9	9.6	10.9	29.1	25.8	38.3	17.4	11.1	32.7	23.1	20.5	21.4	

Wetland Protection Act Resource Areas

Inland Resource Areas:

- Banks and beaches
- Bordering vegetated wetlands
- Land under water bodies and waterways
- Land subject to flooding
- Riverfront areas

Coastal Resource Areas:

- Land under the ocean
- Designated port areas
- Coastal beaches
- Coastal dunes
- Barrier beaches
- Coastal banks
- Rocky intertidal shores
- Salt marshes
- Land under salt ponds
- Land containing shellfish
- Anadromous/Catadromous fish runs

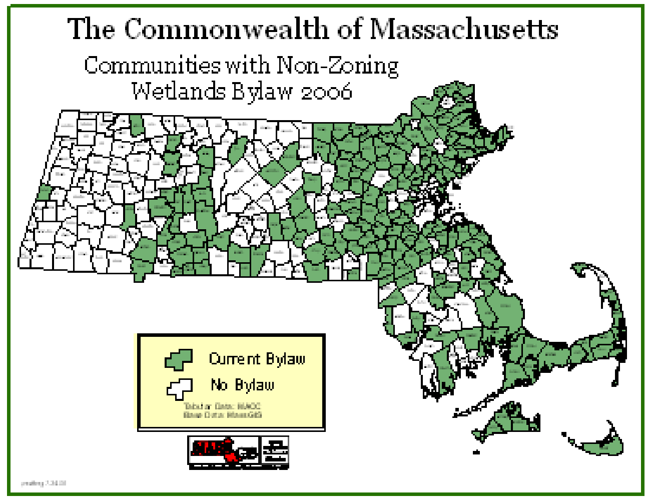

Figure 70. Communities with non-zoning wetland bylaws as of 2006.

Massachusetts provides a higher level of protection for its salt marshes through the Wetlands Protection Act Regulations and the Wetlands Restriction Program. The regulations are less protective of subtidal wetlands and habitat. Although the Wetlands Protection Act offers some protection for these areas, they nonetheless are being altered by increased boat activity, and declines in water quality from nonpoint source pollution and nitrogen loading.

Bordering vegetated wetlands provide an intermediate level of protection, but state rules allow for up to 5,000 square feet of wetlands to be altered or filled for a number of different reasons. Moreover, state, and federal regulations offer limited protection to isolated wetlands.

In general, cumulative impacts from many small projects are a major threat to all types of wetlands and are often the most significant cause of wetland degradation and habitat decline. This is because the existing management framework for wetland protection is inadequate for assessing and protecting against cumulative impacts.

An important part of the problem in protecting wetlands is that some conservation commissions may not be using existing state regulations as effectively as possible to protect wetlands and marine habitats. The present regulatory process is inadequate to deal with the growth that is fueling the continuous loss of wetlands.

Because the Wetlands Protection Act provides what many consider only a statewide minimum level of protection, many communities (in fact the vast majority in eastern Massachusetts - see Figure 70) have adopted zoning or non-zoning bylaws to further protect the interests of the Massachusetts Wetlands Protection Act. Sometimes these local measures add additional wetland resource values of sedimentation control, recreation, agricultural and historical values, aesthetics, and aquaculture. These local efforts provided an enhanced layer of regulatory oversight and protection to wetland resources.

The DEP has worked with other agencies in the Executive Office of Energy and Environmental Affairs (EEA) to develop a strategy to fully implement the policy of no net loss of wetlands adopted in June of 1990. A three-tiered approach of avoidance, minimization, and mitigation is used to achieve this goal, and was fully implemented in wetland permitting with the adoption of the 2005 revisions to the regulations.

Wetlands Protection Act

In 1963, with the adoption of the Jones Act, Massachusetts became the first state in the nation to protect coastal wetlands, preceding even the efforts of the federal government. This law, in conjunction with the “Hatch Act,” passed in 1965 to protect inland wetlands, eventually evolved into the current state Wetlands Protection Act (WPA). Significant revisions of the WPA regulations were promulgated in 1978 for coastal wetlands, in 1983 for inland wetlands, and in 1997 for river front areas. These revisions established the current system of resource areas, presumption of significance, and performance standards.

The Massachusetts wetland laws and regulations are still viewed as one of the most protective in the country. However, given the state’s historic loss of wetlands and the fact that this loss continues today, concern remains about the adequacy and enforcement of the law. Still, during the past decade, the program has been strengthened considerably with upgraded policy directives, especially in the area of no net loss of wetlands and wetland restoration efforts, as well as new efforts to document illegal wetland alteration activity using aerial surveys, which in turn has prompted additional compliance with the law. Furthermore, because the law is viewed as a minimum state standard, and because municipalities may adopt stricter laws under home rule, the Massachusetts wetland laws and regulations continue to be driven forward as certain approaches become more widespread at the local level.

At its core, the WPA is designed to protect the natural resource values of both inland and coastal wetlands. The regulations specifically define five inland wetland resource areas and eleven coastal resource areas for protection. Each of the resource areas plays a role in the protection of one or more of the statutory interests listed in the preceding section.

The primary responsibility for implementing the WPA regulations rests with local conservation commissions, which consist of three to seven appointed members. The regional office of the DEP is responsible for oversight and review of local decisions that are appealed. DEP also provides technical assistance and training to conservation commissions, as do other entities like the Buzzards Bay National Estuary Program for Buzzards Bay municipalities, and the Massachusetts Association of Conservation Commissions (MACC), a non-profit advocacy organization supporting conservation

In Massachusetts, wetlands delineation is primarily based on the occurrence of specific vegetation (originally primarily so, see Jackson, 1996), with confirmation of wetland hydrology by some other feature. The WPA specifies that boundaries of vegetated wetlands be delineated based on the occurrence of vegetation that is indicative of saturated conditions for a significant portion of the year. Non-vegetated wetlands, such as coastal banks and coastal dunes, are typically delineated based on geological features.

The WPA Regulations (codified principally under 310 CMR 10.00) require that a permit be obtained from the commission before proposed activities that would alter wetlands can occur. This permit, called an Order of Conditions, should include conditions necessary to protect the interests of the Wetlands Protection Act. At a minimum, performance standards provided in the regulations must be met. Activities within 100 feet of wetlands require a review of the project to determine whether wetland alteration might occur, and a permit is needed. Projects within this 100 ft. buffer zone that are presumed not to affect wetlands are issued a “negative determination” on the applicability of the WPA laws and regulations by the conservation commission.

Stormwater Policies and Regulations

In 1996, the state adopted stormwater rules and guidelines relating to the implementation of the Wetlands Protection Act by conservation commissioners. In 2005, DEP recognized that the policies were outdated and began updating them, and in 2007, they released a draft of the new stormwater regulations and policies. These new regulations still do not address standards to meet nitrogen and bacteria TMDLs adopted by the state and EPA.

During the same period, some municipalities adopted their own local stormwater regulations, and the Buzzards Bay NEP assisted in the development of some of these in the Buzzards Bay watershed[106].

Local and state stormwater policies and regulations remain one of the most challenging components of the WPA regulations for conservation commissioners to enforce. These regulations are particularly important for protecting and restoring water quality. For these reasons, it is especially important for commissions to collect fees to utilize the services of outside consultants to review stormwater plans and stormwater calculations for all large projects. Commissioners should also attend training sessions to learn how to conduct a preliminary review of stormwater plans for adequacy, and should require the submission of a stormwater plan checklist.

The state stormwater policies and recommendations are discussed in detail in Action Plan 3 Managing Stormwater Runoff and Promoting LID.

Wetlands Restriction Program

The Coastal and Inland Wetlands Restriction Acts, enacted by laws in 1965 and 1968, are referred to today as the Wetlands Restriction Program, although certain elements of the program are now carried out under the Wetlands Conservancy Program described below. The program was intended to protect the state’s most significant wetlands. Although the program terminated 30 years ago, the deed restrictions enacted by the program remain in force.

The purpose of the Wetland Restriction Program was to provide protection to wetlands by prohibiting certain activities in advance of any work being proposed. The regulations for these laws are 310 CMR 13.00 (inland) and 310 CMR 12.00 (coastal). The law was particularly important when it predated the passage of the state Wetland Protection Act in 1972 and the companion coastal regulations adopted in 1978.

In the 1960s, 70s, and 80s, the regulatory predecessor to the Division of Conservation and Recreation (DCR[107]) was the lead on this effort and mapped wetlands in a number of cities and towns in Massachusetts. They also placed deed restriction orders pursuant to either the

[106] In 1995, 1999, and 2003, the Buzzards Bay NEP drafted more protective local unified model stormwater regulations for adoption of consistent regulations among conservation commissions, boards of health, and planning boards. The latter two boards were not required to adopt the state stormwater regulations, and the BBNEP sought to promote a consistent approach among municipal departments.

[107] Formerly called the Department of Environmental Management.

Coastal Wetlands Restriction Act (MGL Chapter130, Section 105) or the Inland Wetlands Restriction Act (MGL Chapter 131, Section 40A). The Wetlands Restriction Program was first applied to coastal wetlands in the 1970s, particularly salt marshes, tidal flats, barrier beaches, sea cliffs, dunes, and salt ponds. No lands under the ocean were restricted.

These permanent wetland restriction orders were placed in 53 municipalities and restricted activities on approximately 46,000 acres of coastal wetlands and 8,000 acres of inland wetlands.

The restriction orders were recorded at the registry of deeds in the counties where the properties were located, and are carried forward with future landowners, who should be informed of the restriction at the time of purchase or deed title search. Municipalities where these wetlands orders were placed should have copies of their community's restricted wetlands plans and restriction orders. In some cases, the original maps provided to the towns appear to have been lost or forgotten. Many of these deed restrictions can now be searched and viewed online in databases posted by county deeds offices. Violations of the deed restrictions are enforced by DEP pursuant to 310 CMR 13.00 and 310 CMR 12.00.

Today, some property owners may not be aware of deed restrictions that were applied to their property under this program. Moreover, many conservation commissioners - unpaid volunteers that may serve their community for two or three years-- may not have even heard about the wetland restriction program. A further complication is that wetland restriction maps, which do not show property bounds, are attached to the deed by reference to county registry of deeds book and page numbers, listing the owner at the time. There is no information referencing town assessors map plot and lot numbers. Because the maps had never been converted to digital form, complying with the Deed Restriction Program can be challenging for both the property owner and municipal conservation commissions.

An important nuance of the Wetland Restriction Program is that the boundary of the wetland resource feature is not based on current definitions of those features, but the boundary of the feature delineated on a map recorded in a plan book at the deeds office at the time. This is especially important to recognize in beach and dune areas, where the mapped restricted activity area may be broader than the salt marsh area.

In Buzzards Bay, some or all of the coastal wetlands in 6 out of 10 coastal towns have been restricted, but significant inland wetlands have been restricted in only one community in the drainage basin. This program, which was originally intended to be the cornerstone of wetlands protection in Massachusetts, has fallen short of its goal because of the high implementation cost.

The following Buzzards Bay watershed municipalities have Wetland Restriction Act Deed Restrictions: Bourne, Falmouth, Marion, Plymouth, Wareham, and Westport.

Wetland Conservancy and Wetland Loss Programs

In contrast to the Wetlands Restriction Program, the subsequent Wetlands Conservancy Program on the other hand was meant to primarily map and track the core wetlands 1/4 acre or larger in the state that could be identified on aerial photographs. The Department of Environmental Protection's Wetlands Conservancy Program, which evolved from the work of the Wetland Restriction Program, is an ongoing effort to map the state's core wetlands using aerial photography and photo interpretation to delineate wetland boundaries. The program produces maps identifying wetlands that are one quarter acre or larger. DEP uses these maps to document the extent and condition of the state's wetlands and to improve coordination among regulatory programs on wetland and water quality issues.

Wetland delineations developed in this inventory are photo interpreted and do not substitute for the delineation information required under the wetland regulations. The photo interpretation method is particularly weak in lower, flat slope wetlands in glacial till.

The program also is mapping eelgrass beds along the coast. These important wetland resources serve as nursery areas for finfish and shellfish, filter pollutants, and buffer the shoreline from waves. Since these habitats are negatively affected by pollution, they are good indicators of water quality along the coast.

In 2003, the Conservancy Program began systematically analyzing discrepancies between the original wetland mapping performed in 1993 and updated aerial photos from 2001 (Figure 71 and Table 26). In 2003, DEP announced that it would be using this approach in a systematic way to pursue criminal violations of the state's Wetland Protection Act. This effort evolved into DEP's Wetland Loss Program. This program has continued its investigations on larger illegal alterations around the state, and the agency has prepared maps of wetland alterations for each municipality.

The wetland change maps were created in an automated way, using computer software to document changes in mapped wetland coverage. It is important to recognize not all alterations identified by the DEP study are illegal activities. Some wetland loss was the result of legal actions sanctioned by state and local permits. Some of the mapped wetland losses were artifacts of human error of interpretation, or minor errors in the mapping of wetland boundaries. Other losses, however, will likely be the result of unpermitted activity, and may result in criminal prosecutions by state or federal agencies. Table 27 shows a summary of wetland loss sites and acreage in Buzzards Bay municipalities based on evaluations of aerial photographs.

The process of documenting wetland loss using aerial photographs will omit most wetland losses less than 4,000 square feet. Thus, the Conservancy Program's surveys do not include the many smaller incremental wetland infringements that may be occurring in the watershed that could cumulatively account for additional undocumented wetland losses.

Under state law, there is a two-year statute of limitation for violation of the Wetlands Protection Act. However, in the case of filled wetlands, every day the fill remains represents a new violation. Thus, decades old fill areas may see enforcement action. Enforcement of filled wetlands can be taken based on aerial photographs and field evidence to actions as earlier as 1990 (the date of key changes in the state wetland regulations).

While DEP and the U.S. Army Corps of Engineers are taking action against the largest violators, it is left to local conservation commissions to take action against smaller violators. Not all conservation commissions are dedicating staff time and resources to address this problem. Both The Buzzards Bay Coalition and Buzzards Bay NEP provided additional supporting information about the losses' at specific site. To date there has been no systematic evaluation of town actions to address these cases.

Local Implementation of the WPA

In 2012, conservation commissions in Buzzards Bay communities processed approximately 1458 permits and actions filed under the WPA (Table 27, sum of orders, restrictions, NOIs, etc.). The communities also issued 24 enforcement orders. Ten watershed towns (Dartmouth, Falmouth, Bourne, Wareham, New Bedford, Middleborough, Acushnet, Rochester, Carver, and Plymouth) have full-time conservation agents, and Fairhaven, Mattapoisett, and Westport have part time agents. Only the Town of Marion has no agent at all. Eight Buzzards Bay communities (Falmouth, Bourne, Wareham, Dartmouth, Carver, Plymouth, Rochester, and Fairhaven) have adopted non-zoning wetlands bylaws to supplement the Wetlands Protection Act. Falmouth, Bourne, and Dartmouth have also adopted regulations to define further their bylaws.

Local bylaws and regulations are valuable for addressing the inadequacies of the WPA regulations. For example, before the state laws and regulations were revised in 1997, a number of towns adopted a fee-system to enable the town to pay for professional staff, or expert advice to evaluate complex projects. These local bylaws typically expand the number of wetland resource areas and interests that can be protected. However, to be truly effective, these bylaws require enforcement and political support of the executive branch of government (selectmen or mayor) and the logistical support of town counsel. In an attempt to protect wetlands more effectively, conservation commissions in the Buzzards Bay watershed have adopted a wide array of enforcement and implementation tools.

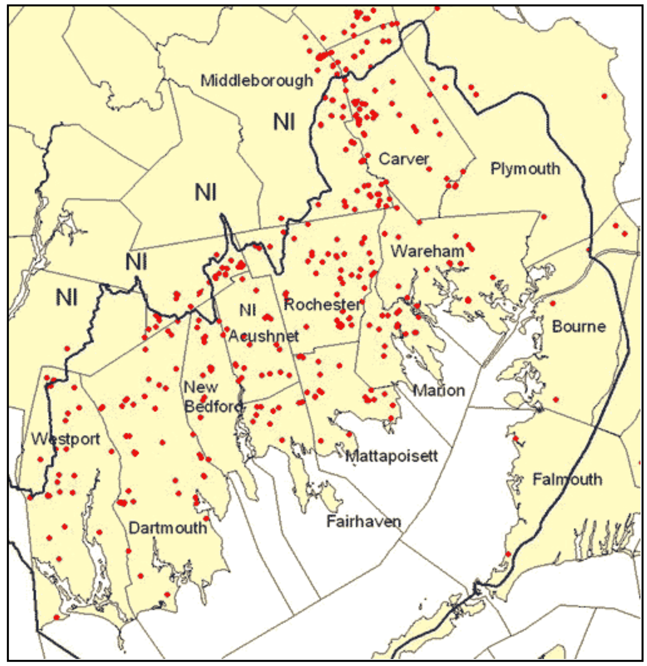

Figure 71. Map and summary sites of wetland loss in the Buzzards Bay watershed.

Table 26. Summary wetland loss sites by town shown in Figure 71.

Town	No. of Sites	Acres Lost
Carver	48	36.4
Middleborough	52	33.7
Rochester	56	26.8
Dartmouth	42	11.5
Mattapoisett	22	11.3
Wareham	18	10.8
New Bedford	14	8.2
Marion	14	6.9
Fairhaven	10	5.2
Westport	28	4.9
Plymouth	15	4.5
Acushnet	20	4.0
Bourne	5	2.4
Falmouth	2	0.2
Gosnold	0	0.0
Total	346	166.8

Table 27. Conservation Commission actions, staffing, regulatory framework, and related information in 2011, and permit data for 2012 (unless otherwise indicated).

Municipality (a)	**Acushnet 2012**	**Bourne 2012**	**Carver 2012**	**Dartmouth 2012**	**Fairhaven 2012**	**Falmouth 2010**	**Middleborough 2012**	**Marion 2012**	**Mattapoisett 2012**	**New Bedford 2012**	**Plymouth 2012**	**Rochester 2012**	**Wareham 2012**	**Westport 2012**
Town Bylaw/City Ordinance	No	Yes	Yes	Yes	Yes	Yes	no(e)	No	No	Yes	Yes	Yes	Yes	No
Town Regulations	No	Dock Regs.	No	Yes	No	Yes	No	No	No	No	Yes	No	No	No
No Build Setback, (# feet Bylaw or Policy (d)	Policy – 25 ft	50 ft. Bylaw	65 ft. Bylaw	No	No	25-100ft Bylaw(b)	No	30 ft. Policy	No	25 ft. Policy	35-50 ft Bylaw(b)	25 ft. Policy	30 ft residential 50 ft commercial	25 ft. Policy
Abutter Notification on RDAs	NP	NP	No	NP	Yes	NP	No	No	Yes	Yes	Yes	No	Yes	No
Non-criminal citation under local bylaw	No	Yes	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	No
Local storm-water regs.	Planning Board Ordinance	No	Yes – Board of Health	No	Planning Board	Yes	No	No	No	NP	No	No	No	No
Isolated Wetlands	No	Yes	Yes	No	Yes	Yes	No	No	No	No	Yes	Yes	Yes	No
Bylaws further limit "Limited Project"	No	NP	NP	NP	No	NP	No	No	No	No	No	No	NP	No
Watersheet Zoning	NA	No	NA	No	No	No	NA	No	No	No	No	NA	No	No
Dock regulations based on Natural Resources	NA	Yes	NA	No	No	Yes	NA	No	No	No	No	NA	Included in Local Wetland By-Law	No
Conservation Agent (FT -fulltime, PT-part-time)	Yes, FT	Yes, FT	Yes, FT	Yes, FT	Yes, PT	Yes, FT	Yes, FT	No	Yes, PT	Yes, FT	Yes, FT	Yes, FT	Yes, FT	Yes,2 PT
Total Staff	1.5	1.5	1.5	2	.25	3	1.5	0.5	1	2	3	1.5	2	1.5
Number of commissioners/ associates	7/0	7/4	6	7/0	7	7	7	5/2	5	5	7	7	7/3	7
Commission members attend site visits	Yes	No	Yes	optional	Yes	Yes	No	Yes	No	Yes	yes	Yes	optional	No
Building Permits, new construction	10	118	445	81	10	49	110	NP	32	82	NP	14	NP	46
Request Determinations of Applicability	6	79	4	32	30	103	12	28	30	26	28	8	37	36
Notices of Intent	13	NP	16	47	24	75	25	21	27	18	35	9	41	49
Orders of Conditions	13	32	21	27(d)	24	NP	25	21	NP	18	35	9	NP	NP
Amended Order of Conditions	0	2	1	NP	5	15	5	2	6	NP	3	1	NP	7
Abbrev. Notices Resource Area Delineation	1	0	4	NP	1	NP	7	0	NP	1	0	0	NP	7
Extended Order of Conditions	0	4	NP	4	4	2	1	5	3	3	NP	1	NP	3
Certif. Compliance	21	14	7	26	12	86	20	16	13	13	NP	6	NP	21
Enforcement orders	0	NP	0	NP	8	3	2	2	NP	8	0	1	NP	NP
# Conservation Restrictions	1	NP	3	1	NP	NP	21	NP	NP	NP	1	0	NP	NP
CR Acres	46	NP	259	16	NP	NP	759.2	NP	NP	0	350	NP	NP	NP
Other Acres Acquired	0	27	NP	15	NP	NP	720	NP	NP	0	328	NP	NP	NP

Information compiled by the Buzzards Bay NEP; permit data for 2012 fiscal or calendar year unless specified. NR= not reported. Notes: (a) Table does not include some types of permits, nor does it include Fall River, because Buzzards Bay watershed portion is mostly protected open space. (b) Actual hard setback varies with resource areas. (c) Under the River Protect Act amendments of the state Wetlands Protection Act, there is a de facto 100 no build setback for the construction of building and septic systems from streams and rivers throughout the Commonwealth. Local bylaws can create no build buffers from bordering vegetated wetlands. Policies can encourage setbacks, but are ultimately unenforceable. Participation in DEP, MACC, or Buzzards Bay NEP wetland training workshops by commission members and staff during the past 5 years was omitted from this table because it does not meaningfully capture weather board members are adequately trained. That is, the necessity of this training depends upon the length of tenure of staff and commission members, and is thus dependent on turnover. (d) Includes order of conditions, amended order of conditions and abbreviated notices resource area delineation.

A good example of a local tool is the use of non-criminal dispositions to levy fines for small violations. This technique is provided for in the bylaws of Fairhaven, Falmouth, and Wareham. Quite simply, the town's enforcement officer (the conservation agent or department of natural resource officer is given the ability to write a citation, much like a parking ticket. The ticket fines can be staggered for a nominal fee (e.g. $10 for certain minor or first offenses) and escalate in fine value. Citations can be issued for each day of violation. Like parking tickets, wetland enforcement citations can be appealed in district court.

This use of non-criminal citations for minor offenses (like mowing of wetlands adjoining lawns) can be a simpler and less costly mechanism to ensure compliance with a town's wetland bylaw, than the issuance of enforcement orders and paying for attorney fees. If towns adopt this technique, they should keep in mind that the purpose of the citations is to encourage compliance with the law, not to raise revenues for the town.

Other strategies include:

- Confiscation of heavy equipment used in illegal operations (Falmouth).
- Bringing of criminal charges against chronic violators (Falmouth).
- Use of local Department of Natural Resource police to gain access to private property to investigate suspected wetland violations (Falmouth).
- Detailed filing requirements (Bourne, Rochester, Falmouth, Carver).
- Restrictive policy on new dock and pier construction (Bourne, Falmouth, Wareham).
- Designation for sensitive wetlands as Areas of Critical Environmental Concern or as DCPC (Bourne, Falmouth).
- No-build setback (in law or regulations) from wetlands for all structures (Bourne, Carver, Falmouth).
- Recording of enforcement orders on deeds until mitigation activities are satisfactorily accomplished (Rochester).

Chapter 91 Waterways Program

Chapter 91 of the Massachusetts General Laws regulates waterways in Massachusetts and enables the Commonwealth to both protect and promote public use of its tidelands and other waterways. The law was passed in 1866, but the basis of the law originated with the Colonial Ordinances of 1641-1647, and led to what is known today as the "public trust doctrine." This doctrine holds that the air, the sea, and the shore belong not to any one person, but rather to the public at large.

Chapter 91 regulates activities on both coastal and inland waterways, including construction, dredging and filling in tidelands, great ponds and certain rivers and streams. An important component of the law is that the

Local Wetland Protection Efforts

Municipal conservation commissions are empowered to oversee and implement most of the key components of the state Wetlands Protection Act. It is often stated that conservation commissions are the first line of defense in wetland protection. While this is true, they are not the last word in wetland protection. If an applicant, or abutter, or concerned parties feels a conservation commission is being too strict or lenient in their interpretation of the state Wetlands Protection Act, they can appeal the decisions to DEP. Through the DEP appeals and adjudicatory process, DEP has the last word on what the state laws and regulations mean, and how they should be interpreted.

If the conservation commission or town residents feel the state's minimum level of protection is not adequate, towns are empowered by the Home Rule Amendment to the state constitution to adopt wetland protection bylaws and regulations that are more stringent than the Wetlands Protection Act regulatory requirements.

Some local wetlands bylaws spell out standards like setback distances of construction from wetlands. Other bylaws provide an additional authority to the conservation commission to promulgate regulations without further town meeting approval. When no authority to adopt regulations exist, one strategy is to seek approval at town meeting for regulation adoption on a specific issue, such as docks and piers, setbacks, or abutter notification. An important local regulation need is a mechanism for protecting isolated wetlands, requiring replication at a ratio of at least 2:1, creation of a "no activity zone" of 50 feet, and eliminating some of the state Wetland Regulation "limited projects" allowances.

Commissions should strive for the greatest level of wetlands protection possible under the WPA, including protection of critical habitat areas such as shellfish areas and eelgrass beds. The complexity and magnitude of wetlands protection requires that towns have professional conservation administrators or agents to guide and facilitate the conservation commission's actions. Local wetlands bylaws often include filing and review fees to help defray the costs of technical reviewers on difficult projects, and the passage of a 1983 state law provides this option automatically. Consultant services may include resource area survey and delineation, hydrologic and drainage analysis, impacts on municipal conservation lands, and stormwater management plan review and analysis. Despite this opportunity, some conservation commissions seldom avail themselves of hiring consultants to review large or complex projects.

Wetland regulation have become complex as of result of the combination of science, policy, and law on which they are based. Consequently, towns should require attendance by conservation commission members at Wetland Protection Act training courses. Courses are available from the Massachusetts Association of Conservation Commissions and the Buzzards Bay NEP.

Finally, the Board of Selectmen is crucial to this effort and should appoint conservation commission members who are dedicated to a strict but fair implementation of the WPA. Trying to create a "balance" by appointing members that have no desire to implement the law is a violation of the public trust.

Commonwealth owns the land below the low water mark, and privately owned land between the high water and low water marks is subject to public rights, namely fishing, fowling, and navigation.

While Chapter 91 is discussed more fully in other action plans, from a wetlands protection point of view, the Chapter 91 program is an important mechanism to address wetland alterations caused by illegal structures. In addition, tidelands that have been filled in, even 100 years ago or more are still subject to the law, and this fact can have important implications for wetland enforcement and wetland alteration projects.

Clean Water Act and Federal Wetlands Permits

The federal Clean Water Act mandates that permits be issued for fill in wetlands (Section 404), for excavation and construction in navigable waters (Section 10), discharges to wetlands and surface waters (section 402), and in the case of discharges (which includes fill), require that the discharge complies with state water quality standards (section 401).

Section 404 of the Clean Water Act is implemented by the Army Corps of Engineers, and regulates discharges of dredged and fill material into wetlands and other waters of the United States. Under Section 10 of the Rivers and Harbors Act, the Corps regulates any excavation or construction in traditionally navigable waters. Section 10 permits often involve the construction of piers.

In Massachusetts, the issuance of NPDES permits lies with the U.S. EPA Region 1 office in Boston, However, Section 401 permits (Water Quality Certificates) are issued by DEP's Division of Water Pollution Control, which must certify that any activities requiring federal permits, e.g. NPDES or Section 404, are consistent with state water quality standards.

Water quality certification enables the state to protect wetlands from a broad range of activities potentially affecting physical and biological integrity of the wetlands in addition to the chemical integrity of the water column. The DEP's Water Quality Certification program was established to ensure that water quality standards are not violated by these activities. The additional requirement of developing water quality standards for wetlands, allows DEP an opportunity to strengthen this program even further.

Each of these programs adds a layer of protection for wetlands and waterways, but they may not be as protective as local and state regulations. On the other hand, if a local permit was issued for a project within wetlands, and the appeal period has lapsed (that is, the project is protected under state law), enforcement action can still be taken if a federal permit was not obtained. Generally, however, federal, state, and local wetland laws are viewed as complimentary permitting pathways. No one jurisdictional level can override the decision of another. Thus, each jurisdictional level has the ability to prohibit or limit a project, but an approval does not limit the rights of different jurisdictions to further modify, limit, or deny a project. This reality means that projects constructed in wetlands or surface waters are typically designed to meet the most stringent performance standard of any of the jurisdictions issuing a permit.

As a result of the U.S. Supreme Court's 2001 decision in Solid Waste Agency of Northern Cook County v. United States Army Corps of Engineers, 531 U.S. 159 ("SWANCC decision"), federal jurisdiction over isolated inland wetlands has been severely limited. Because these wetlands are not identified as resource areas in the state's Wetland Protection Act, and because state jurisdiction for these areas was provided only through the Water Quality Certification process, which was tied to the federal definition of "waters of the United States," the protection of isolated wetlands can now only be achieved by local regulatory efforts.

Planning and Preemption

Managers should not rely too heavily on the wetlands regulatory process as the principal tool to protect wetlands. By their nature, wetlands permits are a piecemeal decision making approach where it is difficult to achieve strategic goals. These wetland protection goals can be achieved more effectively through planning and preemption. Planning involves the identification of sensitive resources and the justification of their significance. It establishes a framework upon which to justify preemption techniques and base permitting decisions. Relevant local plans that can achieve wetland protection goals include development or updates of master plans, open space and recreational plans, watershed management plans, shellfish habitat maps, harbor watersheet zoning, dock exclusion zoning, management for Areas of Critical Environmental Concern (ACEC) and for those towns in Barnstable County, District of Critical Planning Concern (DCPC) and local comprehensive plans. Using these plans and strategies, a town can prioritize wetlands for acquisition, or define uses and activities that are least likely to degrade a municipality's most sensitive wetland resources.

Preemption is the foreclosing of opportunities for use of wetlands by not allowing certain activities to be proposed for permitting. Preemption tools include the zoning, conservation restrictions, land acquisition, temporary moratoriums, and, if effectively managed, ACECs (although this program is now considered toothless as implemented). To the greatest practical extent, the plans described above should explicitly identify wetlands and habitat areas that should be the target of preemption strategies.

Many conservationists believe the best way to protect land is to own it. Vigorous municipal land-acquisition programs and the blossoming of the nonprofit land-trust movement in the 1980s have led to the acquisition of many wetlands through purchase and donation. Ownership by public conservation agencies or private conservation organizations may offer the best preemption situation because these groups have neither the philosophy nor the financial incentive to propose development in or near wetlands. State agencies can support these efforts by allowing land donations or conservation restrictions in lieu of fines in enforcement cases. This approach and related recommendations are addressed in Action Plan 12 Protecting Open Space and Action Plan 9 Protecting Bio-Diversity and Rare and Endangered Species Habitat where there is a fuller discussion of non-regulatory techniques for protecting critical areas. In particular, tax incentives that accrue from various options are listed.

Major Issues

Wetland Replication

In 1983, regulations describing general performance standards for BVWs were adopted to allow the discretionary destruction of up to 5,000 sq ft, if the area is replaced in accordance with seven general conditions. Wetland replication may also be required under other circumstances. Many scientists and managers are concerned with the use of wetlands replication as a routine management tool for two reasons. First, wetlands replication projects have a high failure rate. In New England, it has been estimated that 50% of all replication efforts fail because of inadequate design or maintenance. Second, many functions performed by natural wetlands may not be performed by artificial or replicated wetlands. Although it may be possible to replicate the flood control, sediment trapping, and waterfowl values of some wetlands, scientists have identified at least 75 complex ecological relationships among soils, hydrology, water quality, vegetation, and wildlife, many of which take centuries to develop. Many of these relationships play significant or yet undetermined roles in the protection of the eight wetland interests listed in the WPA or of other interests included in local wetland bylaws. Many wetland replication projects have difficulty recreating even the typical vegetative community of a wetland, much less these other complex relationships that make a natural wetland.

For these reasons, wetland destruction should be avoided except in extreme cases or on projects with an overriding public purpose. When wetland destruction is the last resort, a genuine effort must be made to recapture the lost values of the destroyed wetlands. Given the high failure rate of replicated wetlands, a ratio of replicated wetlands to destroyed wetlands of much greater than 1:1 must be required to achieve a true no net loss.

Adequate Local Staffing and Resources

In the 1991 Buzzards Bay CCMP, inadequate staffing to conservation commissions was an important problem limiting the effectiveness of local conservation commissions. In 1991, most commissions did not have full time agents, today most do (only the Town of Marion does not), but the workload for commissions is very high, and relative staffing levels among communities is very uneven (Table 27).

Irrespective of staff levels, all conservation commissions should adopt a policy of requiring the attendance of at least one commission member on site visits, particularly for any project involving the construction of buildings, roads, or land clearing. Such a policy helps ensure that the commission members are directly engaged in evaluating sites and the potential impacts of proposed projects.

Conservation Commission Training

Local conservation commissions represent the first line of defense for implementing the WPA. Successful protection of wetlands by conservation commissions depends on two factors: a good understanding of wetland laws and regulations, and proficiency on the delineation of wetland boundary, which at both the state and federal level, is based on interpretation of vegetation and soil types.

The WPA and its associated regulations are complex and have a number of areas in which educated judgments and interpretations are required. Since the 1991 Buzzards Bay CCMP, training of both staff and commission members has improved in many communities, but remains problematic in others (Table 27). Moreover, both commission members and staff change frequently, so training must always be an ongoing effort.

Wetland boundary delineation can be difficult in some Buzzards Bay habitats because some vegetation can be found in both wetland and upland conditions. In these areas, interpretation of soils is especially important. An example of a specific technical issue that should be addressed by training relates to wetlands in spodosol soils. Because spodosols with certain features are a wetland indicator, it is important that commission members and agents have a good understanding of these features.

Currently, training of commission members is not compulsory. Courses are taught by the DEP intermittently, and many commissions are never formally trained to interpret and enforce the provisions of the Act and its regulations. Although "hands on" experience is valuable, it should be supplemented with a comprehensive understanding of the program. Without this understanding, the learning curve is extended and, when combined with the relatively high turnover-rate of commission members, often results in a poorly informed commission that inadequately administers regulations it does not fully understand. Detailed training on how to identify wetlands and soils is thus a critical requirement. Consequently appointing boards (selectmen) should require training for commission members, and they in turn should require training of their staff.

Dock and Pier Construction

Through the WPA, conservation commissions have the authority to review projects on land under the ocean, land under salt ponds, fish runs, and land containing shellfish. This authority can be used to protect valuable marine habitats such as DMF-designated productive shellfish areas, town-designated resource areas, habitat in ACECs, fish runs, and eelgrass beds, by prohibiting or limiting the number of new docks, piers, and their associated dredging activities, as well as reducing or mitigating the impact of approved projects.

In order to reduce the likelihood that a decision by a conservation commission is overturned, commissions should develop, and towns adopt, an explicit management plan regarding the location and construction of projects in the critical habitat areas previously discussed. The plans should clearly define and delineate the sensitive habitats that are being protected, the reason for protecting these areas, the type of projects that harm the habitats, and how the adverse effect is created. Regulations could then be adopted that protect these special areas.

For more on issues relating to the use of regulatory measures to control water-based activities refer to Action Plan 6 Managing Impacts from Boating, Marinas, and Moorings.

Buffer Zone Protection and No-build Setbacks

The 100-ft. so called buffer zone around all coastal and inland wetlands is a jurisdictional area that triggers a regulatory review pursuant to the state wetland regulations. There are no performance standards for these areas other than how the proposed activity will directly affect the wetland resource. Buffer zones are important because they protect the wetland from a wide variety of pollutants and provide valuable wildlife habitat.

A house construction project will be reviewed for construction impacts to an adjacent wetland but not for the subsequent activity associated with the house being occupied. Studies have shown that a 25-foot setback from wetlands is inadequate to prevent future wetland impacts from homeowner activity. A 50-foot setback has appeared to be more effective at protecting wetlands. Towns are permitted to adopt construction setbacks from wetlands, just as they adopt setbacks under local zoning.

The Town of Carver has adopted a 65-foot no structure zone around wetlands under their local bylaw, and Falmouth and Bourne have adopted varying no-touch or no-construction zones that vary from 25 to 50 feet depending upon the resources (Table 27). Some towns have adopted a policy of encouraging applicants to maintain a certain distance setback, but without a local bylaw or regulation in place, such a setback requirement is unenforceable under the state regulations. Municipalities should be explicit in the local bylaws, ordinances, or regulations whether setbacks are “no-build” or “no structure” or if they are “no-work” or “no alteration” areas.

Article 97 of the Massachusetts Constitution

"The people shall have the right to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and esthetic qualities of their environment; and the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources is hereby declared to be a public purpose. The general court shall have the power to enact legislation necessary or expedient to protect such rights.

In the furtherance of the foregoing powers, the general court shall have the power to provide for the taking, upon payment of just compensation therefore, or for the acquisition by purchase or otherwise, of lands and easements or such other interests therein as may be deemed necessary to accomplish these purposes.

Lands and easements taken or acquired for such purposes shall not be used for other purposes or otherwise disposed of except by laws enacted by a two thirds vote, taken by yeas and nays, of each branch of the general court."

River Protection Act Compliance

The implementation of the 1997 amendments to the Wetland Protection Act, known as the Rivers Protection Act (and the subsequent supporting regulations), have been subject to litigation and caused confusion at the local level. The River Protection Act created a new resource area 200 feet from the riverfront area that, in many respects, was treated like other resources areas such as bordering vegetated wetlands and dunes. This new resource area is not provided with a jurisdictional buffer. For the purposes of the Act, rivers were defined as any stream or brook that flowed year-round[108]. In some respects, the first 100 feet from these rivers are considered no-build zones for structures and septic systems, but the law and regulations provide many exceptions for preexisting and small lots. Because of the various case decisions relating to the River Protection Act, there is a need for a simplified summary of regulations for commission members and the public.

Conservation Lands and Article 97 Land Protection

An important part of wetland protection at the local level involves acquisition by local government of the most important wetland and habitat areas (discussed further in Action Plan 12 Protecting Open Space). Sometimes, land thought to be protected as open space because it is owned by a conservation commission, may not be protected. For example, in 2005, Massachusetts

[108] Streams indicated by solid blue lines on 7.5-minute scale topographic maps are presumed to conform to this definition.

Supreme Judicial Court[109] found that land acquired for conservation purposes by a town meeting vote, can in fact be disposed of for other purposes, if a conservation restriction (also known as a conservation easement) was never placed on the deed. For these reasons, it is important that conservation commissions review the deed of each property they own (deeds are now available online) to ensure the appropriate conservation or use restrictions are properly recorded as per the intent of town meeting. Sometimes conservation commissions jointly hold conservation restrictions with an area lands trust.

Certain public and private lands may also have other deed restrictions. Many are held in perpetuity, but some deed restrictions expire after 30 years, so mechanisms must be in place to ensure that these deed restrictions are renewed.

Similar to conservation restrictions, certain public lands voted for open space protection at town meeting are considered Article 97 lands. Article 97 of the Massachusetts Constitution requires that public land acquired for natural resource purposes not be used for other purposes, or otherwise disposed of, without a two-thirds vote of the legislature. To support Article 97 lands, in 1998, EEA (then EOEA) adopted an Article 97 Disposition Policy to help ensure that state agencies "shall not sell, transfer, lease, relinquish, release, alienate, or change the control or use of any right or interest of the Commonwealth in and to Article 97 land."

Despite these protections, some Article 97 lands have been converted to other uses. To address this problem, in 2007 an article was introduced in the Massachusetts senate called Public Lands Preservation Act. The bill sought to make it Commonwealth policy to require a legislative approval to change the use or disposition of Article 97 land acquired for natural resource purposes, unless there is no feasible alternative to such a conversion, but only if equivalent replacement land is provided, so there is no net loss.

Isolated Vegetated Wetlands (IVWs)

So-called "Isolated Vegetated Wetlands" (e.g., wetland areas that are not hydrologically connected by some surface channel to a river, stream, estuary, pond, or ocean) are not now recognized as a resource area in the Wetland Regulations. To be recognized under the WPA, wetlands must border a water body, the smallest of which is a 10,000-sq-ft pond, or fit the definition of isolated land subject to flooding, in which case only limited interests may be protected. IVWs contribute to the same eight interests listed in the WPA, and hence should be protected. The term "isolated" has a different meaning in the WPA than the U.S. ACOE Section 404 program, but the nuances are lost on local conservation commissions and DEP.

A special problem in protecting isolated wetlands is the fact that, if a municipality lacks regulations or bylaws to protect isolated wetlands, their conservation commissions may not require the applicant to identify these wetland areas on site plans submitted for a Notice of Intent wetlands permit application. Consequently, if such a site plan were submitted to DEP for the purposes of determining whether a Water Quality Certificate is needed, DEP would be unaware of the existence of these isolated wetlands, and may incorrectly determine that a Water Quality Certificate is not needed. To solve this problem, conservation commissions should require the applicant to delineate isolated wetlands on wetlands permit site plans.

Some isolated wetlands may be classified as vernal pools, which may offer them some added protection if certified by the state. Nonetheless, it is important that conservation commissions adopt local wetland bylaws or regulations to protect isolated wetlands more effectively.

Protection of Endangered Species, Anadromous Fish Habitat

Anadromous species like alewives (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) have declined dramatically during the past century in Buzzards Bay. Not only were these fish historically important as a fishery in Buzzards Bay, but they are also important food species for many fish, whales, and coastal birds. The cause of these declines may have been the result of many factors, but degradation of coastal wetlands and water quality may have been important factors. These issues are discussed further in Action Plan 8 Restoring Migratory Fish Passage and Populations.

Buzzards Bay also contains important populations of some endangered and threatened species. For example, Buzzards Bay has the largest colony in North America of the Roseate Tern (*Sterna dougallii*), a federally listed endangered species. Protection and enhancement of these important species requires special efforts to enhance the reproductive success of their populations or to restore their habitat. These efforts, and other needed actions are discussed in Action Plan 9 Protecting Bio-Diversity and Rare and Endangered Species Habitat, and Action Plan 8 Restoring Migratory Fish Passage.

USDA Wetlands Reserve Program

The Wetlands Reserve Program is a voluntary program established by the USDA Natural Resources Conservation Service (NRCS) that offers landowners the opportunity to protect, restore, and enhance wetlands on their property. NRCS provides technical and financial

[109] Massachusetts Supreme Judicial Court (June 2005 Town of Hanson v. Lindsay) found that land acquired for conservation purposes as stipulated in the Town Meeting Vote, but not subsequently reflected in the deed, can be "disposed" (see summary fact sheet at caselaw.findlaw.com/ma-supreme-judicial-court/1222292.html.

support for these efforts, as noted on the NRCS website, NRCS's goal "is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program" and offer landowners "an opportunity to establish long-term conservation and wildlife practices and protection." While the USDA accepted applications for federal FY13 funding under the FY08 authorization, future funding will depend on reauthorization of a Farm Bill.

In practical terms, this program allows farmers to sell a permanent conservation easement on unproductive wetland portions of their land, and restore wetlands and permanently protect those areas. The program is especially important for lands owned by cranberry growers because it provides an incentive for the growers to sell off smaller unproductive or underutilized cranberry bogs. Under the rules of the program's original authorization, USDA paid farmers up to $18,000 per acre for these lands. This amount may change in a future reauthorization and implementation of the program.

While the program primarily targets private lands, some municipalities have participated in the program. In 2006, the Town of Bourne[110] participated in the program. For an abandoned cranberry bog they acquired, they received $15,000 for a permanent conservation easement on the bog, and over $60,000 for wetland restoration. As of October 2013, this project was still in the permitting stage for the wetland restoration component. The restoration involved the reestablishment of a herring run and a salt marsh. The Town of Marion undertook two similar initiatives with an abandoned bog they own (Grassi and Goldovitz bogs, awards in 2005 and 2007 respectively). Both the Marion bog restoration projects were completed in October 2013.

Management Approaches

Most of the action needed to achieve the goals of this action plan relate to improved enforcement of existing regulations, or the need to adopt municipal laws and regulations that supplement the minimum standards imposed by state and federal laws. Improved enforcement and implementation of wetland laws and regulations are addressed principally through better training of municipal staff (conservation agents) and municipal conservation commissions. Wetland regulations are among the most complex that are enforced locally, and there is a steep learning curve in their successful implementation. Because local conservation commissioners are volunteer appointees with little training in wetland science, it is important that state and regional agencies (like the Buzzards Bay NEP) provide training and support to these commissions.

The most challenging aspect of wetland regulations is the accurate delineation of wetland boundaries. Although certified plans submitted to a municipality by an applicant's engineer may accurately show the location of wetland flags and the presumed wetland boundary, the accuracy of the placement of the wetland flags is only as good as the skill of the wetlands biologist that placed them. Because there is no certification of wetland biologists to flag wetlands, and because the boundary of wetlands is defined by complex criteria of soils, species composition, and cover of wetland plants, it is vital that conservation agents and commission members have adequate training in wetland delineation, and review the data sheets provided by applicants. This is especially important in the Buzzards Bay watershed because large areas of the watershed have flat areas that slowly grade from wetland to non-wetland habitat. These wetland areas are appreciably underestimated in maps based on aerial surveys of wetland cover, like those maps produced by the Department of Environmental Protection's (DEP) Wetland Conservancy Program.

Another challenging element of state and local regulations are the state (and any local) requirements to treat stormwater. The review of stormwater designs is often beyond the capability of most conservation commission members and agents. The state has amended the wetland laws to allow conservation commission to hire experts to review plans and pass these costs on to the applicant. Conservation commissions should utilize this provision and hire the necessary consultants. The Buzzards Bay NEP has often provided these services to municipalities at no cost.

The destruction of wetlands is permitted under state regulations, and if wetlands are destroyed, they must be replaced. However, the quality of these wetlands is often poor, and they may not serve the same function of the wetlands they replace, or they may not even remain wetlands. This suggests that wetland restoration should not be conducted at a 1:1 ratio, but at a 2:1 ratio or higher. There must be follow through in monitoring and evaluation of mitigation wetlands to require corrective action if the project fails (e.g. if the mitigation wetlands were constructed at the wrong elevation so that the wetland species did not survive).

With respect to training needs, at the state level, the DEP could address training needs in several ways. First, they could conduct more regular training for DEP employees in BVW delineation, with special emphasis on spodosol soil evaluation (a common soil type in the Buzzards Bay watershed). This training can help ensure consistency in state and local interpretation of wetland boundaries. DEP could also conduct training for DEP employees on the difference between state Wetlands Protection Act definition of "isolated" wetlands and the federal definition of isolated wetlands, which is often a point of confusion at both the state and federal level. The

[110] As of 2010, municipalities were no longer eligible under the program.

Buzzards Bay NEP or MACC could help provide these training workshops.

Conservation commission members must be more willing to attend training workshops. Because the town officials may have regular full time jobs, such training may need to be taken on weekends. The boards of selectmen that appoint these commissioners should require that conservation commission members attend training workshops on the state Wetlands Protection Act. This training is especially important for new members, but even long serving members can benefit from periodic training courses. In turn, conservation commissions should require their agents to attend an advanced wetland training class at least once annually. Many towns already participate in these training programs. The Buzzards Bay NEP and MACC can assist in providing the necessary training.

Buzzards Bay National Estuary Program can support conservation commissions by providing needed training workshops on wetland delineation and wetland regulation enforcement. Where requested, the Buzzards Bay NEP can assist by reviewing wetland boundaries and by mapping impairments and fills documented in aerial surveys.

Even with adequate training, there will always be the need to have experts review complex elements of projects. Once just a component in local bylaws, the state amended the wetlands laws and regulations to allow conservation commissions to hire experts to review projects, and pass those costs on to the applicant. Where appropriate, conservation commissions utilize these provisions and hire technical consultants to review complex projects, stormwater plans, or other needs.

Conservation commissioners should not rely on conservation commission staff and their recommendations on the issuance of wetland permits. All conservation commissions should adopt a policy requiring that commission member be present on all site visits where there is proposed construction of structures, roads, or clearing of land and RDAs on undeveloped land.

With respect to mitigation problems, DEP should require in its regulations that when wetlands are allowed to be altered or destroyed, restoration and/or replication will be at a ratio of at least 2:1.

With respect to enforcement of the state regulations, the state could be creative in its collection of fines. For example, where appropriate, DEP could allow conservation restrictions, land donations, or fee acquisitions of important wetland wildlife habitat or unique communities in lieu of cash fines for wetland violators.

In terms of restoring past wetland impairments, conservation commissions should review the wetland loss maps prepared by DEP, or the tidal restriction or filled wetland atlases produced by the Buzzards Bay NEP (and available on line.) In this way, when a town DPW consults the conservation commission in advance of road, drainage, or sewer work, the conservation commission can suggest modifications to the DPW project to address past wetland impairments.

Municipalities should adopt local wetland bylaws or regulations that address local needs. These local regulations should always require notification of abutters for filings of requests for determination under the state Wetland Protection Act. Such a local requirement will minimize the frequency of "negative determinations" issued incorrectly by local conservation commissions when a notice of intent was clearly warranted. Numerous other issues can be addressed with local wetland regulations, like better protection of isolated wetlands, which have limited protection under state and federal laws. The Buzzards Bay NEP has extensive experience in drafting local wetland bylaws and regulations, and should continue to provide this technical assistance to municipalities. Buzzards Bay NEP could help towns draft laws and regulations, and the Buzzards Bay Coalition could assist with outreach and communication to facilitate passage.

Education and improved awareness about local wetland laws and their benefits is often needed. The Buzzards Bay NEP could also produce a basic primer for new conservation commission members to compliment more detailed guides prepared by MACC and DEP. The Buzzards Bay NEP also has prepared informational materials for town meetings, or for the public to explain the importance or purpose of local wetland regulations.

The proper enforcement of wetland laws and regulations is essential. The Buzzards Bay NEP and MACC can provide technical assistance and training to town officials on interpreting and enforcing wetland regulations, especially focusing on technical issues that cause the greatest confusion. For certain projects, the Buzzards Bay NEP could assist in project and design review.

Municipalities should address current weaknesses in the Wetlands Protection Act by adopting local bylaws and regulations to meet local needs. Conservation commissions and boards of selectmen must show leadership in defending the need for these local regulations at town meeting (or before the city council), because these legislative bodies must approve these laws (town bylaws or city ordinances).

Required no-build setbacks is another way to ensure that projects are not likely to affect wetlands, and all Buzzards Bay municipalities should adopt local bylaws to require a minimum setback of 50 feet to wetlands.

To improve compliance with local wetlands laws, towns should use non-criminal citations as a tool for encouraging compliance with local bylaws. This can be a useful tool to supplant enforcement orders for more egregious problems.

Agents and conservation commission members should attend training meetings on how to write decisions and orders of conditions so that the local decisions "stand up in court." Writing decisions is somewhat of an art, and requires that the basis of a decision, such as a denial, be clearly articulated with the appropriate justification. This also means that where applicable, denials should be made under the local regulations, but approved under the state regulations.

To ensure that projects are undertaken as approved, it is important that conservation commissions require the recording of plans and wetland boundaries (in addition to the order of conditions) at county deeds offices in their orders of conditions. Technically this is required by law, but unless the conservation commission requires proof of this recording, or collects a fee to record the order themselves, the recording of the order may not occur. Municipalities must always implement a tracking system to ensure that permit orders are recorded.

Protecting wetlands includes proper management of public lands and can include acquiring wetlands and adjoining habitat. Conservation commissions should inventory properties they own and periodically review aerial surveys to determine whether their properties have been subject to any incursions from adjacent properties. Conservation commissions should also review all town owned conservation and open space lands to ensure the appropriate deed restrictions were recorded at the county deeds office to implement town meeting and town board votes.

The conservation commission should work with the municipality's open space committees to identify large wetland systems within their town, and make these properties a priority for acquisition (see Action Plan 12 Protecting Open Space) through Community Preservation Act funds, town meeting articles, or initiative like the USDA Wetlands Reserve Program. Municipalities (selectmen, conservation commissions, land trusts, etc.) should also utilize non-regulatory wetlands protection techniques. These techniques include encouraging or purchasing conservation restrictions and use tax assessment strategies that encourage land to be kept in forest, farmland, and recreational/open space lands (MGL Chapter 61, 61A, and 61B) and differential taxation policies allowing for open space to be taxed at a rate significantly lower than for residential or commercial property (MGL Chapter 54, Special Act 797 of 1979).

Public agencies owning barrier beaches (principally municipalities, but also the Massachusetts Department of Conservation and Recreation) should develop management plans for barrier beaches. Municipalities can address this problem through coastal and beach committees. These beach management plans should identify beach protection and restoration strategies, public acquisition goals, and site-specific issues to address wetland and habitat protection, and to address issues related to sea level rise and minimizing storm damage impacts.

Education is a vital ingredient in the adoption and implementation of wetland protection and restoration strategies. Non-governmental groups like the Buzzards Bay Coalition should support town meeting articles in support of local wetland bylaws and wetland setback buffers. The Buzzards Bay Coalition should undertake a public awareness campaign to educate residents about the importance of wetlands and the role of conservation commissions in their community.

Other state policies and laws could enhance these local efforts. For example, the Massachusetts Legislature could pass laws that improve protection of Article 97 lands or laws that create state income tax incentives for lands placed in conservation protection.

Financial Approaches

The costs of adoption of regulations or better enforcement are modest compared to restoration. Many training courses are available at little or no cost. Other needed actions, like the restoration of wetlands, or the permanent protection of wetlands and habitat will only be achieved through additional government funding. For example, a funding level of $1 million per year could leverage the protection or restoration of many hundreds of acres annually.

Monitoring Progress

Most of the elements of this action plan can be addressed through tracking programmatic actions, like the adoption or update of bylaw and regulations. Some actions, like numbers of acres lost, restored, or protected are useful metrics, and are already being tracked by DEP or the Buzzards Bay NEP.

Related Action Plans

Many Buzzards Bay CCMP action plans contain approaches and solutions that compliment this action plan. This is true in part because land under surface waters are in fact wetlands under state and federal regulations, and this wetland habitat is greatly affected by water quality. The following action plans are particularly relevant to this action plan: Action Plan 8 Restoring Migratory Fish Passage, Action Plan 9 Protecting Bio-Diversity and Rare and Endangered Species Habitat, Action Plan 10 Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies, Action Plan 12 Protecting Open Space, and Action Plan 13 Protecting and Restoring Ponds and Streams.

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Action Plan 8 Restoring Migratory Fish Passage and Populations

Problem[111]

In the Buzzards Bay watershed, there are more than 8,000 acres of ponds and hundreds of stream miles. Prior to colonial settlements most of these ponds and streams were likely important habitat for fish species that spent portions of their life cycle in both fresh and marine waters. These diadromous species include river herring (bluebacks and alewife), historically the most predominate species, in many rivers. Other locally important diadromous fish are the eel, white perch, rainbow smelt, and sea run brook trout. All these species have declined dramatically in the Buzzards Bay watershed during the past 200 years. Historically, the declines were largely caused by river obstructions, particularly the widespread construction of milldams during the 19th century, but culvert installation, channelization of streams, loss of bordering tree and shrub vegetation, and pollution and sediment discharges have all been contributing factors. The loss of suitable river spawning habitat (gravel bottom streams with fast moving cool water, for example) has affected many species. Water diversion and pumping for agricultural purposes can impede migrations and result in juvenile fish mortality.

All these species will benefit most appreciably from the elimination of obstructions to migration and the creation of more suitable river and stream spawning habitat. In many cases, dam removal may be the best management option, in other cases, new fish ladder installations may be the only practical solution. Improved water management practices by cranberry growers, and preventing excessive drawdowns by municipal water supplies during drought years is important to avoid placing adult and juvenile populations at risk.

In the case of river herring, while there were some modest improvements in certain populations toward the end of the twentieth century, offshore fishing pressures, and bycatch takings have resulted in new dramatic declines. Restoration of river herring populations will require rigorous controls of offshore catch.

Goals

Goal 8.1. Ensure that the migration of fish species between salt and fresh water is unimpeded.

Goal 8.2. To restore degraded stream habitat and stream functions to ensure the diversity and abundance of fish in Buzzards Bay streams.

Goal 8.3. To manage fishing pressures on anadromous fish populations to ensure the fish harvest and bycatch are sustainable.

Objectives

Objective 8.1. Ensure adequate funding of state fisheries restoration programs.

Objective 8.2. Ensure that local, state, and federal fisheries regulators manage better the catch and bycatch of river herring and other diadromous fish to promote their recovery and population sustainability.

Objective 8.3. Improve passageways and remove impediments and obstructions to fish migration.

Objective 8.4. Ensure adequate stream flow for fish migration.

Approaches

State and local managers must identify and restore priority fish habitat sites and remove obstructions to fish migration. Many smaller herring runs need to be elevated as a priority for restoration because of their cumulative benefits. A special focus of the state and towns should be a coordinated restoration of fish habitat along the entire length of the Weweantic River. While these river restoration efforts are underway, the National Marine Fisheries Service, Regional Fisheries Management Councils, and the Atlantic States Marine Fisheries Commission should limit the catch and bycatch of river herring in offshore waters and take other measures. DEP could require, as a condition in all state water withdrawal permits, that there is adequate flow in rivers during adult and juvenile migration periods for species in the stream. Permittees should always be required to use appropriate screening of water withdrawal intakes to prevent stranding, mutilation, entrainment, or impingement of young herring.

Costs and Financing

Developing and implementing designs to repair fish passageway structures in the watershed, and to remove obstacles, including dams, may cost millions. Federal grants can cover some of these costs but state and local government may need to provide additional funding for natural resource staff. Regulatory solutions have negligible costs to government. The installation of a fish counter on a particular stream may cost $10,000 or more.

Measuring Success

The number of restoration efforts undertaken, or quantifying the number of upstream or downstream river miles or pond acres newly accessible or restored are easily tracked. Different management actions may benefit some species and not others. Ultimately, the size of the fish species population will be the best measure of success and can be determined through automated fish counters, observations by volunteers, direct capture, or through catch, mark, and release programs.

[111] In the 1991 Buzzards Bay CCMP, objectives and recommendations relating to fish migration were found in the "Protecting Wetlands" action plan.

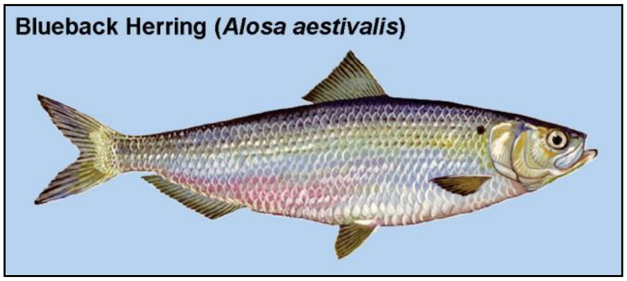

Figure 73. The blueback herring, *Alosa aestivalis*.

Background

For centuries, fish species that migrate between freshwater and saltwater habitat were historically important to the coastal economy and ecosystem of Buzzards Bay. Most of these species including "river herring" (the alewife *Alosa pseudoharengus and* blueback herring *Alosa aestivalis*, Figure 73), white perch, brook trout, tomcod, shad and rainbow smelt are defined as anadromous species because adults come from the sea to lay their eggs in fresh or brackish water. The American eel is defined as catadromous because the adults lay eggs in salt water and the young travel to or mature in freshwater streams and connected ponds. Collectively, anadromous and catadromous species are also called "diadromous" species.

These diadromous species likely inhabited most Buzzards Bay ponds and streams before development (Colette and Klein-MacPhee, 2002). Some of the present day larger diadromous habitat systems in the Buzzards Bay watershed are shown in Figure 72. These diadromous species, particularly the *Alosa* species, were not only once an important local fishery and food source in the Buzzards Bay watershed, but juveniles and adults of these species remain an important food species for many commercially and recreationally important fish, some whales, and many coastal birds, including the Roseate Tern (*Sterna dougallii*), a U.S. endangered species with 60% of the North American breeding population found in Buzzards Bay.

The historical loss of anadromous fisheries is well documented in town records, local historical texts, and state reports because these fisheries were so important to local economies and municipal revenues. Belding even notes how in some Massachusetts towns, widows received herring as a form of public charity.

Historically, river herring (alewife and blueback) were always the most economically important and abundant species in terms of biomass, so the ability of rivers to sustain these species is documented best (e.g. in Belding (1921) and Nelson et al., 2011). In many rivers, the most dramatic herring declines seemed to have occurred between 1800 and 1900 and were related primarily to changes in the natural flow regime of rivers and streams, although sewage and "trade wastes" from saw mills and

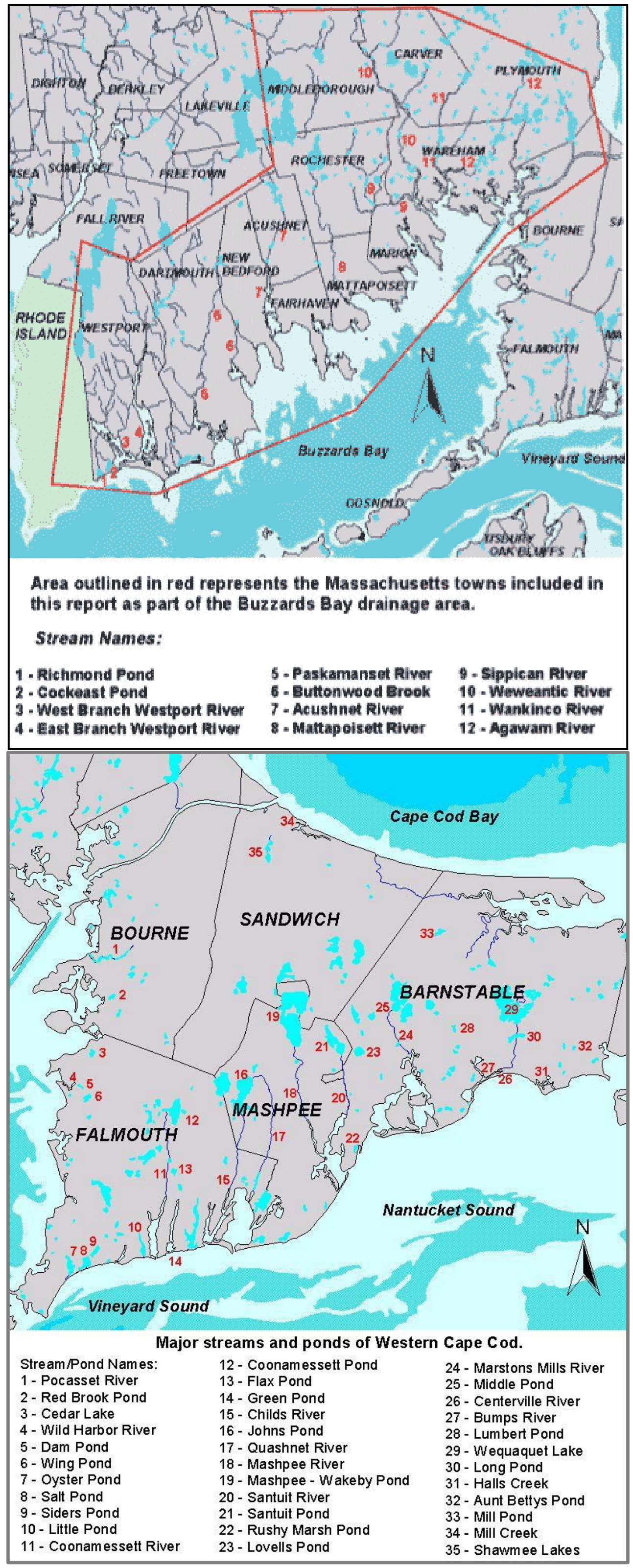

Figure 72. Map of major herring runs in the mainland portion of the Buzzards Bay watershed (top) and on Cape Cod (bottom) as contained in a DMF report.

Figures from Division of Marine Fisheries Technical Report TR-15A and TR-16A Survey of Anadromous Fish Passage in Coastal Massachusetts Part 1. Southeastern Massachusetts (Reback et al., 2004a, b). Note that not all the anadromous streams of Buzzards Bay are shown on these maps.

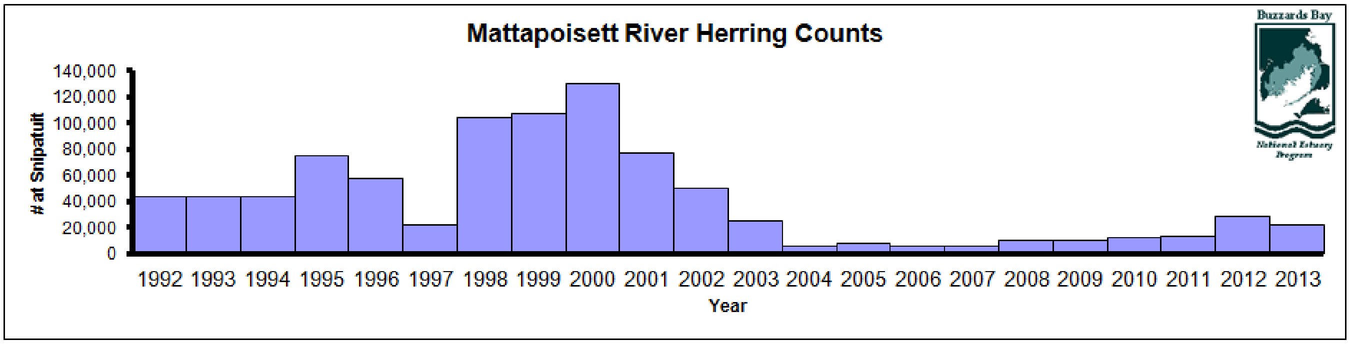

Figure 74. Counts of herring passing upstream as measured by a counter at Snipatuit Pond.
Data courtesy of Alewives Anonymous.

iron works were believed to contribute to some population declines (Belding 1921). Additional alterations in stream flows during the 20th century left most anadromous fish runs decimated compared to conditions in colonial times.

The changes in the natural flow and hydraulic regime of Buzzards Bay streams since colonial times, has also been documented in maps and texts, and can be inferred from other studies. As noted by various authors, prior to European settlement in the Northeast US, beavers were abundant[112], and many small second order streams were not free flowing because beavers dams created a massive network of interconnected streams and ponds (Naiman et al., 1986; Poff et al., 1997). By the early 1700s, beaver populations in southeastern Massachusetts were becoming extirpated (Griffith, 1913[113]; Crapo, 1912[114]). Many of these dams and beaver ponds became the sites of millpond dams to power water wheels for agricultural milling and sawmills, or stream crossings that became roads and bridges (Poff et al., 1997). In many respects, beaver dams and small milldams probably had similar effects on nutrient cycling, habitat, and fish migration, although the magnitude of beaver dam effects are presumably less because of their porosity and intermittent breakage (Hart et al., 2002). Thus, while early milldams and stream crossings may have helped preserve some of the early natural mosaic of beaver created shallow ponds and deep marshes after beaver were extirpated, their static nature and greater height required the creation of fish passage canals and ladders to maintain fish runs.

Belding (1921) and others document both successful and failed attempts to restore fish passage past milldams. Local efforts also included the creation of artificial connections to ponds. The most successful of the redirection of river flow was the connection of Snipatuit Pond to the Mattapoisett River. Formerly the pond connected at its north end to swamps feeding into Quittacas Pond, which then flows to both the Taunton and Acushnet Rivers. Until the past decade, the Mattapoisett River herring run was one of the largest in Buzzards Bay.

Prior to the 1930s, fish passage and river herring management was largely done by towns. After the publication of the Belding reports, there was a movement to establish new Massachusetts General Laws enhancing the ability of the state to better manage fish passage. The Massachusetts DMF created a Fishway Crew whose actions in the 1930s led to large gains in improved fish passage and increased fish abundance in many Massachusetts runs during the 1940s through the 1980s, although other factors could have contributed to these increases. The Fishway Crew continued to construct projects in the 1990s and 2000s but with fewer staff and lower resources due to repeated budget cuts.

In the 1991 Buzzards Bay CCMP, physical obstructions to migration were identified as one possible cause of some recent declines of diadromous species in Buzzards Bay rivers. Other impairments included impediments to spawning migration or escapement of adults or juveniles, overfishing, poor water quality, and habitat degradation (e.g., channelization of streams). Of these, physical obstructions in the form of dams, constraints associated with roadway construction (e.g. collapsing or obstructed culverts), failing fish bypass structures, and other obstructions were presumed to be the greatest impediments to herring migration in Buzzards Bay.

Because of these concerns, during the 1990s and into the 21st century, the Buzzards Bay NEP recommended increased support for the work of the state Division of Marine Fisheries. Where possible, the NEP provided funding and technical support to towns in their work with DMF to improve herring runs in the bay's most productive river systems (Table 28). The Buzzards Bay NEP's efforts, together with the more comprehensive contributions and leadership by the Massachusetts Division of Marine Fisheries (DMF), and actions by local officials appeared to payoff, and in the late 1990s, several area rivers showed increasing return of river herring Figure 74 and Figure 75).

[112] One of the first shipments from Plymouth to England was two barrels of beaver and mink pelts.
[113] Herring were able to migrate up Beaver Dam Brook in Carver.
[114] In a 1731 deposition, a beaver dam is noted by Snipatuit Pond in Rochester.

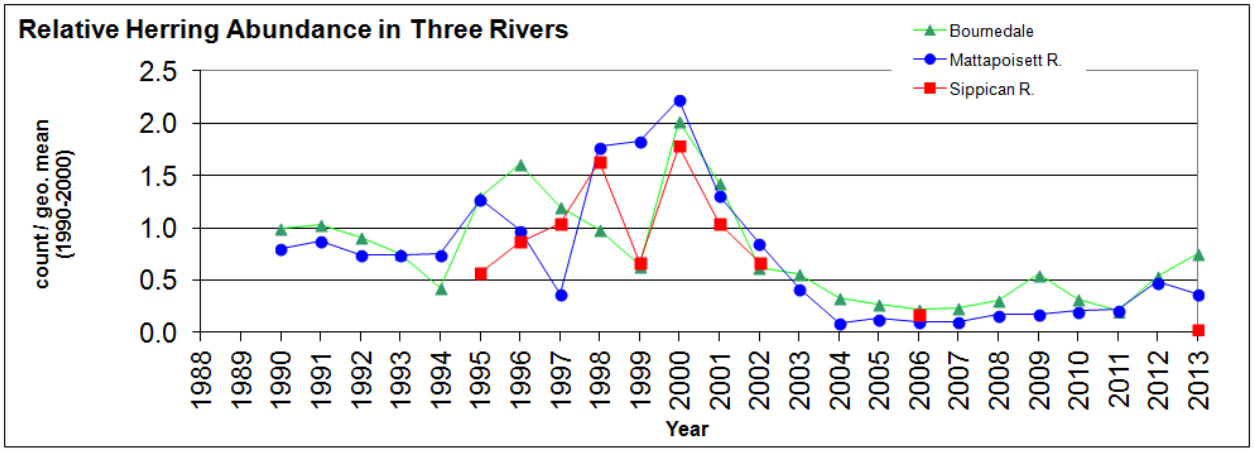

Figure 75. Herring counts in three Buzzards Bay area rivers plotted against the geometric mean of fish abundance during the period 1990-2013.

Note that the geometric mean for the Sippican River during this period was a few hundred fish, whereas the geometric mean for the Herring River for the same period was several hundred thousand fish. Counts were not available for the Sippican river from 2003 to 2005 and 2007-2012 because of various equipment technical issues. Herring River data courtesy of the Massachusetts Division of Marine Fisheries and Alewives Anonymous.

However, after 2000, river herring began to show new unprecedented and precipitous declines. These declines were observed not just in Buzzards Bay, but throughout the eastern seaboard of the U.S. herring runs that might have once had hundreds of thousands of returning fish, now were reported to have declines of 90% or more of the population. These new declines appeared to be independent of improvements or declines in water quality, changes in habitat, or development patterns of each river herring watershed. Thus, in one century, important herring runs like the Mattapoisett River went from sustaining millions of fish around 1900, to hundreds of thousands of fish in 2000, to just over 5,000 fish in 2004.

The large-scale disappearance of river herring in the past decade has generated considerable regional debate about the causes. Factors often cited as contributing to this decline include loss and degradation of habitat, overfishing (including offshore bycatch from ocean herring fisheries), and increased predation due to recovering striped bass populations (NMFS, 2007; Hass-Castro, 2006; Wilson, 2007). In 2006, the NOAA National Marine Fisheries Service designated both blueback herring and alewives as species of concern (NMFS, 2007).

To address alewife and blueback herring declines, Massachusetts implemented a three-year moratorium on the catch of herring in rivers and inshore areas beginning in December 2005. By the end of 2007, bans on herring fishing were also enacted by Rhode Island, Connecticut, and North Carolina.

These bans may have slightly improved stocks as there has been an increase in counts in both the Herring and Mattapoisett River runs by 2012 (Figure 75). Several fishing environmental groups asserted these actions would remain ineffective because overfishing by ocean mid-water trawling was the primary cause of these herring declines[115]. Because of the impacts to herring stocks, and presumed impacts to offshore ground fisheries, in December 2007, several environmental groups filed a lawsuit against the federal government to ban this trawling from certain ground fish areas[116].

Restoration Efforts

Generally, dam removal is one of the most effective strategies to increase anadromous fish spawning habitat upstream of the obstruction. Where dam removal is not an option, fish ladders can be used. Past diadromous fish restoration activities in the Buzzards Bay watershed have been spearheaded by the Division of Marine Fisheries, sometimes prompted or supported by municipalities, and largely focused on the construction and restoration of fish ladders. More recently, the Buzzards Bay Coalition has been initiating steps toward dam removals, both through municipal collaborations, and through the outright purchase of dam containing properties.

In some areas, non-profit organizations have been instrumental in promoting actions by state and federal government, and maintaining fish runs. Most notably, the citizens group Alewives Anonymous has long been a leader managing, promoting, and enhancing the herring runs in Marion and Mattapoisett. Their actions have in-

115 Herring Alliance. 2007. Empty Rivers The Decline of River Herring and the Need to Reduce Mid-water Trawl Bycatch. October 2007. Retrieved from www.herringalliance.org/images/stories/Herring_Alliance_River_Herring_Report.pdf. Last accessed October 2013.

116 Northwest Atlantic Marine Alliance and Midcoast Fishermen's Association versus United States Department of Commerce; case ongoing.

Table 28. Stream and herring restoration efforts in the Buzzards Bay watershed funded by the Buzzards Bay NEP.

Principal Calendar Year	Municipality	Buzzards Bay NEP Grant Award	Short Title	Primary or Secondary Benefits	Description / Comments / Outcome
1996	Mattapoisett	$5,000	Mattapoisett Herring Weir Reconstruction	primary	Construct a new concrete fish ladder and water control structure at the Mattapoisett River Herring Weir. Buzzards Bay NEP funds were to assist the town meet their match requirement on a larger state grant. DMF developed designs and oversaw the ladder construction.
1996	Rochester	$23,000	Snipatuit Road Culvert Replacement	primary	Replace inadequate culverts beneath Snipatuit Road to facilitate fish passage up Mattapoisett River into Snipatuit Pond for spawning.
1996	Westport	$2,241	Adamsville Herring Run Restoration	primary	Construct and install a new 30ft. Denil type fish ladder at Adamsville Pond in Westport. Buzzards Bay NEP assisted in permitting, DMF developed designs.
2001	Falmouth	$19,000	Cedar Lake Herring Restoration	primary	Culvert replacement under Chester St. Addressed some stormwater issues as well.
1998	Wareham	$35,000	Weweantic River Fish Ladder Construction at Horseshoe Pond		Buzzards Bay NEP wrote grant proposal and received funds from DEP and MET to construct a new ladder in the long defunct bypass. Project did not proceed because of failed negotiations between property owner and town.
2003	Falmouth	$16,000	Curley Blvd. Stormwater Discharge Designs	primary	Remediated discharge to Dam Pond above Wild Harbor and included culvert improvements to help herring migration.
2003	Westport	$3,500	Adamsville Pond Herring Ladder Restoration	primary	Included culvert and stream modifications.
2004	Plymouth	$15,000	Agawam River Stormwater Remediation	secondary	Reduce sediment discharges to herring stream.
2005	Fairhaven, Mattapoisett, Rochester	$73,000	Mattapoisett River Valley Aquifer Project	secondary	Multiple grants in 2004-2005 involving the purchase of lands or CRs for open space protection on hundreds of acres within water supply area, and protect stream water quality.
2005	Plymouth	$15,000	Agawam River Stormwater Remediation Project	secondary	Installation of BMPs along Mast Road with secondary benefits to stream water quality.
2006	Westport	$10,045	Cockeast Pond Culvert Replacement & Herring Run Improvement	primary	Replace defective culvert & improve fish approach on River Road. Buzzards Bay NEP assisted with permitting.
2009	Rochester	$7,500	Sippican River Sediment Sampling	secondary	The town used project funding to conduct sediment sampling on the Sippican River/Hathaway Pond and to obtain a legal opinion on water and access rights related to the removal of Hathaway Pond Dam as part of an evaluation of the feasibility of dam removal.
2009	Rochester	$20,000	Leonards Pond Anadromous Fishway Improvement	primary	Engineering/construction to replace inefficient wooden Denil fishway. May also provide passage for shad, eels, sea run trout, and river herring.
2009	Bourne	$15,000	Fishway Restoration Phase I	secondary	Survey the fishway, surrounding salt marsh and assess the feasibility of restoring the fish run.
2010	Bourne	$45,000	Herring Pond Ladder Improvements	primary	Replace collapsed culvert that is the sole entrance and exit point for a 376-acre pond that is prime herring spawning habitat.

Includes all projects completed after the completion of the 1991 Buzzards Bay CCMP.

cluded volunteer efforts to clean debris and trash from fish runs, and to enact other stream restoration efforts.

To better evaluate stream condition and the success of restoration efforts, the Buzzards Bay Coalition has organized volunteers to monitor herring runs, assist with herring counts, track the condition of herring runs, and monitor stream flows. They have also added, or will soon add, electronic fish counters to the Agawam, Wankinco, Acushnet, Sippican, and Weweantic Rivers. The Massachusetts Division of Marine Fisheries has embraced these and similar efforts and have held workshops and produced guides for the collection of data by these volunteers[117].

Most municipalities in Buzzards Bay have a herring inspector or other natural resource officer fulfilling that role. These individuals are responsible for enforcing herring catch limits, permit compliance, condition of the herring run, and sometimes maintenance of water control structures. In most instances, the demands of herring management far exceed the time availability of these municipal officers.

During the 1990s several river systems in the Buzzards Bay watershed were identified as priorities for herring restoration by DMF and the Buzzards Bay NEP including the Mattapoisett River, Weweantic River (in-

[117] Information Retrieved from www.mass.gov/eea/agencies/dfg/dmf/programs-and-projects/anadromous-fish-restoration.html. Last accessed April 22, 2013. See also Nelson (2006) at www.mass.gov/eea/docs/dfg/dmf/publications/tr-25.pdf.

cluding the Sippican River tributary), and the Agawam River. More recently, the Buzzards Bay NEP provided funding or technical assistance (in partnership with DMF) to a number of municipalities to help restore some of the of smaller herring runs including the Adamsville Pond system in Westport.

Herring Fishery

With the disappearance of the American shad from most Massachusetts rivers during the 1800s, herring became the most abundant and economically important diadromous species (Belding, 1921). Even today, blueback herring, and the alewife in particular remain, one of the most abundant of the diadromous fish. There are roughly 8,000 acres of open pond and lake systems in the Buzzards Bay watershed, but probably less than 40% of this area is accessible to alewife. A list of the ponds and major existing herring runs and habitat are shown in Table 29.

Although less important today than in past centuries, the commercial and recreational herring fishery remains relevant. Smoked or kippered herring and egg roe (served for example in omelets) remain local delicacies. Many more fish are captured as bait for recreational fisherman and lobster traps.

Prior to the 2005 moratorium on the taking of herring statewide, the taking of river herring was prohibited on Tuesdays, Thursdays, and Sundays, and they could be caught only with hand-held dip nets. River herring are also subject to additional regulations that may be imposed on the local community, and fishing may be banned from certain runs if the population is threatened.

The Mattapoisett River Herring Run

The DMF herring surveys (Reback et al., 2004a-b) contain good summaries of anadromous fish runs and impairments in the Buzzards Bay watershed, but because the Mattapoisett River run is the largest in Buzzards Bay, and considerable effort has been applied to its restoration, it is worth providing an overview of this run.

The Mattapoisett River, which begins at the 731-acre Snipatuit Pond in Rochester and flows 20 miles south to its discharge into Mattapoisett Harbor, has historically contained the watershed's most productive and abundant herring populations[118]. At the turn of the twentieth century, the river had an estimated annual sustainable yield of 3,000 barrels, or approximately 1.4 million fish, with the total fish stock estimated at 1.8 to 1.9 million fish per year, and was one of the best herring streams in the Commonwealth (Belding, 1921). During the past 30 years, the highest count observed was in 2000, with 130,000 fish, or 7% or less than the circa 1900 fish stock.

Table 29. Acreage of existing Buzzards Bay alewife pond habitat.

River	Pond	Acres	Pond Primary Location
Acushnet River	Acushnet Sawmill Pond	8	Acushnet
Acushnet River	Hamlin Street	5	Acushnet
Acushnet River	New Bedford Reservoir	233	Acushnet
Agawam River	Halfway Pond	229	Plymouth
Agawam River	Pond above Glen Charlie	34	Plymouth
Agawam River	Glen Charlie Pond	168	Wareham
Agawam River	Maple Park	20	Wareham
Agawam River	Mill Pond	138	Wareham
Agawam River	Besse Bog Reservoir	34	Wareham
Agawam River	Kennard Bog	19	Wareham
Cedar Lake Ditch	Cedar Lake	21	Falmouth
Cockeast Pond Stream	Cockeast Pond	101	Westport
Gibbs Brook	Dicks Pond	47	Wareham
Herring Brook	Wings Pond	26	Falmouth
Mattapoisett River	Rochester Fish Hatchery	32	Rochester
Mattapoisett River	Snipatuit Pond	731	Rochester
Monument (Herring) River	Great Herring Pond	413	Plymouth
Monument (Herring) River	Little Herring Pond	81	Plymouth
Red Brook (Buttermilk)	White Island Pond	322	Plymouth
Red Brook Conrail Run	Red Brook Pond	19	Bourne
Richmond Pond	Richmond Pond	54	Westport
Russells Mills Pond	Paskamanset/Slocum	4	Dartmouth
Sippican River	Leonards Pond	53	Rochester
Sippican River	Hathaway Pond	19	Rochester
Wankinco River	Tihonet Pond	93	Wareham
Wankinco River	Parker Mills Pond	82	Wareham
Westport West Branch	Grays Mill Pond	3	Little Compton
Weweantic River	Horseshoe Pond	45	Wareham
Wild Harbor River	Dam Pond	7	Falmouth
Total		2,943	

Areas as reported in Reback (2004a) or as calculated by the Buzzards Bay NEP from apparent water surface boundaries, including some deep marsh area, as defined in 2009 DEP wetland conservancy maps and 2009 MassGIS aerial photographs. The area of some ponds has been variable. For example, Horseshoe Pond, which consists of roughly 32 acres of open water and 17 acres of deep marsh (circa 2009 imagery), has been variable during the past decade because of changes in water control structures. The site is also tidally influenced, and occasionally has intrusion of salt water. Some of the passages to these ponds, including Horseshoe Pond, are in poor or impaired condition. The value of pond habitat, and the biomass of fish it can sustain, is a function of pond depth (volume) and other factors. Great Herring Pond is on the boundary of the Buzzards Bay watershed and is often allocated to watersheds of Cape Cod Bay.

Local and state efforts, starting in around 1990, some partially funded by the Buzzards Bay NEP, helped allow the recovery of the herring population in the Mattapoisett River during the late 1990s. Specifically, near the river's headwater spawning area in Snipatuit Pond, five culverts beneath Snipatuit Road were undersized (30" diameter and submerged). Because herring typically migrate during daylight hours and lighted passages are required for migration, these long darkened culverts presented a significant obstacle to their upstream migration. The Buz-

[118] Snipatuit Pond originally was connected to Quitticas Pond, but about 1755, colonists of Rochester dug a ditch to connect the Pond to the Mattapoisett River to establish a new run on that river.

zards Bay NEP funded solution included replacement of the small culverts with a single large box culvert, which would allow more light to reach the interior of the culvert and eliminate the existing obstacle to migration. The construction was performed by the Rochester Highway Department with guidance provided by the Massachusetts Division of Marine Fisheries.

Near the river's mouth at the Route 6 dam, additional problems were impeding fish passage on the Mattapoisett River. The fishway at the dam restricted upstream passage of alewives because it was both too steep and too turbulent. In addition, water elevations at the dam, which are controlled for municipal water supplies, required better management during normal operating conditions and during herring run season (March through May).

To accomplish these connected goals of improving the fish ladder and improving water management, the towns of Mattapoisett, Marion, Rochester, and Fairhaven joined together to seek funding for the project. Improvements to the dam structure were funded by the Commonwealth of Massachusetts with local support from each town. Additional funds for the fishway were provided by the Buzzards Bay NEP. The Massachusetts Division of Marine Fisheries helped design the Denil-type fish ladder and guide the installation efforts in December 1996.

At the time, this project resulted in a dramatic increase in herring population, and was considered a success story. While there were some improvements in the herring population to about the year 2000, (possibly due in part to the fish passage restoration efforts), the herring population began a collapse beginning in 2001 (see Figure 74). This new collapse, seen across most area fish runs, could be related to offshore fishing pressures or other factors.

The Weweantic River

The Weweantic River run is a historically noteworthy run. Until the late 1800s, river herring passed all the way up the Weweantic River to Federal Pond (36 acres), Crane Brook Pond (today 38 acres), and Sampson Pond (302 acres), and along another tributary all the way to Wenham Pond (48 acres) near the Middleborough border[119] (Figure 77). However, this run eventually was destroyed by modifications to the Tremont Pond dam[120]. At present, passage of anadromous fish only occurs in

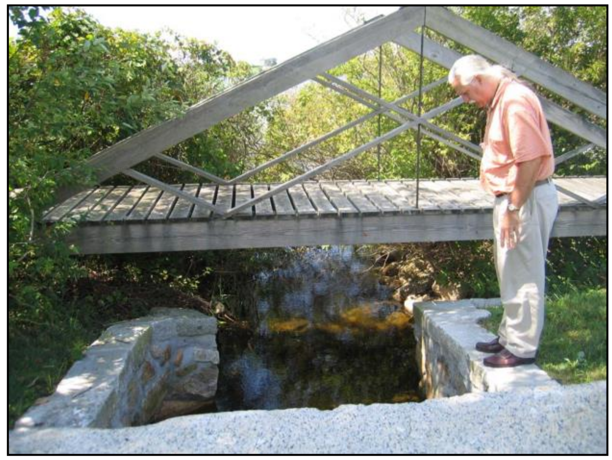

Figure 76. This water level control structure at Cockeast Pond, Westport was modified to enhance herring passage.

Many small runs need less infrastructure and cost less to restore anadromous fish passage.

Horseshoe Pond, and in the river below Tremont dam[121], although passage at the dam is considered generally ineffective (Reback et al., 2004a). The pond has become somewhat tidal because a central gate in the dam was removed sometime in the 1980s or 1990s (Figure 78).

Any anadromous fish restoration strategy for the upper Weweantic River will be defined by the restoration approach taken at Tremont Pond. That is because the dam at Tremont Pond[122] is now an insurmountable barrier to anadromous fish, cutting off hundreds of acres of ponds and dozens of miles of upstream habitat. Because water in the dam is 24 feet above stream level, either a fish elevator, or an expensive series of ladders and pools would need to be installed if the pond were to be preserved. Dam removal would only be viable if a broad consensus were developed between the town, abutters, and various agencies, and adequate financing available. Because Tremont Pond (31 acres) and all the previously mentioned former herring ponds upstream total 550 acres, a comprehensive Weweantic River anadromous fish restoration effort would increase anadromous fish habitat appreciably in the Buzzards Bay watershed.

The Weweantic River is of note because it contains the state's only rainbow smelt run with a spring taking allowed with net fishing (Reback, 2004a). Currently the smelt, which must lay their eggs in brackish water, only use the lower river to the Horseshoe Pond dam. In the 1990s, DMF had developed designs for the installation of a Denil Ladder at Horseshoe Pond (Reback, 2004a), but the project fell through because a lack of agreement with the dam owner of the time. More recently, the Buzzards Bay Coalition has purchased the dam property with

[119] See maps and sources at buzzardsbay.org/weweantic-herring-historical.html. Historical documents like Bliss (1888), Griffith (1913), and an 1815 description of the Town of Carver touch upon these historic pathways and ponds.

[120] There may have been a poorly function bypass up until the 1890s, but Belding (1921) suggested the vibrant historical Weweantic River run was all but destroyed by the creation of the first dam in the 1860s.

[121] See photos and observations reported at glooskapandthefrog.org/weweantic%20river%20revisited.htm.

[122] The dam is owned by the Town of Wareham and was once a functioning hydroelectric dam.

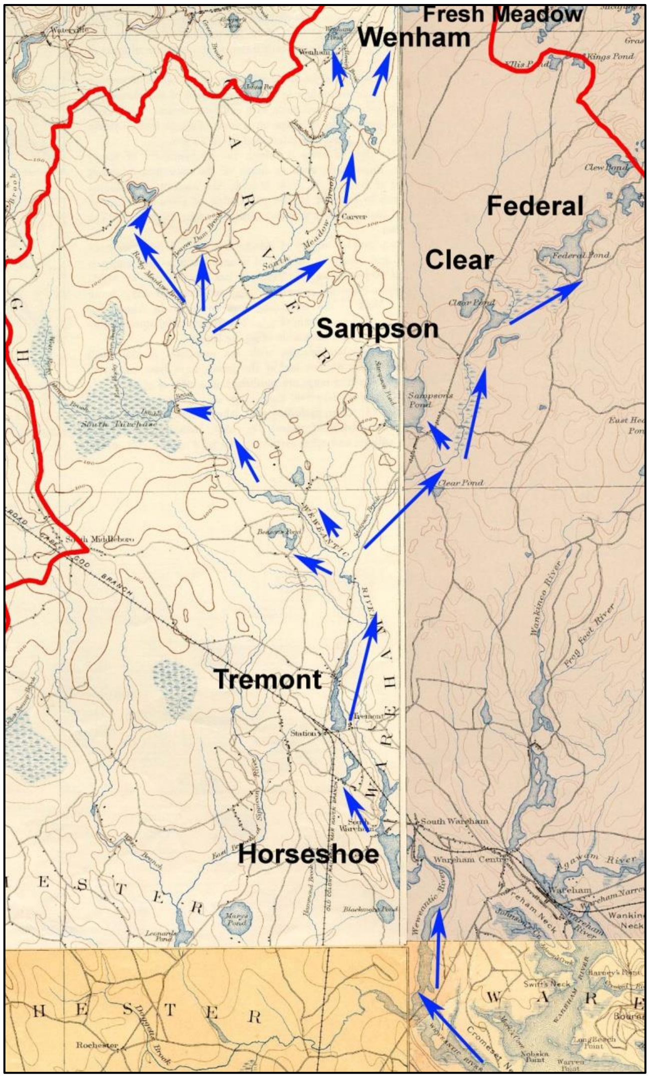

Figure 77. Likely Weweantic River diadromous fish passage prior to the 1890s.

Additional explanation at buzzardsbay.org/weweantic-herring-historical.html.

the intention of addressing the problems created by the dam, and the project is under consideration as part of the 2003 Bouchard oil spill natural resource damage restoration effort[123].

Smaller Herring Runs

There are a few small ponds in Buzzards Bay that may be used by herring and anadromous fish, and which are not in DMF's herring surveys. In fact, wherever there is a stream with unimpeded passage to a small pond, some number of river herring will attempt to travel to the pond. Some of these smaller ponds are functioning well for their size; others have various degrees of impairments.

Photo courtesy of Tim Watts.

Figure 78. Horseshoe dam during a spring high tide (view looking upstream).

Saltwater intrusion occurs in the pond during spring tides and storm surge conditions, allowing some fish passage.

Major Issues

Dam Removal

Dams not only impede the migration of diadromous fish, but they create environments that favor warm water and pond (lotic) spawning species, over species that favor cool water stream (lentic) habitats. As noted in ASFMC (2009), "wherever practicable, tributary blockages should be removed, dams should be notched, and bypassing dams or installing fish lifts, fish locks, fishways, or navigation locks should be considered. Full dam removal will likely provide the best chance for restoration; however, it is not always practicable to remove large dams along mainstream rivers." Whether or not dam removal is practical also depends in part on a variety of social, political, flooding, water rights, aesthetic, and other values associated with the water impoundment created by the dam (Lane, 2006). The discussion of these costs and benefits often becomes emotionally charged (Stanley and Doyle, 2003).

In this context, selecting sites for dam removal requires careful assessment to determine the costs, environmental benefits, public and private liabilities, and costs of maintaining dams that may be unsafe, whether any rare or endangered species would be affected by the loss of adjoining surface waters and bordering vegetated wetlands, and other factors. Many ponds in the Buzzards Bay watershed are agricultural impoundments, particularly cranberry bogs. Removal or alteration of these dams may involve complex water rights issues.

The removal of dams often involves an assessment of what is the natural flow regime for a particular river or stream. As noted above, the natural flow of rivers in the Buzzards Bay watershed have a long history of alteration beginning with the extirpation of beavers in colonial times, the construction of numerous mill and road dams in the 17th and 18th century, and the frequent channelization of streams through culvert installation during the

[123] October 2, 2011 Boston Globe article, *$6M in hand, coast restoration is next*, at www.boston.com/news/local/articles/2011/10/02/oil_damage_settlement_to_be_used_to_restore_buzzards_bay/. Last accessed October 11, 2013.

expansive road construction and urbanization of the 20th century.

The cost of removing old milldams varies greatly and is site specific. Because small rivers flowing from impoundments can be impaired by many other stressors, Poff and Hart (2002) have argued that because dam removal can sometimes be expensive, and because the ecological effects of dam removal are hard to predict, "scientists need to develop a better framework for characterizing dams according to their current environmental effects, as well as to the potential environmental benefits that could accrue following removal."

Whatever management solution is selected for a particular river will affect diadromous species differently. Alewife and bluebacks are capable of spawning in a variety of freshwater environments in Massachusetts, but bluebacks tend to spawn in more riverine areas with gravel beds, whereas alewives tend to spawn in more lacustrine (ponds and lakes) areas (Nelson et al., 2011). Consequently, it has been noted that removal of dams on smaller high-order tributaries is more likely to benefit alewives rather than bluebacks or other shad (ASFMC, 2009; Waldman and Limburg 2003).

To date, only one large dam in Buzzards Bay was partially removed. In 2007, Buzzards Bay Coalition and other partners partially removed the dam at the former Acushnet Sawmill using New Bedford Superfund NRDA funds. At Hamlin Street, a series of step-pool weirs were created with granite blocks to create a fish passage system. These projects now allow river herring and American eel to better access the entire 8-mile length of the Acushnet River, the Acushnet River Reservoir, and other upstream habitats. On the Weweantic River, the removal of the dam at Horseshoe Pond was under consideration, as is the dam at Hathaway Pond on the Sippican River. Both dams are owned by the Buzzards Bay Coalition, although the Hathaway Pond dam may soon be transferred to an abutting cranberry bog operator for management for a 10-year period while water use issues are resolved.

Difficult Restoration Sites

In Belding's 1921 treatise on the alewife fishery of Massachusetts, he summarizes obstacles facing many of the runs in Buzzards Bay, including the need to construct fishways at a number of dams, or to enable passageways through certain bog systems. Many of the obstacles identified by Belding's report remain a problem 90 years later, notably including the need for fishways at Lake Noquochoke, Russells Mills, and Smith Mills dams in Dartmouth, and Tremont Pond dam in Wareham. Because of elevations at these sites, they require appreciable expenditures for ladders, perhaps approximately hundreds of thousands of dollars each. The lack of action at these sites may partly be the result of low priorities and lack of funding to municipal and state natural resource agencies. The installation of a fishway at Noquochoke is a particularly interesting case because it could also lead to access of pond habitat that did not exist in Belding's time. The 621-acre Copicut Reservoir at the headwaters of the Copicut River was not built until 1972.

Table 30. List of potential alewife pond habitat and acreage in the Buzzards Bay watershed.

River	Pond System	Acres	Primary Location of Pond
Agawam River	Half Way Pond	229	Plymouth
Bourne Pond Brook	Bourne Pond	11	Bourne
Buttonwood Brook	Buttonwood Park Pond	10	New Bedford
East Branch Westport	Copicut Reservoir	621	Dartmouth
East Branch Westport	Cornell Pond	16	Dartmouth
East Branch Westport	Lake Noquochoke	181	Dartmouth
East Branch Westport	Forge Pond Dam	4	Dartmouth
Mattapoisett River	Tinkham Pond	22	Mattapoisett
Paskamanset/Slocum	Smith Mills Dam	5	Dartmouth
Paskamanset/Slocum	Turner Pond	95	Dartmouth
Pocasset River	Mill Pond	1	Bourne
Pocasset River	Shop Pond	2	Bourne
Pocasset River	The Basin	2	Bourne
Pocasset River	Freeman & Upper Pond	4	Bourne
Wankinco	East Head Pond	85	Plymouth
Weweantic River	Sampson Pond	302	Carver
Weweantic River	Federal Pond	126	Plymouth
Weweantic River	Crane Brook Bog Pond	38	Carver
Weweantic River	Dunham Pond	49	Carver
Weweantic River	Wenham Pond	48	Carver
Weweantic River	Tremont Mill Pond	36	Wareham
Total		1,717	

The Buzzards Bay NEP calculated areas based on water surface boundaries, including some deep marsh area, as defined in 2007 DEP wetland conservancy maps. Some of these ponds, like those on the Weweantic River and Westport East Branch would never become accessible without overcoming the first dam on each system (Tremont Pond and Lake Noquochoke dams respectively), and even then, each subsequent pond may pose its own special set of obstacles. The value of pond habitat, and the biomass of fish it can sustain, is a function of pond depth (volume) and other factors.

Minor versus Major Habitat

As noted in the Division of Marine Fisheries Herring Atlas: "With a small number of exceptions, the important river herring spawning/nursery habitats on coastal streams have been made accessible through the construction of fishways. Many of these structures have become deteriorated and are often of obsolete design. The emphasis of future work should be on the replacement of these fish ladders in order to preserve or augment the populations they serve rather than to create new populations by accessing minor habitats" (Reback et al., 2004a). DMF prioritizes sites based on habitat quantity and quality and assessments of potential herring spawning and nursery habitat, the likelihood of success, and restoration potential and feasibility.

While this approach and policy makes sense from the state level in terms of allocating state resources, from the municipal perspective, some communities may host a number of impaired "minor habitats," and they may have a strong desire to restore these sites. Small pond systems often have small costs associated with their repair (culvert replacements, one or two-step concrete ladders). Adding fish passageways to some of these small pond systems could add hundreds of acres of alewife habitat to the Buzzards Bay watershed, so creating access to these ponds has merit. For example, the Buzzards Bay NEP funded two small herring projects in Falmouth, and one in Westport for a cumulative cost of $10,700 (Table 28). Cumulatively the surface area of minor ponds in Buzzards Bay exceeds the area of all the great ponds combined, although admittedly, many of these small ponds do not have the habitat quality of the larger systems, and with their smaller volumes, sustain less fish biomass than larger systems. Ultimately, the costs and benefits must be weighed in the face of limited availability of restoration funds at the local and state government.

Most large coastal freshwater systems in the Buzzards Bay watershed now have migratory fish access (with some notable exceptions like the upper Weweantic River) and improving deteriorated or poorly functioning structures will likely provide the greatest benefits at the least cost (per fish restored). Nonetheless, many of the larger restoration projects remain difficult to implement because of the high costs (e.g. Tremont Dam).

Water Management Issues and Bog Operations

Concerns are often raised about the potential impact of cranberry bog operations on herring passage and survival. As noted in the DMF herring reports (recommendations in Table 31), "large numbers of young herring are killed each year due to cranberry bog operations" (Reback, 2004a-c). Some of the past impacts could have been avoided by simple and inexpensive screening systems on water intakes and flumes. This led DMF to recommend that withdrawal permits issued by the state not only ensure that there is adequate flow in rivers during juvenile fall downstream migrations, but that permittees use appropriate screening of water withdrawal intakes to prevent stranding, mutilation, entrainment or impingement of young herring. Because of these concerns, in 2004 the Cape Cod Cranberry Growers Association worked with DMF and issued a grower advisory on protecting anadromous fish[124]. The advisory includes recommended practices for ensuring the springtime passage of adults and the fall passage of juveniles. Included in the advisory is a formula for sizing screens to prevent juveniles from being injured by the screen, and how to remove fry that have entered a bog.

While there has been increased awareness of the problem, and cranberry growers increasingly have implemented these practices, sometimes they have not. For example, in October 2010, thousands of juvenile herring were killed during harvesting in a North Falmouth cranberry bog[125].

The DMF has stressed that local officials and property owners often ignore the downstream passage of adults and juveniles, and juvenile mortality in particular can be an important limiting factor in population productivity. An often-reported impact is that water withdrawals or diversions can strand or kill thousands of juvenile fish. DMF (2004) notes "Large numbers of juvenile herring are killed each year due to cranberry bog operations. A simple, inexpensive screening system has been developed which will prevent most of these losses. Despite publicizing the availability of this system through industry media, growers have been reluctant to utilize it. Appropriate screening of water withdrawal intakes to prevent stranding, mutilation, entrainment, or impingement of young herring should be made a condition of any state permits required for the agricultural operation."

A related problem is that of strandings or cessation of stream flows that may be caused by heavy summer and fall withdrawals by municipal water suppliers or cranberry growers that cause the cessation of stream flow, or drops water levels in ponds that preclude juvenile migration. The issue is becoming increasingly problematic on the Mattapoisett River where continuing large municipal withdrawals during drought years, coupled with water diversions for cranberry operations have caused the river to run dry during critical herring migration periods. In Massachusetts, among 39 fish kills investigated in 2011, four were caused by "human-induced low-water conditions."[126] This issue has prompted DEP to initiate a Streamflow Criteria Workgroup to address this and other streamflow problems. Additional discussion of the topic is found in Action Plan 10 Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies.

Other Issues Identified by DMF

As noted in various DMF reports, river herring fisheries are mostly under local control through the authority granted by Section 94 of Chapter 130. Many towns however, are unaware that changes in their local regulations

[124] Retrieved from www.cranberries.org/pdf/advisories/fish_advisory.pdf. Last Accessed October 1, 2013.

[125] Gouveia, A. 2010. Cranberry grower charged in herring kill. Cape Cod Times. December 28, 2010. Retrieved from www.capecodonline.com/apps/pbcs.dll/article?AID=/20101228/NEWS/12280311/-1/rss02.

[126] Annual Report 2011. Massachusetts Division of Fisheries & Wildlife, 94pp.

must be approved of the Director of the Division of Marine Fisheries. In their 2004 report (Reback, 2004a-c) DMF recommended that "In order to insure biologically sound and legally valid local management, the Director should inform cities and towns of this condition and request them to submit current regulations and subsequent changes for approval."

Accidental release of pesticides from agricultural lands causing dramatic losses of juveniles is another recurring problem.

Shoaling of pond outlets and encroachment of vegetation has affected river herring populations in some systems. The deposition and shoaling of sediments, in combination with late season water levels has prevented the migration of large portions of juveniles. Increased water drawdowns by agriculture or public water supplies (both groundwater and surface waters) often exacerbate these problems. At sites with these recurring problems, DMF recommends the installation and maintenance of outlet structures that would retain depth, reduce deposition, and provide for easier maintenance. The emphasis of diadromous fish management in coastal streams has focused on river herring and American shad. Consequently, little is known about white perch, rainbow smelt, and tomcod populations in the Commonwealth. DMF has recommended that more resources should be directed toward these species and management strategies that would protect them be developed. The stocking of shad has been largely unsuccessful in Massachusetts. The Division of Marine Fisheries has recommended development of a program similar to that successfully adopted in other states of taking eggs by constructing a hatchery to rear fish to fry size before their release. This technique, however, may not be applicable to river and tributary habitat of Buzzards Bay.

Obligations and responsibilities of dam owners

MGL Chapter 130 Sections 19, 93, and 94, states that private property owners have the responsibility to provide fish passage if required by the Director of DMF. In recent years, repair mandates and enforcement actions against dam owners has been rare. Property owners need to be made better aware of their responsibilities defined in this statute. Property owners should also be made aware that their financial burdens could be ameliorated by state and federal restoration grants and technical assistance.

Management Approaches

Because offshore bycatch appears to be the one of important contributors to river herring population declines in Massachusetts, it should be an important focus of fisheries research and regulatory agencies. Management of bycatch is complex and requires action, controls, and coordination of the New England and Mid-Atlantic Regional Fisheries Management Councils, the Atlantic

Table 31. General recommendations for Massachusetts herring restoration.

From Reback et al., 2004b (with minor editing).

1. With a small number of exceptions, the important river herring spawning/nursery habitats on coastal streams have been made accessible through the construction of fishways. Many of these structures have become deteriorated and are often of obsolete design. The emphasis of future work should be on the replacement of these fish ladders in order to preserve or augment the populations they serve rather than to create new populations by accessing minor habitats.

2. Most river herring fisheries are under local control through the authority granted by Section 94 of Chapter 130. Many towns having this control, however, are unaware that approval of the Director of the Division of Marine Fisheries is required by the statute and often change their regulations without consulting DMF. In order to insure biologically sound and legally valid local management, the Director should inform cities and towns of this condition and request them to submit current regulations and subsequent changes for approval.

3. River herring passage issues have dealt primarily with upstream migration of adults. Downstream passage of adults, and more importantly juveniles, has been largely ignored, and in some systems may be an important limiting factor in population productivity. Future work should take this into consideration and place appropriate emphasis on this phase of the life cycle and the problems that are associated with it.

4. Large numbers of juvenile herring are killed each year due to cranberry bog operations. A simple, inexpensive screening system has been developed which will prevent most of these losses. Despite publicizing the availability of this system through industry media, growers have been reluctant to utilize it. Appropriate screening of water withdrawal intakes to prevent stranding, mutilation, entrainment, or impingement of young herring should be made a condition of any state permits required for the agricultural operation.

5. Shoaling of pond outlets and encroachment of vegetation has seriously affected river herring populations in some systems. Deposition of sandy material at the outlets in combination with low late summer/fall water levels has prevented the escapement of large segments of year classes and caused them to be lost to the population through winterkill or greatly reduced growth rates. Outlet structures that would retain depth, reduce deposition, and provide for easier maintenance, should be developed and installed at stream outlets where appropriate.

6. The emphasis of anadromous fish management in coastal streams has been on river herring, American shad and rainbow smelt. Consequently, little is known about white perch and tomcod populations in the Commonwealth. In the future, more attention should be directed toward developing more protective management strategies for these species.

7. Several large coastal streams, notably the Taunton, Charles, and Neponset Rivers, appear to have excellent potential for development of American shad populations. Many years of stocking with adult fish and eggs have yielded negligible results, however. Other states have had success through hatchery egg taking and rearing to fry size before release. This technique should be developed in Massachusetts and applied to the above streams.

8. Removal of dams should be considered as an alternative to fishway construction where appropriate.

States Marine Fisheries Commission, and the NOAA National Marine Fisheries to limit the catch and bycatch of river herring in offshore waters. This also means the New England and Mid-Atlantic Fishery Management Councils would need monitor more effectively the river herring bycatch. To protect river herring, the Secretary of Commerce should consider taking emergency action to implement these new measures where actions can be supported by research.

Because a large area of upstream habitat remains inaccessible in the Weweantic River watershed, DMF should consider and evaluate the fish ladders, bypasses, and dam removal options at Horseshoe Pond and the Tremont Pond dam. A fish elevator at Tremont Pond may cost hundreds of thousands of dollars, but the costs of dam removal may be higher and might involve the loss of dozens of acres of pond.

Water diversion and pumping for agricultural purposes is one of the most significant causes of juvenile herring fatalities. Simple requirements like requiring screens on intakes can greatly mitigate these impacts. Better management of water withdrawals is needed on some Buzzards Bay watershed rivers and tributaries. DEP could require, as a condition in all state water withdrawal permits, that there is adequate flow in rivers during juvenile fall downstream migrations. Permittees should always be required to use appropriate screening of water withdrawal intakes to prevent stranding, mutilation, entrainment, or impingement of young herring. The costs for the state to implement such requirements are negligible, and would be modest for water withdrawal permittees. Adoption of new rules and regulations could be achieved within two years of initiation of such an effort.

Many smaller herring runs may be a priority for restoration by municipalities, even though they may not be a priority by the state for funding. DMF already provides local assistance, but due to workforce and financial constraints, restoration of minor habitat is a low priority. While the state does not have the personnel and funding to restore the many lesser anadromous fish passageway impairments in the Buzzards Bay watershed, municipalities interested in restoring minor anadromous fish habitats should seek guidance from DMF on restoration strategies and secure local sources of funding.

The legislature should dedicate more funding to DMF to undertake its mandates and to fund more investigations of white perch, tomcod, sea run brook trout, and other less well studied anadromous and stream fish populations. Additional staff may be needed to conduct research and monitoring, and the effort might be undertaken in collaboration with university research studies.

DMF and municipal natural resource officers should identify juvenile herring impairment sites and develop written guidelines. They should develop Fishway Operations and Maintenance Plans for each ladder in partnership with relevant growers and property owners, to implement practices to minimize the stranding or destruction of juvenile and adult migrating fish. A watershed evaluation and GIS database could be used to track trouble sites, and would be a useful planning tool for all levels of government. This effort could be undertaken with existing staff. Site-specific written guidelines could help ensure compliance with adopted strategies and promote a better understanding of the problems and solutions for each site. Agreements could also be developed between town natural resource agencies and the property owner. NGOs could facilitate agreements.

Financial Approaches

The regulatory solutions identified in this action plan have negligible costs to government and modest costs to those with water withdrawal permits. Government (state and local) needs to provide some additional funding for natural resource staff and restoration projects. Most of the costs of this action plan are to develop and implement designs to eliminate or repair fish passageway structures and obstacles. These costs could be met through state and federal wildlife and habitat restoration grants, and local funding could be met through town meeting, or local grant programs under the Community Preservation Act. Private dam owners should be made better aware of their responsibilities under MGL Chapter 130 to provide and maintain fish passage, and encouraged to partner with municipalities and the state to attract funding from state and federal sources.

Monitoring Progress

The success of measures undertaken under this action plan can be measured by tracking the abundance of anadromous fish traveling upstream. These counts can be determined through automated fish counters and by the use of volunteers to undertake field counts on representative dates and times. The installation of a fish counter on a particular stream might cost up to $40,000, and federal grants might be available for such devices.

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Action Plan 9 Protecting Bio-Diversity and Rare and Endangered Species Habitat

Problem

The biodiversity of Buzzards Bay and its watershed, particularly populations of locally rare and endangered species, are threatened by habitat loss, alteration, and stresses caused by human activity and pollution discharges. Vital habitats include those that support protected plants and animals, wetlands, fish nursery and spawning areas, submerged aquatic vegetation, and shellfish beds. Protection of these areas can only be achieved by adequate evaluation of threatened species, mapping their habitat, enforcing existing laws, adoption of new laws to create buffers around these habitats, and education of the public and government officials about their importance. The mapped distribution of listed species and vernal pools suggest that not all areas of the watershed have experienced the same level of baseline mapping effort.

The adoption of municipal conservation plans may be another approach to go beyond project permit review and to achieve more comprehensive and effective strategies to protect key wildlife habitat, and to build necessary public support.

Recommendations and discussions related to this action plan are included in Action Plan 7 Protecting and Restoring Wetlands*;* Action Plan 8 Restoring Migratory Fish Passage*;* Action Plan 10 Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies*;* Action Plan 11 Managing Invasive and Nuisance Species*;* and Action Plan 12 Protecting Open Space. This action plan addresses problems not discussed in those action plans, especially those issues relating to the Massachusetts Natural Heritage and Endangered Species Program.

Goal

Goal 9.1. Conserve and protect vital fish and wildlife habitats of Buzzards Bay and in its surrounding watershed.

Objectives

Objective 9.1. Ensure that rare and endangered species areas and vernal pools continue to be mapped and this information made publicly available.

Objective 9.2. Ensure that rare and endangered species habitat is considered in the relevant permit review process.

Objective 9.3. Ensure that important biological and core habitat is protected and conserved.

Objective 9.4. Ensure that the public and government officials are aware of the importance of rare and endanger species and core bio-habitat through effective education efforts.

Approaches

The primary mechanism to permanently protecting the most important habitats in the Buzzards Bay watershed is the purchase or donation of lands for open space protection, or the purchase or donation of conservation restrictions. Municipal conservation commissions and area land trusts should coordinate to both ensure municipal open space plans remain current, and contain clear goals and priorities in targeting the acquisition of priority habitat. Each open space plan update should include the latest information of rare and endangered species habitat, and where appropriate fund inventories to fill data gaps. To provide sufficient funds to meet municipal acquisition goals, all municipalities should consider adopting the Community Preservation Act.

The second most important strategy to protect rare and endangered species habitat is to map accurately these resources. In this regard, municipalities and non-profits should help map listed species habitat and certify vernal pools throughout their community. With technical oversight, volunteers can be trained to map and gather the necessary information to certify vernal pools. Some site investigations can be undertaken by trained individuals using online NHESP reporting tools and species information. Other important habitat types must be mapped by trained wetlands and wildlife biologists. Federal agency staff could provide some assistance to the state in such an effort.

Costs and Financing

Certain costs, like providing trained staff to help organize efforts to certify vernal pools, or update open space plans are relatively modest, and some free technical assistance could be provided by the Buzzards Bay NEP. However, the real cost associated with this action plan is the acquisition of open space and it would be easy for watershed municipalities to utilize several million dollars per year for open space protection. Fortunately, because much of the most desirable land, from an environmental protection point of view, contains considerable areas of wetlands and they are often difficult to build upon, they often have the lowest costs per acre of land available for sale.

Measuring Success

Several direct measures can be tracked for this action plan, with total acres of habitat permanently protected being the most important. Other measures, like the number of vernal pools that have been certified, or species inventoried, are easy to track programmatically. Some species populations within Buzzards Bay or the watershed can be tracked, as is the case with nesting pairs of certain bird species, such as the Roseate Tern and Piping Plover.

Table 32. Total number of MESA listed species (as of 2012) in Buzzards Bay watershed municipalities.

Municipality	Amphibian	Beetle	Bird	Butterfly/ Moth	Crustacean	Dragonfly/ Damselfly	Fish	Mammal	Mussel	Reptile	Vascular Plant	Grand Total
Acushnet									1	1	1	3
Bourne	2	1	11	13		3	1	1	2	3	20	57
Carver			4	3		2	1		2	3	8	23
Dartmouth	1	1	10	11	2	2				2	21	50
Fairhaven			5							2	2	9
Falmouth	1	1	9	12	2	3	2		1	1	26	58
Marion			3	1						2	6	12
Mattapoisett			4	1						2	2	9
Middleborough	1		11	1			1		2	4	9	29
New Bedford	1		5	1	2	2				2	14	27
Plymouth		1	14	19		4	1	2	4	2	25	72
Rochester	1			1			1		2	2	6	13
Wareham	1		5	16		2		1	2	3	18	48
Westport	2	1	4	2					1	1	8	19
Grand Total	10	5	85	81	6	18	7	4	17	30	166	429

There are 149 separate species in the combined list for these towns (47 endangered, 48 threatened, 57 of special concern). Table calculated from summary tables on the NHESP "Town Species Viewer" website at www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/species-information-and-conservation/town-species-viewer.html. Last accessed October 30, 2013.

Background[127]

Natural Heritage & Endangered Species Program

The Natural Heritage & Endangered Species Program (NHESP) is responsible for the conservation and protection of Massachusetts' biodiversity. The primary responsibility of the Natural Heritage and Endangered Species Program is the regulatory protection of rare species and their habitats as codified under the Massachusetts Endangered Species Act ("MESA," MGL Chapter 131A[128]) and Wetlands Protection Act (MGL Chapter131, Section 40). Additional protection is offered under the Massachusetts Forest Cutting Practices Act (MGL Chapter 132, Section 40-46) and supporting regulations (304 CMR 11.00), which require the review of certain forest cutting plans for potential impacts to rare species.

The program is focused on 219 species of vertebrate and invertebrate animals and 256 species of native plants and their habitats that are officially listed as Endangered, Threatened, or of Special Concern under the Massachusetts Endangered Species Act (MESA). A summary of the 149 MESA listed species (47 endangered, 48 threatened, 57 of special concern) in the Buzzards Bay watershed are shown by municipalities and taxa in Table 32 and a complete species list is shown in Table 33. The Program, founded in 1978, is part of the Massachusetts Division of Fisheries and Wildlife, and one of the programs forming the Natural Heritage network. The Natural Heritage & Endangered Species Advisory Committee oversees and guides NHESP activities.

In practical terms, NHESP reviews projects within "Priority Habitats of Rare Species" and "Estimated Habitats of Rare Wildlife" published in the Massachusetts Natural Heritage Atlas[129]. Areas in the latter category, which are a subset of the first category, are used for review of projects under the Wetlands Protection Act. Projects in either category are reviewed for compliance under MESA. These areas, plus another special wetland category-certified vernal pools-are shown in Figure 79. In the permitting process, it is the responsibility of the landowner or project proponent to determine if their project falls within Priority Habitat or Estimated Habitat mapped by the NHESP using published information.

[127] A large portion of the information and text in this action plan was taken from information prepared by the NHESP, particularly information contained on this page: www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/ and the MassGIS website.

[128] The Massachusetts Endangered Species Act (MESA) was enacted in December 1990 (MGL c.131A). Implementing regulations were promulgated in 1992 and revised and implemented as of July 1, 2005 (321 CMR 10.00). The 2005 MESA revisions clarified filing requirements, specified time lines for the review process NHESP must meet, and also implemented fees to help ensure timely reviews and consultations with project proponents.

[129] The atlas is based on observations documented within the last 25 years in the database of the Natural Heritage & Endangered Species Program. Priority Habitat areas are the filing trigger for determining whether or not a proposed project or activity must be reviewed by the NHESP for compliance with the Massachusetts Endangered Species Act (MESA) and its implementing regulations. Areas delineated as Priority Habitats can include wetlands, uplands, and marine habitats.

Table 33. All 149 MESA listed species (as of 2012) in Buzzards Bay watershed municipalities listed in Table 32.

Taxonomic Group Common Name	Scientific Name	# of towns	Last obs.
Amphibian			
Eastern Spadefoot (T)	*Scaphiopus holbrookii*	4	2012
Marbled Salamander (T)	*Ambystoma opacum*	6	2012
Beetle			
Cow Path Tiger Beetle (SC)	*Cicindela purpurea*	4	2008
Northeastern Beach Tiger Beetle (E)	*Cicindela dorsalis dorsalis*	1	2001
Bird			
American Bittern (E)	*Botaurus lentiginosus*	2	1993
Arctic Tern (SC)	*Sterna paradisaea*	2	2010
Bald Eagle (T)	*Haliaeetus leucocephalus*	2	2012
Barn Owl (SC)	*Tyto alba*	4	1985
Common Loon (SC)	*Gavia immer*	2	1921
Common Moorhen (SC)	*Gallinula chloropus*	1	1992
Common Tern (SC)	*Sterna hirundo*	10	2012
Eastern Whip-poor-will (SC)	*Caprimulgus vociferus*	3	2012
Grasshopper Sparrow (T)	*Ammodramus savannarum*	5	2012
King Rail (T)	*Rallus elegans*	2	1995
Least Bittern (E)	*Ixobrychus exilis*	2	1993
Least Tern (SC)	*Sternula antillarum*	8	2010
Long-eared Owl (SC)	*Asio otus*	1	1974
Northern Harrier (T)	*Circus cyaneus*	2	2009
Northern Parula (T)	*Parula americana*	3	1995
Peregrine Falcon (E)	*Falco peregrinus*	1	2010
Pied-billed Grebe (E)	*Podilymbus podiceps*	1	1984
Piping Plover (T)	*Charadrius melodus*	9	2011
Roseate Tern (E)	*Sterna dougallii*	10	2012
Sharp-shinned Hawk (SC)	*Accipiter striatus*	3	2001
Short-eared Owl (E)	*Asio flammeus*	1	historic
Upland Sandpiper (E)	*Bartramia longicauda*	5	2011
Vesper Sparrow (T)	*Pooecetes gramineus*	6	2012
Butterfly/Moth			
Barrens Buckmoth (SC)	*Hemileuca maia*	4	2012
Barrens Dagger Moth (T)	*Acronicta albarufa*	2	2003
Buchholz's Gray (E)	*Hypomecis buchholzaria*	2	2010
Chain Dot Geometer (SC)	*Cingilia catenaria*	6	2006
Chain Fern Borer Moth (T)	*Papaipema stenocelis*	1	2011
Coastal Heathland Cutworm (SC)	*Abagrotis nefascia*	3	2001
Coastal Swamp Metarranthis (SC)	*Metarranthis pilosaria*	3	2011
Drunk Apamea Moth (SC)	*Apamea inebriata*	3	2002
Dune Noctuid Moth (SC)	*Sympistis riparia*	1	2006
Frosted Elfin (SC)	*Callophrys irus*	3	2010
Gerhard's Underwing (SC)	*Catocala herodias gerhardi*	4	2011
Hessel's Hairstreak (SC)	*Callophrys hesseli*	2	1987
Imperial Moth (T)	*Eacles imperialis*	2	2012
Melsheimer's Sack Bearer (T)	*Cicinnus melsheimeri*	3	2008
Oak Hairstreak (SC)	*Satyrium favonius*	1	1996
Pale Green Pinion Moth (SC)	*Lithophane viridipallens*	4	2011
Pine Barrens Lycia (T)	*Lycia ypsilon*	1	2010
Pine Barrens Speranza (SC)	*Speranza exonerata*	4	2011
Pine Barrens Zale (SC)	*Zale lunifera*	3	2011
Pine Barrens Zanclognatha (T)	*Zanclognatha martha*	1	2011
Pink Sallow Moth (SC)	*Psectraglaea carnosa*	4	2010
Pitcher Plant Borer Moth (T)	*Papaipema appassionata*	1	1971
Precious Underwing (E)	*Catocala pretiosa pretiosa*	2	2011
Sandplain Euchlaena (SC)	*Euchlaena madusaria*	1	2010
Slender Clearwing Sphinx (SC)	*Hemaris gracilis*	2	2010
Spartina Borer Moth (SC)	*Photedes inops*	3	2007
The Pink Streak (T)	*Dargida rubripennis*	1	1998
Unexpected Cycnia (T)	*Cycnia inopinatus*	2	2008
Water-willow Borer Moth (T)	*Papaipema sulphurata*	9	2011
Waxed Sallow Moth (SC)	*Chaetaglaea cerata*	3	1986
Crustacean			
Agassiz's Clam Shrimp (E)	*Eulimnadia agassizii*	1	1970
American Clam Shrimp (SC)	*Limnadia lenticularis*	3	1985
Coastal Swamp Amphipod (SC)	*Synurella chamberlaini*	2	2010
Dragonfly/Damselfly		18	2013
Attenuated Bluet (T)	*Enallagma daeckii*	3	2004
Comet Darner (SC)	*Anax longipes*	5	2013
Ocellated Darner (SC)	*Boyeria grafiana*	1	1912
Pine Barrens Bluet (T)	*Enallagma recurvatum*	4	2010
Scarlet Bluet (T)	*Enallagma pictum*	4	2012
Spatterdock Darner (SC)	*Rhionaeschna mutata*	1	2012
Fish			
Bridle Shiner (SC)	*Notropis bifrenatus*	6	2009
Shortnose Sturgeon (E)	*Acipenser brevirostrum*	1	1871
Mammal			
Northern Right Whale (E)	*Eubalaena glacialis*	2	2010
Southern Bog Lemming (SC)	*Synaptomys cooperi*	2	1894
Mussel			
Creeper (SC)	*Strophitus undulatus*	1	2007
Dwarf Wedgemussel (E)	*Alasmidonta heterodon*	2	historic
Eastern Pondmussel (SC)	*Ligumia nasuta*	7	2010
Tidewater Mucket (SC)	*Leptodea ochracea*	7	2011
Reptile			
Blanding's Turtle (T)	*Emydoidea blandingii*	1	1994
Diamond-backed Terrapin (T)	*Malaclemys terrapin*	6	2012
Eastern Box Turtle (SC)	*Terrapene carolina*	14	2012
Eastern Worm Snake (T)	*Carphophis amoenus*	1	historic
Northern Red-bellied Cooter (E)	*Pseudemys rubriventris pop. 1*	6	2012
Wood Turtle (SC)	*Glyptemys insculpta*	2	1993
Vascular Plant			
Acadian Quillwort (E)	*Isoetes acadiensis*	1	2009
Adder's-tongue Fern (T)	*Ophioglossum pusillum*	4	2012
Algae-like Pondweed (T)	*Potamogeton confervoides*	2	1974
American Sea-blite (SC)	*Suaeda calceoliformis*	1	1995
American Waterwort (E)	*Elatine americana*	1	1980
Bayard's Green Adder's-mouth (E)	*Malaxis bayardii*	2	1919
Bead Pinweed (E)	*Lechea pulchella var. moniliformis*	1	1910
Bristly Foxtail (SC)	*Setaria parviflora*	6	2010
Britton's Violet (T)	*Viola brittoniana*	1	1909
Broad Tinker's-weed (E)	*Triosteum perfoliatum*	2	2012
Bushy Rockrose (SC)	*Crocanthemum dumosum*	4	2011
Canadian Sanicle (T)	*Sanicula canadensis*	2	2005
Climbing Fern (SC)	*Lygodium palmatum*	1	2010
Creeping St. John's-wort (T)	*Hypericum adpressum*	1	2008
Dwarf Bulrush (T)	*Lipocarpha micrantha*	5	1990
Eastern Silvery Aster (E)	*Symphyotrichum concolor*	1	1926
Grass-leaved Ladies'-tresses (T)	*Spiranthes vernalis*	2	1981
Gypsywort (E)	*Lycopus rubellus*	3	2000
Heartleaf Twayblade (E)	*Listera cordata*	1	historic
Houghton's Flatsedge (E)	*Cyperus houghtonii*	1	1890
Inundated Horned-sedge (T)	*Rhynchospora inundata*	2	2008
Lesser Snakeroot (E)	*Ageratina aromatica*	2	1935
Linear-leaved Milkweed (T)	*Asclepias verticillata*	3	1915
Lion's Foot (E)	*Nabalus serpentarius*	4	1933
Long-beaked Bald-sedge (SC)	*Rhynchospora scirpoides*	3	2012
Long-leaved Panic-grass (T)	*Panicum rigidulum ssp. pubescens*	5	2012
Long's Bitter-cress (E)	*Cardamine longii*	1	2000
Long's Bulrush (T)	*Scirpus longii*	1	2011
Mattamuskeet Panic-grass (E)	*Dichanthelium dichotomum ssp. mattamuskeetense*	4	1999
Mitchell's Sedge (T)	*Carex mitchelliana*	1	1989
Narrow-leaved Spring Beauty (E)	*Claytonia virginica*	1	historic
New England Blazing Star (SC)	*Liatris scariosa var. novae-angliae*	8	2011
New England Boneset (E)	*Eupatorium novae-angliae*	1	2008
Northern Gama-grass (E)	*Tripsacum dactyloides*	2	2011
Ovate Spike-sedge (E)	*Eleocharis ovata*	1	1992
Oysterleaf (E)	*Mertensia maritima*	1	1857
Pale Green Orchis (T)	*Platanthera flava var. herbiola*	3	1997
Papillose Nut Sedge (E)	*Scleria pauciflora*	1	2010
Parker's Pipewort (E)	*Eriocaulon parkeri*	1	2006
Philadelphia Panic-grass (SC)	*Panicum philadelphicum ssp. philadelphicum*	3	2000
Pinnate Water-milfoil (SC)	*Myriophyllum pinnatum*	4	1983
Plymouth Gentian (SC)	*Sabatia kennedyana*	10	2011
Pondshore Knotweed (SC)	*Persicaria puritanorum*	4	2009
Prickly Pear (E)	*Opuntia humifusa*	1	2007
Purple Cudweed (E)	*Gamochaeta purpurea*	3	1889
Purple Milkweed (E)	*Asclepias purpurascens*	1	2011
Purple Needlegrass (T)	*Aristida purpurascens*	4	2009
Pygmyweed (T)	*Crassula aquatica*	2	2006
Redroot (SC)	*Lachnanthes caroliana*	2	2011
Reed Bentgrass (E)	*Calamagrostis pickeringii*	1	2010
Resupinate Bladderwort (T)	*Utricularia resupinata*	3	2002
Rigid Flax (T)	*Linum medium var. texanum*	4	2006
Round-fruited False-loosestrife (E)	*Ludwigia sphaerocarpa*	2	2010
Salt Reedgrass (T)	*Spartina cynosuroides*	2	2009
Saltpond Grass (T)	*Leptochloa fusca ssp. fascicularis*	1	1985
Saltpond Pennywort (T)	*Hydrocotyle verticillata*	2	2005
Sandplain Flax (SC)	*Linum intercursum*	3	2011
Sea Pink (E)	*Sabatia stellaris*	1	1988
Sea-beach Knotweed (SC)	*Polygonum glaucum*	4	2010
Short-beaked Bald-sedge (T)	*Rhynchospora nitens*	2	2002
Subulate Bladderwort (SC)	*Utricularia subulata*	2	2001
Swamp Oats (T)	*Sphenopholis pensylvanica*	2	2000
Tall Nut-sedge (E)	*Scleria triglomerata*	1	1888
Terete Arrowhead (SC)	*Sagittaria teres*	5	2009
Tiny-fruited Spike-sedge (E)	*Eleocharis microcarpa var. filiculmis*	1	2006
Torrey's Beak-sedge (E)	*Rhynchospora torreyana*	1	1989
Walter's Sedge (E)	*Carex striata*	3	2003
Weak Rush (E)	*Juncus debilis*	3	2002
Wright's Panic-grass (SC)	*Dichanthelium wrightianum*	2	2001

Table calculated from summary tables on the NHESP "Town Species Viewer" website at www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/species-information-and-conservation/town-species-viewer.html. Accessed October 30, 2013.

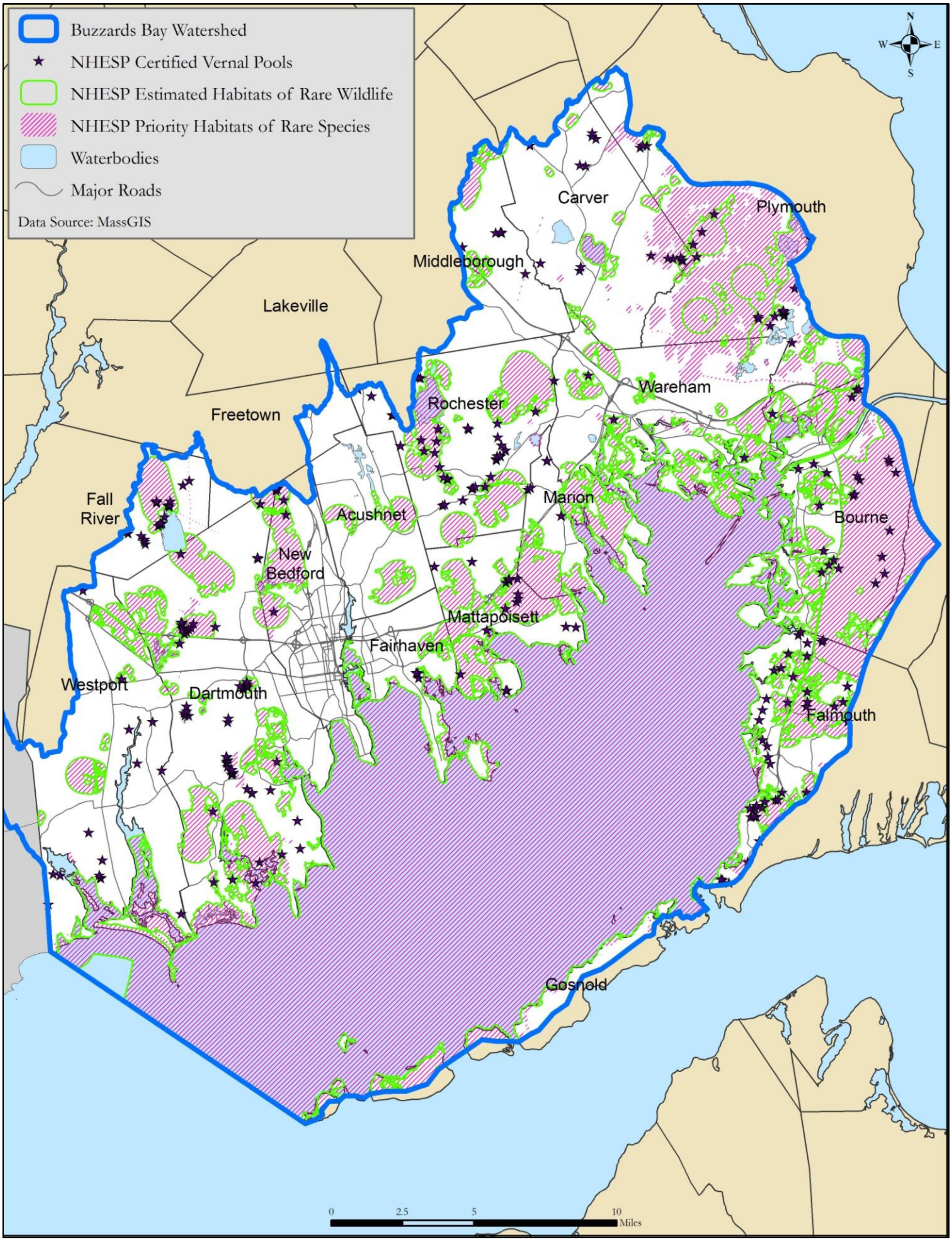

Figure 79. Location of certified vernal pools and rare and endangered species wildlife (purple hatching) and plant species only (green) in the Buzzards Bay watershed (MassGIS data retrieved 2013).

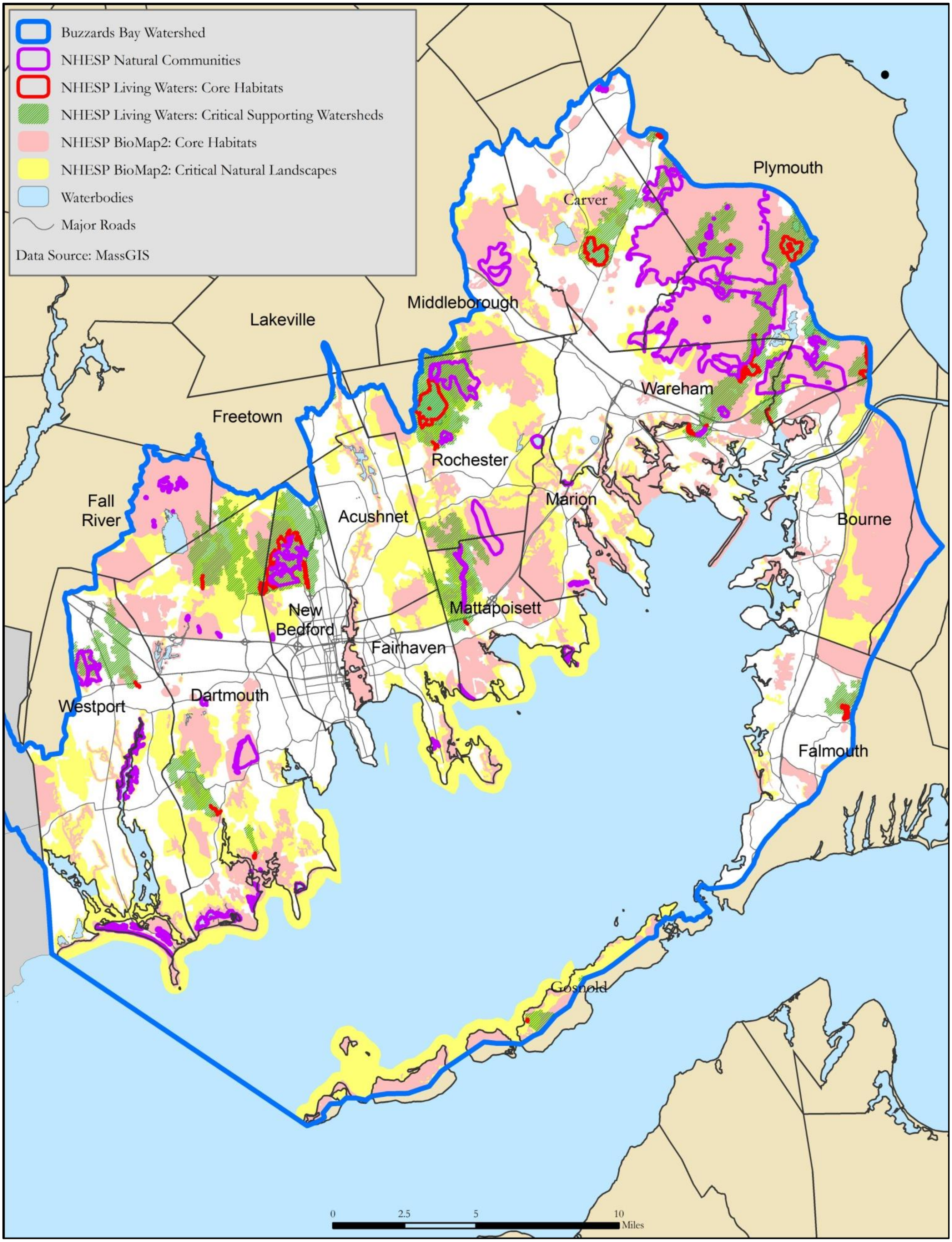

Figure 80. Additional habitat and supporting habitat areas mapped in support of NHESP mission (MassGIS data retrieved 2013).

In recent years, the posting of GIS coverages and online mapping tools of NHESP habitat areas has assisted with compliance with these state laws. NHESP also has webpages summarizing all species observed in each municipality. The precise location of specific species is not disclosed online to protect those populations. NHESP has also set up online reporting tools and species identification pages that should help result in more accurate and comprehensive mapped coverages of listed species.

In broader terms, the goal of the NHESP is the protection of the state's wide range of native biological diversity. This is achieved by biological field surveys, effective information exchange, research, endangered species regulations, project review, restoration projects, focused land protection efforts, and education.

In support of this broader mission, NHESP undertook several projects to map additional areas. NHESP delineated these areas using a variety of data sources, primarily field data, ancillary literature, and color-infrared aerial photographs, and created GIS map coverages in partnership with MassGIS. These additional mapped areas are shown in Figure 80.

The first of these efforts was completed in 2002, when NHESP scientists mapped additional areas that support rare and endangered species habitat as part of the BioMap biodiversity mapping project. The effort resulted in the BioMap Core Habitat GIS map layer that depicts the most viable habitat for rare species and natural communities in Massachusetts, and Supporting Natural Landscape that buffers and connects Core Habitat areas, and identifies large, naturally vegetated blocks that are relatively free from the impact of roads and other development[130].

In 2003, a similar effort was undertaken in the Living Waters project. This effort resulted in two additional map coverages. The first of these was the Living Waters Core Habitats that represents lakes, ponds, rivers, and streams that are important for the protection of freshwater biodiversity in Massachusetts. The companion coverage was the Critical Supporting Watersheds (CSWs) data layer that represents those areas with the most direct hydrologic contributions to Living Waters Core Habitats. As such, they represent the areas with the highest potential to sustain or degrade Living Waters Core Habitats[131].

Finally, in 2006, NHESP completed the Natural Communities data layer that consists of mapped areas that represent the extent of various natural communities in Massachusetts where agencies have an interest in preserving biodiversity through conservation. These polygons are based on records of natural communities and "on-the-ground" field data and available information about the landscape (particularly topographic maps and aerial photographs). The draft classification lists names and describes 105 natural community types found in Massachusetts[132].

The areas mapped through all these efforts (in Figure 80) are not directly offered the same legal protection as Priority Habitats of Rare Species and Estimated Habitats of Rare Wildlife under state law. They are however, used by federal, state, and municipal groups to establish priorities for awarding grants and technical assistance in efforts to protect open space and restore habitat.

Federal Endangered Species Act

Although this action plan largely focuses on the Massachusetts Endangered Species Act, the Federal Endangered Species Act of 1973 (www.epw.senate.gov/esa73.pdf et seq., as amended) is an important consideration in the review of projects that may affect federal listed species in the bay[133]. Federal laws and regulations authorize the determination and listing of species as endangered and threatened, and prohibit the unauthorized taking, possession, sale, and transport of endangered species. Furthermore, section 7 of the Act requires that federal agencies ensure that any action authorized, funded, or carried out by a federal agency is not likely to jeopardize the continued existence of listed species or to modify their critical habitat. The U.S. Fish and Wildlife Service (USFWS) administers the Act, and the NOAA National Marine Fisheries Service is the steward federal agency for offshore living marine resources and habitat, especially fish, whales, dolphins, sea turtles and other marine life. A list of coastal and marine species in Buzzards Bay listed under the federal act is shown in Table 34.

Vernal Pools

Vernal pools are small, shallow ponds that exist only during periods of high groundwater, and disappear during the driest periods of the year. Typically, they exist only in the winter, spring, and early summer. Their ephemeral nature means they generally lack fish, which in turn means they become ideal nurseries for certain species of amphibians, molluscs, crustaceans, and insects

[130] Natural Heritage and Endangered Species Program biologists delineated Core Habitats for rare aquatic species and exemplary aquatic habitats using Natural Heritage Element Occurrences along with other field datasets.

[131] The CSWs were produced through the AQUALAND grid-based watershed model at a 30 x 30 m resolution. The AQUALAND model was created through the combined efforts of the Natural Heritage Program and the University of Massachusetts' Landscape Ecology Program.

[132] According to NHESP, all sites in the "Natural Communities" mapped areas have been visited by NHESP biologists or by other biologists who have submitted reports on community occurrences that NHESP biologists have reviewed and accepted. Aquatic community types are not included. The natural community types are from Swain and Kearsley (2011).

[133] Proposals to build offshore turbines, and the 2012 proposed navigation changes for escort tugs in Buzzards Bay, are two examples that triggered a review under the federal regulations.

Table 34. Federal listed threatened and endangered species (and their state classification) with the potential to occur in Buzzards Bay and along its shores.

Common Name[1]	Scientific Name	Federal Status[2]	State Status[3]	Regulatory Authority
Reptiles				
Diamond-backed Terrapin	*Malaclemys terrapin*		ST	MDFW
Green Sea Turtle	*Chelonia mydas*	T	ST	NMFS
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	E	SE	NMFS
Leatherback Sea Turtle	*Dermochelys coriacea*	E	SE	NMFS
Loggerhead Sea Turtle	*Caretta caretta*	T	ST	NMFS
Birds				
American Bittern	*Botaurus lentiginosus*		SE	MDFW
Arctic Tern	*Sterna paradisaea*		SC	MDFW
Bald Eagle	*Haliaeetus leucocephalus*	[4]	SE	MDFW
Common Moorhen	*Gallinula chloropus*		SC	MDFW
Common Tern	*Sterna hirundo*		SC	MDFW
King Rail	*Rallus elegans*		ST	MDFW
Least Bittern	*Ixobrychus exilis*		SE	MDFW
Least Tern	*Sternula antillarum*	E[5]	SC	MDFW, USFWS
Pied-Billed Grebe	*Podilymbus podiceps*		SE	MDFW
Piping Plover	*Charadrius melodus*	T	ST	USFWS
Red knot	*Calidris canutus rufa*	C		USFWS
Roseate Tern	*Sterna dougallii*	E	SE	MDFW, USFWS
Mammals				
North Atlantic Right Whale	*Eubalaena glacialis*	E	SE	NMFS

[1] As reported in a draft environmental assessment for a proposed navigation rule change in Buzzards Bay (modified from ARCADIS, 2012).

[2] Federal Listed by the US Fish and Wildlife Service: E - federal listed endangered, T - federal listed threatened, C - candidate.

[3] State Designations by the Massachusetts Division of Fisheries and Wildlife: SE - state listed endangered, ST - state listed threatened, SC - state listed special concern.

[4] Bald eagles occur in Buzzards Bay but the species have been federally delisted. Nesting bald eagles and their nests are still protected by law under the Bald and Golden Eagle Act.

[5] Designation for interior U.S. populations only, not in Buzzards Bay.

because of the lack of fish predation. Vernal pools are thus extremely important to various wildlife species that may breed exclusively in these habitats. Some species, such as fairy shrimp, spend their entire life cycles confined to vernal pool habitat.

The Massachusetts Wetlands Protection Act (WPA) Regulations (310 CMR 10.00) provided the original legal basis for protecting vernal pool habitat in Massachusetts; vernal pools first received protection in 1987 when 'wildlife habitat' was added as one of the eight interests protected under the WPA regulations. Vernal pools were not recognized as a specific wetland type, but rather a distinct wetland function that provided important wildlife habitat functions. Consequently, "vernal pool habitat" (310 CMR 10.04) was defined primarily by the wildlife that depend on vernal pools.

Certified vernal pools are protected if they fall under the jurisdiction of the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00), and the certification of a pool only establishes that it functions biologically as a vernal pool. Certification does not determine that the pool is within a resource area protected by the Wetlands Protection Act.

Certified vernal pools are also afforded protection under the state Water Quality Certification regulations (401 Program), the state Title 5 regulations, and the Forest Cutting Practices Act regulations. The Water Quality certification is particularly significant, because under the Federal Clean Water Act's Section 401 requirements, certified pools are considered to be Outstanding Resource Waters (ORW), and state policy does not permit fill or discharges within ORWs. The number of vernal

Table 35. 2013 Certified Vernal Pools versus a 2000 study of potential vernal pools.

Municipality	2013 Certified Vernal Pools	2000 study of potential Vernal Pools
Acushnet	0	48
Bourne	26	51
Carver	19	91
Dartmouth	54	252
Fairhaven	4	48
Fall River	39	151
Falmouth	57	96
Marion	3	22
Mattapoisett	20	58
Middleborough	12	388
New Bedford	6	28
Plymouth	46	392
Rochester	47	131
Wareham	3	100
Westport	14	253

Potential vernal pools were based on an analysis of 1993 and 1999 aerial photographs and wetland coverages. Data at www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/pvp.html.

pools certified in each Buzzards Bay municipality (as of 2009) is shown in Table 35.

Major Issues

Despite the importance of vernal pools, most remain unprotected because they have not been documented and certified. This is illustrated by Table 35, which shows that many vernal pools have been certified in some communities, and none in others, despite the fact that they may likely contain dozens. There are also a number of regulatory technical limitations as to how vernal pools area protected under state and federal regulations.

In January 2009, NHESP and the Massachusetts Division of Fisheries and Wildlife proposed, and then later accepted, changes as to how vernal pools were certified. The report concluded that the Guidelines for the Certification of Vernal Pool Habitat needed to be revised to provide an even more defensible basis for certifications. This resulted in more rigorous data submission requirements and at the same time, made the certification of new pools more challenging, and even created a new appeal process for vernal pools.

A major issue revolving around the certification of vernal pools is the fact that most are on private property, and regulators are not allowed to map these areas without permission of landowners. However, agencies do accept data supporting the certification process from residents and citizen groups.

Because of limitations of state and federal protections for vernal pools, many Massachusetts municipalities have adopted their own vernal pool regulations. For example, the Town of Falmouth prohibits any construction on or alteration of natural landscapes within 100 feet of a vernal pool.

A similar issue relates to the apparent inconsistent level of mapping efforts of MESA listed species in each municipality. As shown by Table 32, the highly urbanized City of New Bedford has 27 listed species, whereas the adjacent more rural Town of Acushnet has only 3. Similarly, Dartmouth has 50 species listed, whereas Westport, which is comparable in size and habitat has only 19. In this latter case, the discrepancy between species documentation can be largely attributed to the studies of butterflies, moths, plants, and birds in Dartmouth by the Lloyd Center for the Environment.

Funding Issues

The state's efforts to protect and map important wildlife areas have been hindered by funding cutbacks. In 2004, the Natural Heritage Program was removed from the state's operating budget, and since then the program has been funded by a patchwork of project-specific bond monies, fees, federal grants, and voluntary contributions. The largest funding source has become voluntary donations on state income tax forms, with over 20,000 taxpayers contributing to the Natural Heritage & Endangered Species Fund.

More stable and expanded funding could assist the program in mapping important wildlife areas and help the program meet its goals. Such funding would not only assist the program in better implementing education and regulatory components of the program, but also address scientific information shortcomings plaguing most wildlife programs. These needed data include more current distribution and abundance data, lack of systematic population monitoring, lack of information on diseases and pathogens, and lack of information on invasive species that may be threatening endemic populations.

Management Approaches

An important first step to protecting endangered and threatened species is to adequately inventory and map their distribution. The NHESP has improved its online information pages about rare and endangered species, and has created online reporting tools, but broader and coordinated participation by trained volunteers, environmental groups, and technical experts is needed to systematically overcome apparent inconsistencies in the level of documentation in each municipality. The Buzzards Bay NEP and Buzzards Bay Coalition could promote a more coordinated effort in the Buzzards Bay watershed.

With respect to vernal pools, these are the easiest special habitat type to inventory, and municipal conservation commissions and local environmental organizations should exchange information and identify needs to better map and certify vernal pools in each community. With technical oversight, volunteers can be trained to map and gather the necessary information to certify vernal pools, and utilize online reporting tools. Sites of investigation can be identified using the NHESP report of potential certified vernal pools in southeastern Massachusetts. As noted earlier, other priority habitat types must be mapped by trained wetlands and wildlife biologists. Federal agency staff could provide some assistance to the state in such an effort.

The primary mechanism to permanently protecting the most important habitats in the Buzzards Bay watershed is the purchase or donation of lands for open space protection, or the purchase or donation of conservation restrictions. Municipalities (particularly conservation commissions) and area land trusts must take action in both establishing priorities and goals in open space protection. To help set acquisition priorities, municipalities should update their open space plans to include priority habitat to ensure that the protection of rare and endangered species habitat remains a high priority for land acquisition and protection. To provide sufficient funds to meet municipal goals, all municipalities should consider adopting the Community Preservation Act.

To help educate the public, municipalities should post on their website maps of rare and endangered species habitat and certified vernal pools and include information as to why it is important to protect these habitats in their community. Information could also be made available in brochures, and included in mailings like water bills. Posting and distributing this information increases the public's awareness of the important habitat that needs to be protected in each community. The costs of this are modest, especially if the town maintains its website in house. The conservation agent could work with the webmaster to post relevant information, and keep it updated and the Buzzards Bay NEP can provide technical assistance. To compliment state and local information, the Buzzards Bay NEP could post maps and lists of rare and endangered species in each Buzzards Bay watershed municipality or links to state pages where this information is available. These lists and online maps help local officials and residents to better understand important habitat areas in their community. The Buzzards Bay NEP should encourage town officials to utilize the newly available online mapping tools made available in 2012 on the NHESP website[134].

To assist municipalities in setting local priorities, state land protection programs and environmental restoration programs should prioritize state listed rare and endangered species and core bio-habitat in the scoring criteria in their land and habitat protection programs. Scoring could account for projects that coincide with mapped rare and endangered species habitat, BioMap Core Habitat, BioMap Supporting Natural Landscapes, and Living Waters areas. The Massachusetts EEA and U.S. FWS are key lead agencies in protecting important habitat types in Massachusetts. EEA already incorporates such priorities in their land acquisition programs (like the EEA's LAND, Landscape Partnership, and Conservation Partnership Grant programs). These criteria may not be an explicit consideration in other agency grant programs (such as DEP 319), but may be indirectly considered. Federal agencies tend to focus on habitat for federally listed species, but they should also consider any available designations of state listed priority habitat in their proposal ranking criteria.

To help improve local protection efforts, NHESP should provide additional training to municipal conservation agents and local planners on the use of NHESP maps and resources, and in the adoption of local strategies to compliment state protection efforts. This assistance could be accomplished by circuit riders to provide local training and support materials necessary for improved local protection.

Financial Approaches

Certain costs, like providing trained staff to help organize efforts to certify vernal pools, or update open space plans are relatively modest, and some free technical assistance could be provided by the Buzzards Bay NEP. However, the real cost associated with this action plan is the acquisition of open space and it would be easy for watershed municipalities to utilize several million dollars per year for open space protection. Despite the high costs of land acquisition, because much of the most desirable lands from a habitat protection standpoint contain considerable areas of wetlands, they are often difficult to build upon and their cost per acre is low compared to easy to build upon lands.

Monitoring Progress

Several direct measures can be tracked for this action plan. In terms of protecting important habitat, the total acres of open space permanently protected is now being tracked, and is one of the most important measures for that action. Other measures, such as the number of vernal pools that have been certified, or number of listed species inventoried in each municipality, and their geographic extent are easy measures to track programmatically. Some species populations within Buzzards Bay or the watershed are now being tracked, as is the case with nesting pairs of certain bird species, such as the Roseate Tern and Piping Plover. Ongoing annual bird counts may provide insights as to changes in habitat and climate changes. Efforts to enumerate seals and other marine

[134] NHESP "Town Species Viewer" website at www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/species-information-and-conservation/town-species-viewer.html. Last accessed October 30, 2013.

mammals have been inconsistent, but could be undertaken periodically if such measures are determined useful indicators of specific impairments.

References

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Action Plan 10 Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies

Problem[135]

As growth in the region has increased in recent decades, both the quantity and quality of Buzzards Bay public water supplies have been threatened. In some cases, both public and private water withdrawals are cumulatively affecting wetlands, anadromous fish runs, and other wildlife habitat, particularly during droughts. Buzzards Bay's growing population is creating a need for additional water supplies, but available land to develop future water supplies is disappearing because of the intensity of land use and the loss of open space.

Goals

Goal 10.1. Protect and preserve groundwater and surface water supplies in order to ensure a sustainable supply of high quality drinking water.

Goal 10.2. Protect and restore the natural flows of rivers and the natural waters of ponds, lakes, and wetlands and the habitat that depend on them.

Goal 10.3. Maintain natural hydrology.

Goal 10.4. Protect and preserve estuarine and brackish surface water habitats in river mixing zones.

Objectives

Objective 10.1. Encourage water use conservation and increase utilization efficiency to minimize water withdrawals, system losses, and associated impacts.

Objective 10.2. Encourage water reuse for irrigation, industrial process water, and other non-potable uses within public health constraints.

Objective 10.3. Update state regulations to reduce the potential of affecting wetlands, surface waters, and other public water supplies.

Objective 10.4. Encourage LID techniques for enhanced stormwater recharge to maximize groundwater recharge.

Objective 10.5. Manage water withdrawals and wastewater discharges from existing and new development to help maintain recharge to the aquifers.

Objective 10.6. Manage equally both public and private water withdrawals in a subwatershed, including the adoption of water use rates that encourage conservation.

Objective 10.7. Limit non-essential water use during droughts.

Objective 10.8. Develop new water supplies and improve infrastructure to improve distribution and reduce redundancy to avoid over utilization of existing wells.

Objective 10.9. Identify and protect open space for future water supplies, when needed, located as far from significant surface water resources as possible to minimize potential impacts on natural water resources.

Objective 10.10. Incorporate new information, when available, from ongoing or planned state studies on water budgets and sustainable yields into local water resources planning and regulation.

Objective 10.11. Encourage accurate tracking of water use by agricultural users and promote agricultural BMP practices for water conservation.

Objective 10.12. If and when desalinization occupies a water supply role in the watershed, encourage control technologies and operational measures that minimize entrainment and impingement impacts at intakes and preserve the natural salinity structure of receiving water bodies at outlets.

Objective 10.13. Collect and maintain water use data in support of this action plan and for tracking success.

Approaches

Managing water withdrawals to minimize environmental impacts is complicated and politically challenging and will require the implementation of long-term strategies. The objectives articulated above provide a clear road map for the approach needed. Some of the strategies require adoption of new state or local regulations to meet one of the listed objectives, and DEP must prevent new withdrawals from subwatersheds with flow stressed rivers.

Costs and Financing

The costs of these solutions and the mechanisms to finance will vary with each community, and financing options will be dependent on the strategy chosen.

Measuring Success

Tracking stream flow in stressed stream watersheds, together with tracking municipal water withdrawals and agricultural withdrawals in those stressed stream recharge areas will be the principal environmental measures that need to be tracked for this action plan. Regulatory action and outreach efforts can be used to track programmatic actions.

[135] This action plan was not in the 1991 CCMP.

Background

Among the 17 Massachusetts communities and a small portion of Rhode Island that comprise the Buzzards Bay watershed, there are eight major river subwatersheds on its western shore (the Westport River, Paskamanset River, Acushnet River, Mattapoisett River, Sippican River, Weweantic River, Wankinco River, and Agawam River). This contrasts with the eastern shores on Cape Cod (Bourne and Falmouth), and the Elizabeth Islands, where there are no significant riverine flows (Figure 81). These surface and groundwater flows are an important natural resource to the area (USGS, 1990; DEM 1995)

The total volume of water available within the Buzzards Bay watershed is dependent on the hydrologic cycle (Figure 82). All water in the watershed originates as precipitation that falls upon the surface of the land and ponds and begins its journey back to the ocean. Some of that rain and snowmelt infiltrates into the ground where it replenishes groundwater aquifers and travels slowly through the aquifers before discharging to rivers, streams, or coastal waters. A large amount of this precipitation, perhaps 50% on an average annual basis, evaporates or transpires from vegetation back to the atmosphere as water vapor. Some of this precipitation runs off the land surface as stormwater runoff, or into stormwater drainage systems, quickly entering streams or manmade channels, or discharging directly to the ocean.

The relative amounts of groundwater recharge, evapotranspiration, and stormwater runoff are dependent upon climatic factors, geology, and the amount and characteristics of impervious manmade surfaces and stormwater conveyances. In addition, water withdrawals from wells or reservoirs and disposal of wastewater effluent affect the amount, distribution, and residence time of water within the watershed.

Humans can alter the natural hydrology of watersheds through the cumulative water withdrawals for drinking water, irrigation, industrial processes, or other uses. These withdrawals, together with water diversions undertaken for agriculture, or transported from impervious surfaces via stormwater drainage networks, can reduce the quantity of water available within watersheds or subwatersheds. These actions can also change the transport and residence time of water within these systems.

The effect of stormwater drainage systems on subwatershed hydrology can be important. The impervious surface area within a watershed, and the manner in which stormwater runoff from those surfaces is managed, significantly influences a watershed's hydrology, the quantity of water available to support natural water resources, and the residence time of water within the watershed before it discharges to the ocean.

Figure 81. Principal rivers and subbasins of the Buzzards Bay watershed.

Traditional stormwater management has emphasized quickly conveying stormwater away from its point of origin to ultimately discharge in wetlands or the ocean, as if stormwater was an undesirable waste product. New stormwater treatment requirements and low impact development (LID) practices that towns are now adopting are reversing this trend. These new stormwater practices minimize stormwater runoff, retaining stormwater near its point of origin, and infiltrate it to recharge groundwater supplies and increase the hydrologic residence time of water within the watershed or subwatershed. These practices increase the amount of water available within a watershed to support water resources, and can offset impacts of water supply withdrawals on groundwater. We address these principles with recommendations in this action plan and in recommendations in Action Plan 3 Managing Stormwater Runoff and Promoting LID.

The relative importance of water withdrawal impacts versus stormwater management impacts on the natural hydrology of a watershed is variable and dependent upon specific characteristics of the watershed or subwatershed. In urbanized watersheds that have few if any significant water withdrawals (water is imported from outside of the basin), stormwater management practices will be the dominant anthropogenic influence on watershed hydrology. In contrast, in predominantly rural watersheds that have significant water supply sources (perhaps supplying a nearby urbanized watershed), groundwater withdrawals are a dominant anthropogenic influence on watershed

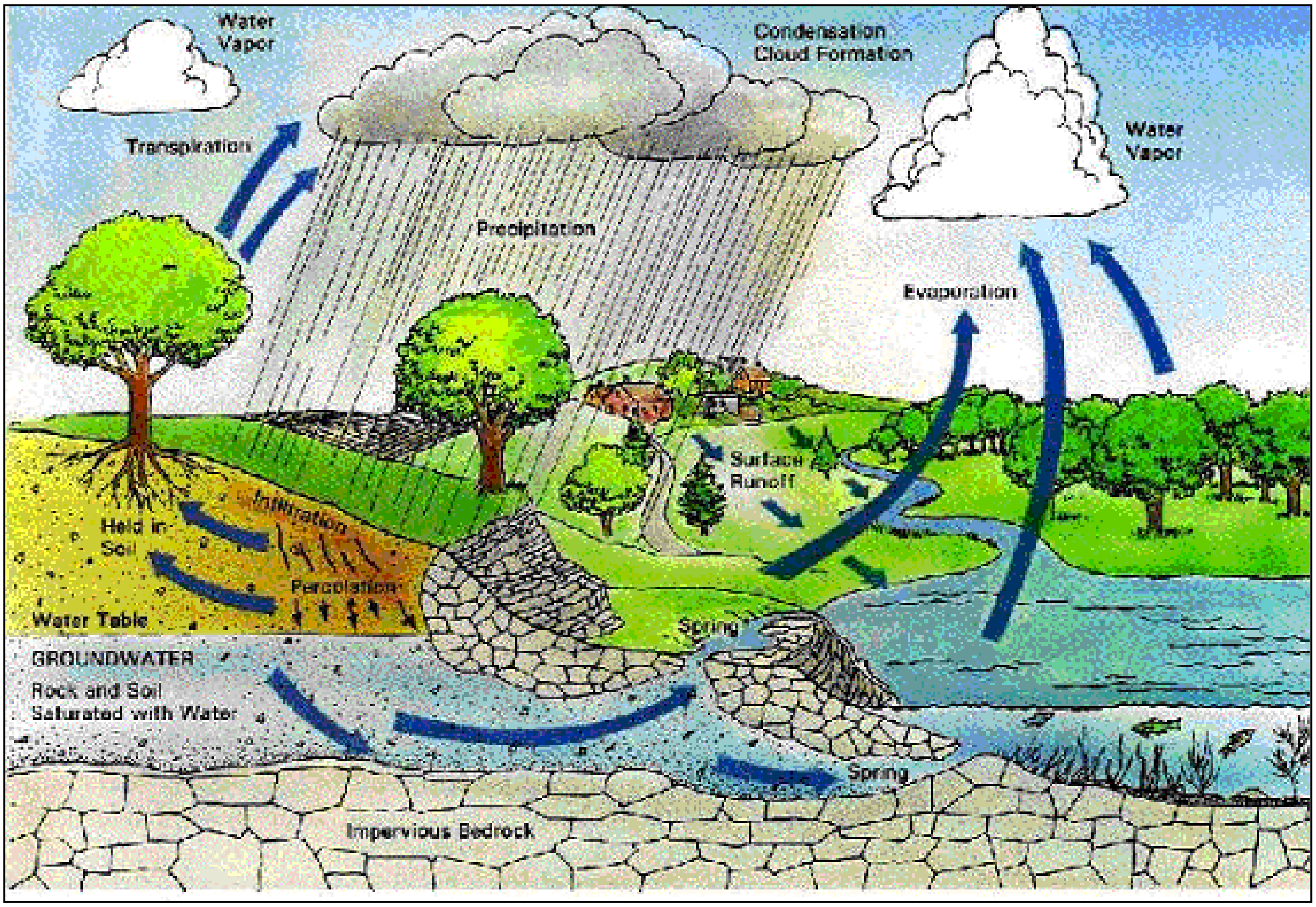


Figure 82. Illustration of the water cycle.

hydrology. Most watersheds will fall somewhere between these two extremes.

Many of the withdrawals discussed here are subject to the Water Management Act (MGL Chapter 21G), which became effective 1986. The Act authorizes the Massachusetts Department of Environmental Protection (DEP) to regulate the quantity of water withdrawn from both surface and groundwater supplies to ensure adequate water supplies for current and future water. The supporting regulations are 310 CMR 36.00.

Key components of the law are a registration program and a permit program. Since 1988, water withdrawals from ground or surface sources in excess of an annual average of 100,000 gallons per day or 9 million gallons in any three-month period must apply for a Water Management Act Permit. Within the Buzzards Bay watershed, cranberry bogs, public water suppliers, 18-hole golf courses, and sand and gravel facilities are the common uses required to obtain a permit.

Buzzards Bay Water Supplies

Of the 15 communities principally located within the Buzzards Bay watershed, eight have public water supplies located within the watershed (Dartmouth, Fairhaven, Mattapoisett, Carver, Marion, Wareham, Westport, and Bourne); two communities receive water from outside the watershed (New Bedford and Acushnet); and several communities that straddle the watershed have water supply sources both inside and outside the watershed (Falmouth, Plymouth, and Fall River). Two communities have no municipally owned water supplies, and are served either by individual onsite private wells or by small private water supply companies (Rochester and Westport).

Wells drawing groundwater account for the majority of these municipal water supplies, but surface water ponds serve large population areas including Fall River, New Bedford, Acushnet, and portions of Falmouth. The sources of all these water supplies and some of their characteristics are summarized in Table 36.

Private water supply wells serve large portions of the less developed portions of the Buzzards Bay watershed. In these areas, small-volume private wells serve individual homes, and larger volume private wells service campgrounds, restaurants, hotels, golf courses, and other private facilities that cater to the public. In a few areas, private water supply companies may serve a small portion of a community.

Figure 83 shows all of the major public drinking water wells and surface water reservoirs contained in the

Buzzards Bay watershed. This map includes some smaller volume, non-community water supplies for restaurants, campgrounds, and similar public places. The figure does not show the location of agriculture and other private irrigation wells. Figure 84 shows the service areas of these public water supply wells.

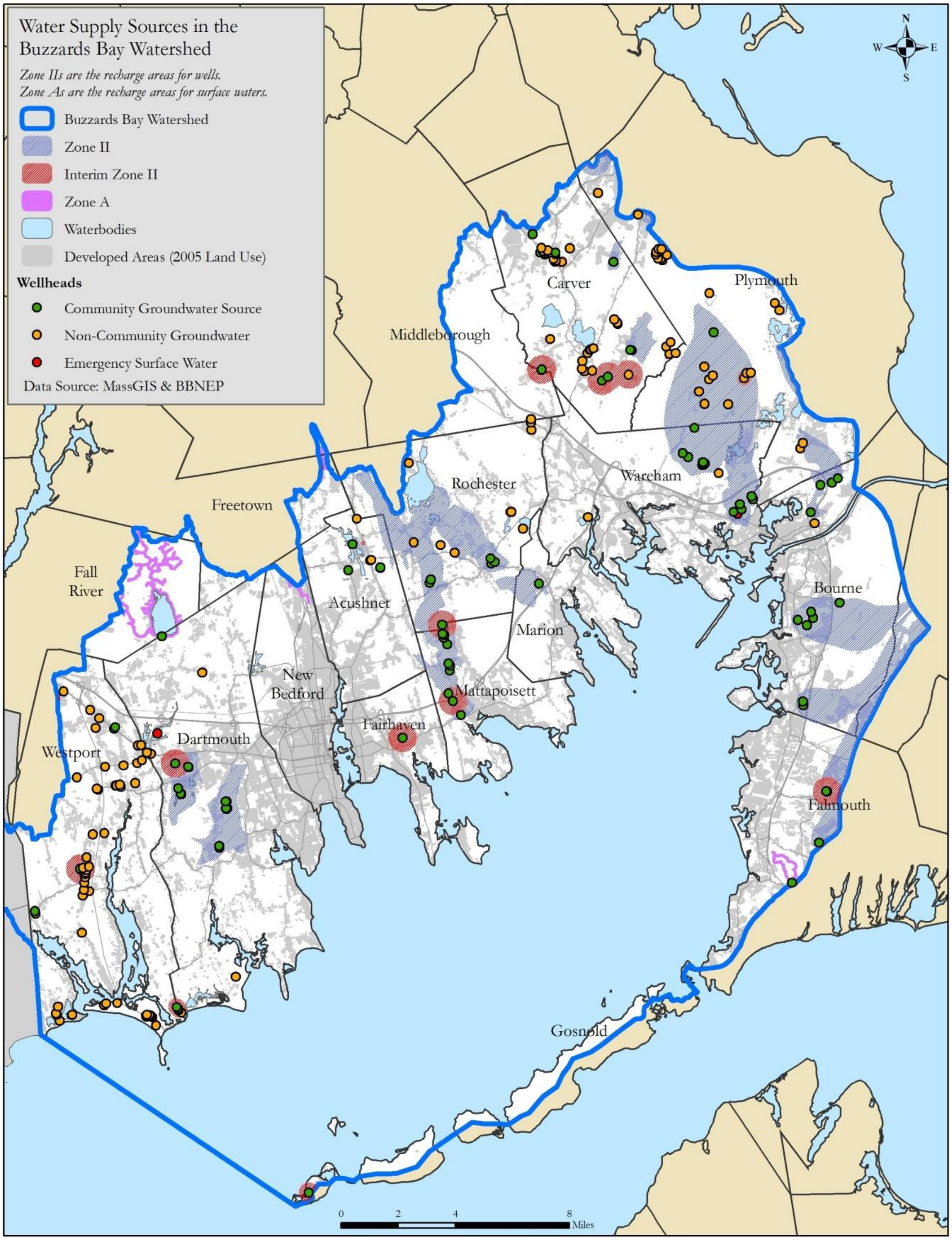


Figure 83. Water supplies in the Buzzards Bay watershed.

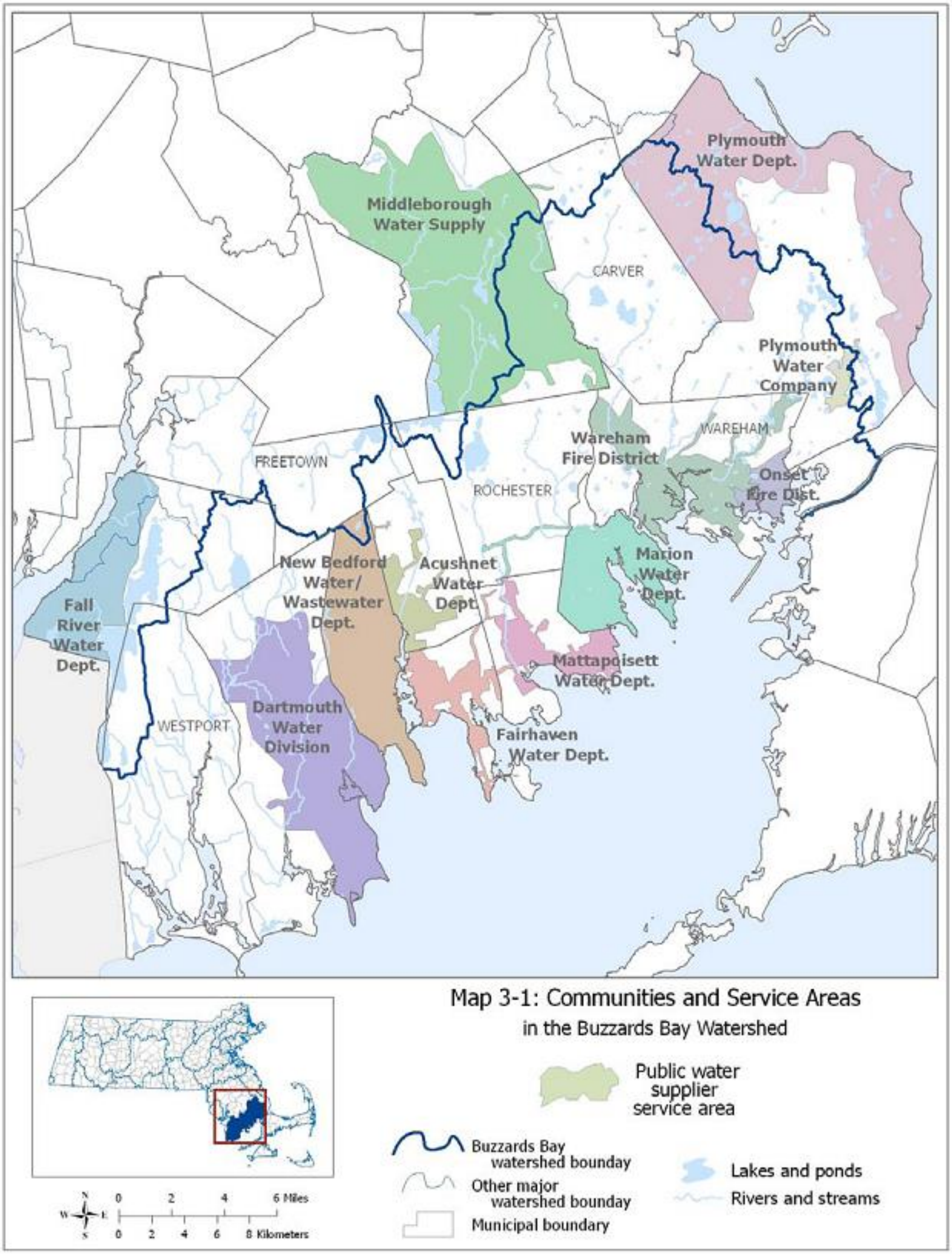


Figure 84. Public water supply service areas of the Buzzards Bay watershed.

Not shown are service areas of Bourne and Falmouth, although most areas of these towns are served by public wells. Source: EOEA (2006) Water Assets Study: Regional Summary Report.

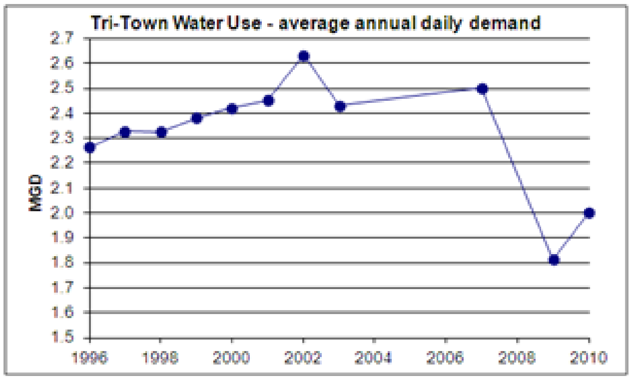


Figure 85. Combined water use in the towns of Marion, Mattapoisett, and Fairhaven.

Average water use declined with implementation of water conservation measures, but peak summer use during drought years remains high.

As noted above, the City of New Bedford obtains its water from outside of the Buzzards Bay watershed (Long and Quittacas Pond). The City's water supply system supplies water to most of the City, as well as large areas of Acushnet, Dartmouth, and Freetown. Large amounts of this drinking water, particularly from New Bedford, Acushnet, and parts of Dartmouth, are collected by the New Bedford sewer system, which discharges, into Buzzards Bay off Clarks Point. Some of the New Bedford water supply is discharged to septic systems in the greater New Bedford area, creating a net gain of water recharge into the Buzzards Bay watershed.

In other parts of the Buzzards Bay watershed, there are net transfers out of the basin. Most notably, Fall River, whose population is virtually entirely located out of the Buzzards Bay watershed, obtains some of its water from the Copicut Reservoir in Westport.[136]

Important subbasin transfers also occur, and these are not regulated by the state. For example, wells in the Mattapoisett River subwatershed supply water to the towns of Fairhaven and Marion that are in other Buzzards Bay subwatersheds (Figure 81). In fact, pumping to these two towns alone account for a transfer of 65% of the water outside the Mattapoisett River subwatershed. Similarly, Dartmouth pumps water from the Paskamanset River subwatershed, which discharges to septic systems in other subwatersheds, or discharges directly to Buzzards Bay via the town's wastewater facility. Groundwater withdrawals are highest in the Paskamanset and Mattapoisett Rivers subwatersheds, and both rivers have been identified as stressed because of municipal and agricultural

Table 36. Average residential per capita water use for Buzzards Bay public water supplies as reported in 2007.

(Data from DEP from http://www.buzzardsbay.org/download/rgpcd07.pdf as downloaded 6/27/08.)

PWSID	**PWS Name**	**Town/ City**	**DEP-Accepted RGPCD (gal/person/day)**	**DEP-Accepted Unaccounted for Water (%)**
4003000	Acushnet Water Department	Acushnet	68	22
4036000	Bourne Water District	Bourne	69	9
4036001	Buzzards Bay Water District	Bourne	54	9
4036002	North Sagamore Water District	Bourne	79	8
4052001	South Meadow Village	Carver	NS	NS
4072000	Dartmouth Water Department	Dartmouth	72	10
4094000	Fairhaven Water Department	Fairhaven	63	9
4095000	Fall River Water Department	Fall River	65	22
4096000	Falmouth Water Department	Falmouth	79	20
4169000	Marion Water Department	Marion	81	11
4173000	Mattapoisett Water & Sewer Dept	Mattapoisett	55	6
4182000	Middleborough Water Supply	Middleborough	69	9
4201000	New Bedford Water Department	New Bedford	59	14
4239000	Plymouth DPW Water Division	Plymouth	83	14
4239045	Plymouth Water Co.	Plymouth	167	6
4239055	Pine hills LLC	Plymouth	65	3
4310000	Wareham Fire District	Wareham	60	13
4310003	Onset Fire District	Wareham	45	17

water withdrawals. According to the USGS, in 1992, well withdrawals from those two subwatersheds accounted for 57% of all the groundwater used in the Buzzards Bay watershed (Bent, 1995).

All water withdrawals within the Buzzards Bay watershed, whether from large volume wells or numerous small volume wells, affect the overall water budget of the watershed. Likewise, all withdrawals within river basin subwatersheds affect the water budgets of those subwatersheds. The consumptive portion of water withdrawals (that which is evaporated, transpired by irrigated vegetation, conveyed as stormwater runoff, or transport-

[136] Fall River Water Department is authorized to withdraw a combined volume of 14.59 MGD from a linked reservoir system that is located within two basins: the Copicut in the Buzzards Bay watershed and the North and South Watuppa Ponds located in the Mt. Hope watershed. A single source meter is located at the point at which the water from the Copicut enters the North Watuppa Pond. (DEP 2000 Buzzards Bay Water Quality Assessment Report.

Photo courtesy of the MAFWS Riverways Program.

Figure 86. More than 1000 feet of the Mattapoisett River ran dry in October 2007.

ed out of basin and not returned through wastewater discharges or infiltration of excess irrigation water) represents a cumulative loss of the overall water available within the watershed or subwatershed to sustain water resources and their associated flora and fauna. Whether these withdrawals and transfers have impacts that must be addressed by management, action depends on a number of factors.

Local officials and residents often under appreciate the environmental impacts of municipal water withdrawals because of misconceptions about the sources of their water supplies, or a lack of appreciation that surface water supplies and groundwater supplies are fundamentally connected. Confusion arises also when groundwater withdrawals are taken below impervious sediment layers (confining areas) which prevent a "cone of depression" forming in the water table around the wellhead. Even in those situations, sufficiently high water withdrawals will cause a lowering of the water table over a broad area around the wells, which can lower pond levels and dry out wetlands.

In general, larger water withdrawals located closer to surface freshwaters and wetlands will potentially have a more immediate and noticeable impact on those water resources, especially during drought years. A well that is located 100 feet from a river will intercept groundwater that would have previously traveled to that river in a period of weeks to months whereas a well that is located miles from that river represents years of groundwater travel time away from the river. Therefore, withdrawals from a nearby well that occur during natural low flow periods contribute quickly and directly to reduced and noticeable low flows. In contrast, withdrawals located years of travel time away from a water resource may affect that resource at a time of higher natural flows or affect that resource over a longer period, resulting in a less noticeable change.

If water withdrawals are also exported out of a watershed or subwatershed, the potential impacts can be exacerbated because there is no groundwater return flow from septic system discharge or lawn watering. While the return flow from septic systems is usually a small percentage of most subwatershed budgets, it may be locally significant in a few stressed watersheds. This coupled with past practices to direct stormwater flow into surface waters, instead of recharging to groundwater, can exacerbate the problems related to low river flows.

Impacts to the Mattapoisett River

Water withdrawals appear to have already affected the Mattapoisett River, and unmanaged future water withdrawals from either Snipatuit Pond or from wells in the Mattapoisett River Valley will likely threaten the flow and biological integrity of the Mattapoisett River. These withdrawals include both public and private water supply servers, agricultural withdrawals, and private wells. The largest of these withdrawals are the municipal public wells serving the towns of Mattapoisett, Fairhaven, and Marion, which are close to the river (see Figure 83).

The first assessment of groundwater in the River Valley was conducted by Metcalf and Eddy (1980). A 1984 U.S. Geological Survey study (Olimpio and de Lima, 1984) of stream flow and groundwater found that groundwater withdrawals on the Mattapoisett River depleted stream flows as compared to upstream sections or other similar nearby streams. An earlier study by the Department of Environmental Management's Office of Water Resources also found that water withdrawals from the Mattapoisett River 1980-1981 equaled 87% of estimated base flow. Furthermore, the USGS study concluded that an estimated 78% percent of the Mattapoisett River basin well water is discharged outside of the river subbasin where it serves populations in Marion and Fairhaven. These studies estimated that with the current wells in place along the river, peak water withdrawals exceeding 4.0 MGD during a summer drought period would result in the river running dry.

In September 1999, the Mattapoisett River ran dry for the first time. This occurred during drought conditions, and peak water withdrawals exceeding 4.0 MGD. The river ran dry again 2007 (see Figure 86 and Data from USGS 2008 Water Data Report for station 0110591). The Massachusetts Department of Fish and Game Riverways Program maintain an online "Low Flow Inventory" website[137] that notes that the Mattapoisett River has already experienced low flow problems. They wrote "In September of 1999, a freshwater mussel surveyor for the Massachusetts Natural Heritage and Endangered Species Program found a series of deep pools with little flow between them on the Mattapoisett River at the Route 6 crossing in Mattapoisett. Further upstream just

[137] www.rifls.org/. Last accessed October 13, 2013.

north of Route 195 in Mattapoisett [in the vicinity of public wells], the river was “bone dry,” and local kids were riding their ATVs up and down the stream banks.” This report further notes these low flows may be caused by groundwater withdrawals.

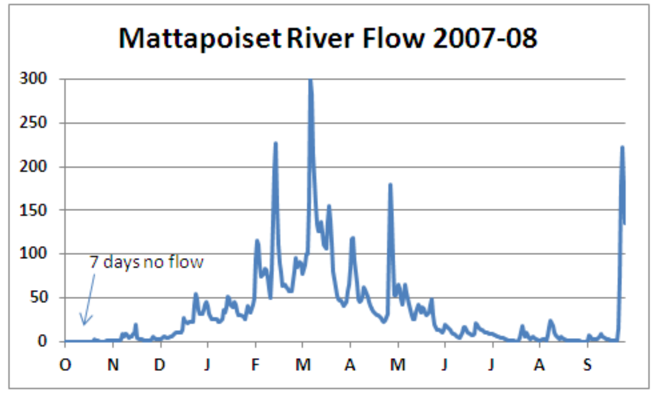
The source of the increased water demands within the watershed is clear. Between 1990 and 2000, the population in the Mattapoisett River watershed increased 10.8%, or roughly 1% per year. The population served by these municipal wells is now around 29,000 during the summer, has increased at about the same rate. Between 1996 and 2003, average water use has been increasing at a faster rate of 1.5% per year. While there is considerable variability on water use from year to year (compare 2002, a drought year to 2003 a wet year), municipal data shows that not only is water demand increasing with population, but average annual per capita usage is increasing as well.

Increased water use by cranberry bogs also contributes to this demand. In the early 1990s, there were 275 acres of cranberry bogs in the watershed, mostly around Snipatuit Pond. A decade later, at least 100 additional acres were added, also mostly around Snipatuit Pond.

In 1997, the state legislature passed a law creating the Mattapoisett River Valley Water Supply Protection Advisory Commission (henceforth the “River Valley Commission”). This River Valley Commission has been collecting roughly $80,000 in fees annually from its water customers. To date, these funds have been used principally to help buy land and protect open space in the aquifer or to fund various water use and withdrawal studies.

Water use regulations may not always be optimally effective at protecting water resources or uniformly applied between different communities. The Interbasin Transfer Act applies only to transfers between major basins (e.g. in and out of the Buzzards Bay watershed) and not between specific subwatersheds (e.g. in and out of the Mattapoisett River watershed. This Act, as well as the Water Management Act which regulates all significant water withdrawals in the Commonwealth, includes registered or grandfathered water withdrawals that were in place before the Acts were implemented.

A compilation of permit information for all of the Buzzards Bay watershed communities has not been performed for this action plan. However, in general, different communities may have different permit conditions dependent upon the specifics of their individual withdrawals, and how long ago those withdrawals were either registered or permitted. Water use restrictions in individual communities are sometimes tied to DEP permit requirements so those restrictions may vary from community to community. In addition, communities may impose restrictions based upon other independent factors. The result is that water restrictions may not be uniform between individual communities within the watershed



Data from USGS 2008 Water Data Report for station 0110591
. Figure 87. Mattapoisett River gauged river flow.

and may not be transparently tied to observable climatic and or hydrologic communities.

The Commonwealth has also developed a set of water conservation standards for use throughout the state. However, these standards are not concretely tied to regulatory acts to encourage or require their adherence. Some towns may elect to use these standards as guidance, but there is no requirement at this time to follow them.

Agricultural Withdrawals

Another important water use in the Buzzards Bay watershed relates to the cultivation of thousands of acres of cranberry bogs. The majority of Massachusetts’ approximately 13,000 acres of cranberry bogs[138] are located in the Buzzards Bay watershed. Cranberry farming is a water intensive agricultural activity, with large amounts of water used for frost protection, irrigation, cooling, and harvesting (Bent, 1995). In some systems like the Weweantic River, bog operations have appreciably manipulated stream flow (Masterson et al., 2009, p. 77). Bogs require irrigation through the growing season while flooding is undertaken for the fall harvest and winter frost protection. Hansen and Lapham (1992, p. 9) estimated that 84 percent of the water supplied for use on cranberry bogs is from ponds and reservoirs. Much of the water used in cranberry farming is eventually returned to the watershed when the flooded bogs are drained back to tributary streams or ponds, with some floodwater infiltrating into groundwater, and some flood and irrigation water lost through evapotranspiration.

The recharge to groundwater from precipitation and floodwaters on cranberry bogs has been considered in two USGS studies in the Buzzards Bay watershed. In the first hydrologic investigation of the Plymouth-Carver Aquifer, Hansen and Lapham (1992) estimated that cranberry bogs constitute a negative 17 inches per year loss of aquifer recharge per unit surface area. Masterson et al. (2009, p. 9) affirmed this estimate and concluded

[138] USDA, NASS New England Field Office Massachusetts Statistics for 2012.

Table 37. Drought restrictions enacted by Buzzards Bay watershed municipalities.
(Information collected by the Buzzards Bay NEP from Buzzards Bay municipalities in 2008.)

Municipality	Mandatory Restrictions	Odd-Even Watering	Other	Fines	Percent On town water	Private Well Restrictions
Acushnet	NB applies to Acushnet					No
Bourne	Yes	Yes	No auto sprinkler	$50 first, $100 thereafter		Yes
Carver	No PWS				No PWS	No
Dartmouth	No				90	No
Fairhaven	Yes				90	No
Fall River	No. Notices put in paper					No
Falmouth	Yes	Yes	Pistol grip required, no washing sidewalks, restaurant water on request	$50, $100, shut-off on 3rd offense		No
Gosnold						No
Marion	Yes	Yes	6:00 a.m.-8:00 a.m. 6:00 p.m.-8:00 p.m.	$50 first, $100 thereafter	98	No
Mattapoisett	Yes	Yes	no pools, auto-sprinklers, or outdoor watering. Can water only during hours specified	$50 first, $100 thereafter	84	No
Middleborough	Yes	Yes	6:00 a.m. - 9:00 a.m. 6:00 p.m. - 9:00 p.m.	$50 first, $100 thereafter		No
New Bedford	Yes				>95	No
Plymouth	Yes	No	5:00 a.m-7:00 a.m. only			No
Rochester	No PWS				No PWS	No
Westport	Comes from Fall River				0	No
Wareham	Yes	Yes	does not apply to water use by hand held hose		48	No

whereas rainfall recharge to the aquifer as a whole was 27 inches per year, recharge in bogs was 10 inches per year. This amount was actually 2 inches higher than natural vegetated wetlands and was based on the assumption that flooded bogs acted more like ponds (which contribute 20 inches of recharge per year) during those periods when cranberry bogs are flooded. It is worth stressing these values are based on annual budgets, and during the summer, bogs become net sinks when surface evaporation and plant transpiration exceed precipitation Masterson et al. (2009, p. 77).

Whether cranberry bog water use recharges to groundwater or is discharged to streams is less important than the potential reduction or cessation of stream flows that may occur during periods when streams are diverted to flood bogs, or when high volumes of groundwater or pond water is withdrawn. Because large water withdrawals (whether for agriculture or municipal water supplies) have a potential to affect the wetlands and aquatic habitat, they are subject to the aforementioned Water Management Act.

Cranberry growers with less than 4.66 unregistered acres of "old style bogs" in production do not require a WMA permit[139]. Best management practices for "new style bogs" not requiring a permit for a 9.33 acre threshold include bog construction laser leveled (or equivalent) to 6 inches, implementation of a tail water recovery system, and irrigation systems and water control structures (dikes and flumes) that meet USDA National Resources Conservation Services (NRCS) standards. The total cumulative magnitude of cranberry bog consumptive water use in the watershed relative to other water withdrawals is unknown.

As noted in Action Plan 8 Restoring Migratory Fish Passage, MA DMF has noted that large numbers of juvenile herring have been killed in the past due to cranberry bog operations. Reback et al. (2004) suggest that growers employ a simple, inexpensive screening system that has been developed that will prevent most of these losses. They recommended that appropriate screening of

[139] According to a 2004 Cape Cod Cranberry Growers' Association grower advisory on the WMA, "the difficulties in metering water usage in cranberry bogs led the Department to agree to issue registrations base on acreage. In 1987, taking into account water used for harvest or trash flow, for initial winter flood, and for fall frost protection this acreage was calculated to be 4.66 acres."

Table 38. Rates and customers of Buzzards Bay water providers.

Municipality or District	Basic Rate	Volume included with base rate and/or rate for additional volume	Average Annual Cost (b)	Primary Water Source Type (a)	Estimated Peak Seasonal Population Served
Acushnet (from NB)	$2 hcf		$254	primarily sw	2,750
Bourne Water District	$48/year	0 included in base charge, all use at an additional $2.25/1000 gal	$251	gw	20,000
Buzzards Bay Water District	$66/year	40,000 included, excess charged $2.75/1000 cf up to 100,000 $3.75/1000 over 100,000	$198	gw	7,500
South Sagamore Water District	$48/year	$2.25/1000 gal	$251	gw	1,000
Carver	no town water				
Dartmouth	$44.10/yr	3200 cf/year, $19.85/1000cf next 900cf $23.15/1000cf next 1600cf $17.56/cf next 1950cf last step $31.97/1000cf	$259	gw	29,000
Fairhaven	$2.13/hcf		$256	gw	16,066
Falmouth	$2.36/hcf		$283	mostly sw	77,500
Marion	$90/year	$18.70/1000cf 0-5000cf $43/1000cf-5001-10,000cf	$363	gw	7,800
Mattapoisett	$92 year (5/8" meter) $120 year (3/4" meter)	2.37/hcf 1-2000 cf $3.25/hcf over 2000cf	$411	gw	6,800
Middleborough	$72.12/yr	2000 cf annual (500 cf/quarter) $1.51/hcf-500-2500 cf; $2.33/hcf 2600-2500 cf; $3.57/hcf over 25000 cf	$240	gw	17,000
New Bedford	26.17/yr	$1.05/cf	$157	sw	79,000 (2x accounts)
Plymouth		$1.33/hcf to 3000cf $1.59/hcf 3001-9000 cf $1.89/hcf over 9000cf	$175	gw	53,000
Rochester	no town water				
Wareham Fire District	$150/yr	8000 cf included, $2.40/hcf for excess	$246	gw	20,000
Onset Fire District	$150/year	7000 cf /yr included, with $2.19/hcf -7001-14000 cf $2.29/hcf 14001-100,000cf, $2.35/hcf over 100,001 cf	$260	gw	6,500
Westport	no town water				

Information collected by the Buzzards Bay NEP from Buzzards Bay municipalities in 2007. Abbreviations: sw=surface water, gw=ground water.

water withdrawal intakes to prevent stranding, mutilation, entrainment, or impingement of young herring should be made a condition of any WMA permits issued to growers.

Major Issues

An early study by the Massachusetts Department of Environmental Management's Office of Water Resources found that water withdrawals from the Mattapoisett River subwatershed in 1980-1981 amounted to 87% of the estimated base flow in the river, and that withdrawals from the Paskamanset River subwatershed equaled 21% of estimated base flow in the river.

In a 1995 study of the hydrology of the Buzzards Bay watershed (Bent, 1995), the USGS identified well withdrawals within the Paskamanset River and Mattapoisett River subwatersheds as having significant impacts on the flows of both rivers, particularly during natural low flow periods. Approximately 78% of the groundwater pumped from the Mattapoisett River subwatershed is transported out of the subwatershed to supply other communities.

Most water withdrawn from the Paskamanset River subwatershed by the Town of Dartmouth serves homes outside the subwatershed. Most of this exported water serves homes tied into the town sewer system that discharges directly to Buzzards Bay. Estimated stream flow deficits for both subwatersheds were of similar magnitude to the water exported out of the subwatersheds for water supply. Furthermore, stream flow measurements in the Paskamanset River subwatershed upstream and downstream from significant groundwater withdrawals proximal to the river showed that the stream flow deficit measured between the two stations was approximately equivalent to the water volume pumped from the intervening wells.

In the 1980s and 1990s, models and studies of the Mattapoisett River aquifer predicted that the Mattapoisett River would run dry if the existing municipal wells withdrew 4 million gallons a day during drought conditions. In 1999, the Massachusetts Natural Heritage and Endangered Species Program observed the upper reaches of the Mattapoisett River to be dry with some isolated pools of water near town wells for Marion, Fairhaven, and Mattapoisett located close to the river. This was the first time the river was known to have run dry, and it occurred during drought conditions with peak water withdrawals exceeding 4.0 MGD.

In 2004, the Buzzards Bay Coalition (then called the Coalition for Buzzards Bay) assisted DCR's RIFLs program and began monitoring the Mattapoisett River. The River again ran dry in 2007, under drought conditions and with water withdrawals exceeding 4 MGD. To date, only the Mattapoisett and Paskamanset rivers are suspected to be significantly impacted by water withdrawals, but smaller river systems have been unstudied.

The relative importance of increasing impervious surfaces and stormwater management in any of the Buzzards Bay subwatersheds is likewise uncertain. However, without concerted attention to sustainable development practices and water conservation, increasing population and development in the subwatersheds will tend to reduce the amount of available groundwater recharge while simultaneously increasing the demand for water withdrawals. This will result in an overall decrease in the water budget for the watershed.

Although only two of the Buzzards Bay river subwatersheds were identified as having documented and significant impacts to water resources because of water withdrawals, the recommendations here are sound policy for all subwatersheds in the Buzzards Bay watershed. With approximately 45 inches of annual precipitation, adequate water is available to supply necessary water to a growing population without significant impact on sensitive water resources. Those subwatersheds that are not currently identified as stressed or have not experienced significant water resource impacts can plan now for future population growth in an environmentally sustainable manner. Communities in the Paskamanset River and Mattapoisett River subwatersheds, where impacts have already been documented, would be advised to follow the management approaches described here in order to not only maintain the current hydrologic balance but to improve the balance so that more water is available for local aquifer recharge than is currently the case.

There are other cumulative impacts to water withdrawals not fully explored here. These include impacts to private wells, combined demands of agricultural and municipal wells on the same system, and how water withdrawals may be affecting the flows of cold-water streams. These issues warrant further study.

Management Approaches

Water resource management in the Buzzards Bay watershed should strive to protect and preserve groundwater and surface water supplies in order to ensure a sustainable supply of high quality drinking water and to protect wetlands and habitat that depend on those water supplies. These seemingly contradictory goals must be met to ensure an adequate quantity and quality water supply for a growing population, while simultaneously protecting sensitive water resources. Clearly, these goals can only be met through a comprehensive strategy that includes conservation, management of uses, requiring more water reuse, as well as stormwater management practices as epitomized by LID practices. Tools for estimating sustainable yield are available (e.g. Archfield et al., 2010) to guide well development, but a better understanding is often needed to predict withdrawal impacts on wetlands, as well as the effects of impervious area in watersheds.

For all these reasons, managers should strive to preserve or restore the natural hydrology of subwatersheds to the greatest extent practicable. This is achieved by:

- keeping water use local at the subwatershed level (where practical),
- adopting water conservation measures,
- uniformly regulating both public or private withdrawals (including agriculture),
- limit non-essential water use during droughts,
- encourage the reuse of treated wastewater for irrigation and industrial use, and
- implementing stormwater LID management practices to maximize groundwater recharge.

In addition, when new water supplies are needed, efforts should be made to site them as far from significant surface water resources as possible, and ensure all the practices above are implemented.

For some non-impacted subwatersheds where maintaining current hydrologic conditions may be adequate, following such practices may be relatively easy. In contrast, regulators may need to take action that is more dramatic in apparently impacted subwatersheds like the Mattapoisett River valley and the Paskamanset River watershed.

In recognition of the daunting challenge in providing an abundant supply of safe drinking water to the public, government officials have begun to consider desalinization as an option for diversifying potable water supplies. While no desalinization, plants are currently planned for the Buzzards Bay watershed, two plants have been planned in the neighboring Taunton River and Mount Hope Bay watersheds, and three other proposals are being explored in coastal Massachusetts. Impacts to the environment from desalinization plants can arise from both entrainment and impingement at the intake and discharges of concentrated brine at the outfall. The Executive Office of Energy and Environmental Affairs has drafted a comprehensive statewide policy for addressing environmental issues and to ensure that desalinization plants do not damage water quality or habitat.

Financial Approaches

In most Buzzards Bay municipalities, the costs of developing new sources and maintaining existing water supplies are funded by ratepayers through an enterprise fund. If a town does not yet have an enterprise fund, adopting one becomes a financial solution in those cases. Most of the actions to meet this plan have relatively low real costs, as most of the effort focuses on better planning, management approaches, and encouraging of water conservation measures. Some of the more expense actions involve eliminating water loss in old water distribution systems.

Monitoring Progress

Documenting stream flow with respect to precipitation, and documenting times when rivers run dry, especially in known stressed stream watersheds, together with tracking municipal water withdrawals and agricultural withdrawals, will be the principal environmental measures that need to be tracked for this action plan. Regulatory action, changes in residential average water use, and outreach efforts can be used to track programmatic actions.

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Action Plan 11 Managing Invasive and Nuisance Species

Problem

Aquatic and terrestrial nuisance and invasive species represent a threat to endemic natural ecosystems of Buzzards Bay and its surrounding watershed. Once invasive species become established in an ecosystem, they are virtually impossible to eliminate. Therefore, management emphasis must be placed on regulatory controls and increased public awareness to prevent new introductions. Monitoring existing and identifying new invasives is an important tool in this effort by potentially helping elucidate transport pathways, and by identifying new introductions at an early stage where there may be a slight potential to eradicate them.

Goals

Goal 11.1. Minimize the potential introduction of new invasive and nuisance species to Buzzards Bay and its surrounding watershed.

Goal 11.2. Reduce the extent and limit the spread of existing invasive and nuisance species that are degrading habitats of Buzzards Bay and its surrounding watershed.

Objectives

Objective 11.1. Adopt and enforce laws, regulations, and policies that will reduce the potential spread of invasive species.

Objective 11.2. Educate the public, farmers, nursery owners, fisherman, pet storeowners, shipping industry, and other relevant sectors about individual actions that can be taken to reduce the threat of introducing invasive and nuisance species to the environment.

Objective 11.3. Fund and promote actions and studies to control and reduce existing populations of invasive and nuisance species.

Objective 11.4. Monitor existing and new invasives in order to help discern introduction pathways and to identify species in early stages of introduction where there may be a slight potential for containment.

Approaches

For the most part, once an invasive species has entered a region, little can be done to reverse its presence or control its population. Therefore, management action should focus on preventing new introductions, and to monitor existing conditions. Monitoring for the presence of introduced species is important so that scientists and managers can better discern whether shifts in naturally occurring species are likely the result of human perturbations, like pollution, or are possibly caused by predation or competition with introduced species. Monitoring can also document trends and help discern pathways of invasive migrations. This information can help inform policy decisions and regulatory formulation.

Posting maps and information about introduced species and enabling easy online reporting by residents can help achieve the objectives of this action plan. CZM and the MassBays Program have already established websites for information on marine aquatic invasives in Massachusetts[140], and residents and municipal officials of Buzzards Bay should be encouraged to use the available online tracking and reporting forms.

The most effective approach to avoiding new introductions is through education and the enforcement of existing laws, regulations, and through adoption and enforcement of new preventative measures. These efforts will not succeed unless there is increased awareness and acceptance of the problem by the public, businesses, and educational institutions. In this way, all these groups can take voluntary measures or implement best management practices to minimize the threat of introducing non-natives into the environment.

Because pathways, impacts, and the extent of introduced species has not been well documented or understood, monitoring and research is needed not only to evaluate success of control measures, but is a fundamental need to better define the extent of the problem and the viability of proposed solutions.

Costs and Financing

Better tracking, mapping, and monitoring of key invasive aquatic and terrestrial species could be achieved with annual expenditures in the tens of thousands of dollars utilizing resident volunteers, online reporting with oversight and review by wildlife scientists and biologists. More comprehensive mapping efforts, together with research into the pathways and impacts of invasives, can cost millions of dollars. Measures to control species through eradication efforts can cost thousands to hundreds of thousands of dollars per site. There is a cost to government to enforce compliance with new regulations in terms of staff, and compliance of industry with these regulations can range from negligible (e.g. species import bans) to substantial (e.g. ballast water treatment).

Measuring Success

Tracking the extent and abundance of introduced species, together with documentation of the rate of new species introductions will be the measure of the success of this action plan, as well as programmatic measures like the adoption of new regulations.

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[140] At www.mass.gov/eea/agencies/czm/program-areas/aquatic-invasive-species/ and mit.sea-grant.net/mitis/.

Background

Introduced species, which are also called non-native, non-indigenous, alien, or exotic species, are those that have the potential to reproduce in large numbers and to out-compete native species for food or space. When they alter other populations, affect the natural balance of ecosystems, or damage the environment, they are more typically called nuisance, or invasive species.

Aquatic and terrestrial invasive species represent a threat to the endemic natural resources and wildlife of Buzzards Bay and its surrounding watershed. Certain species already have affected the bay and watershed. Freshwater emergent wetland plant species like purple loosestrife (*Lythrum salicaria*) and the common reed, *Phragmities* are among the better known. In freshwater aquatic systems, introduced non-native game fish and non-native weeds like the watermilfoil (*Myriophyllum heterophyllum*) have dramatically changed many freshwater ecosystems. In marine ecosystems, the European green crab (*Carcinus maenas*) Asian shore crab (*Hemigrapsus sanguineus*, Figure 88) and the Pacific green fleece alga (*Codium fragilis)* have had profound effects on the coastal ecology and shellfishing economy of Massachusetts. Some introduced species have been around for so many centuries (e.g., the common periwinkle *Littorina littorea*, introduced with the first European settlers), they are now thought of as part of natural ecosystem. New terrestrial invaders, like the Asian longhorn beetle, have infested trees in some parts of Massachusetts, and its arrival in Buzzards Bay watershed would have a profound effect on our forests. Non-native earthworms have become widespread in the northeast, and they are already believed to be causing important changes in forest habitat (Eisenhauer et al., 2007).

Historically, marine invasives have been principally the result of transport via ship ballast water and hulls, or through the introduction of non-native species for aquaculture. In freshwater systems, past practices of stocking ponds with non-native game species has caused dramatic shifts in pond ecosystems. Introductions of certain game fishes by agencies and members of the public have endangered endemic species. In terrestrial ecosystems, escape of non-native ornamental and agricultural species has contributed to the introduction of some species. Climate changes in seasonal temperature and rainfall may facilitate the spread of some invasive species.

Once invasive species become established in an ecosystem, they are virtually impossible to eliminate. This has been particularly true of marine aquatic invasive species.

Because of these harsh realities, management action has principally focused on preventing new introductions and monitoring existing conditions and trends. Monitoring for the presence of introduced species is important. Past monitoring has been inadequate, and the pathways and impacts of introductions are poorly understood. Monitoring to document trends and discerning pathways helps to inform policy decisions and regulatory formulation. Monitoring also helps scientists and managers discern more clearly whether shifts in naturally occurring species are likely the result of human perturbations, like pollution, or are possibly caused by predation or competition with introduced species.

To better define the problem and help address the threats from marine aquatic invasives, in 2000, Massachusetts Coastal Zone Management (CZM) helped form the Massachusetts Aquatic Invasive Species Working Group consisting of a variety of state and federal agencies, nonprofit organizations, and scientists. In 2002, this group published the Massachusetts Aquatic Invasive Species Management Plan (CZM, 2002). Lists of species and other data are also available online at the Northeast Marine Introduced Species (NEMIS) website[141]. The four objectives of this plan were to:

- *Educate the public about threats from aquatic invaders and measures that can be taken to prevent their further introduction and spread.*
- *Reduce the potential for the introduction of aquatic invasive species into Massachusetts waters through preventative measures.*
- *Control the spread of established aquatic invasive species to uncolonized waters of Massachusetts.*
- *Minimize harmful ecological, socioeconomic, and public health and safety impacts from aquatic invaders that have been introduced to Massachusetts waters.*

In 2007, the state of Rhode Island Aquatic Nuisance Species Task Force undertook a similar effort and published the Rhode Island Aquatic Invasive Species Management Plan. The overarching goal of the Rhode Island plan is to "implement a coordinated approach to preventing the introduction of and minimizing the ecological and socio-economic impacts of aquatic invasive species in the marine and freshwater environments…" Additional specific goals were:

- *Prevent the introduction and establishment of aquatic invasive species.*
- *Control the growth and spread of aquatic invasive species.*
- *Abate the impacts and minimize the harmful effects of aquatic invasive species.*

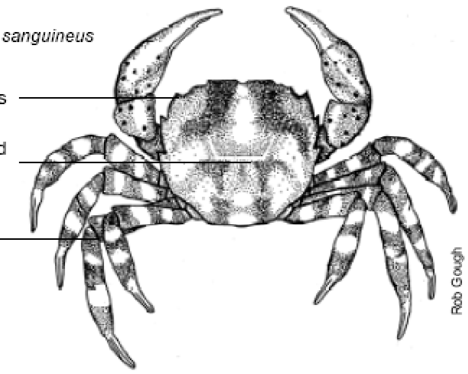
[141] Lists of regional invasive species are retrieved from NEMIS.mit.edu and mit.sea-grant.net/mitis/. Last accessed April 24, 2013.

GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Hemigrapsus sanguineus
Asian shore crab


Salem Sound Coastwatch

PHYSICAL DESCRIPTION
- 3 lateral spines on each side of a square-shaped carapace (shell)
- Light and dark bands on legs with red spots on the claws
- Color variable: commonly orange-brown, also green and maroon
- Carapace width up to 2 in (5 cm)
- Larger males have fleshy bulb at base of pincers



HABITAT PREFERENCE
- Occurs primarily in mid to low intertidal zones and sometimes the subtidal zone
- Tends to aggregate in high densities under rocks
- Tolerant of a wide range of salinity and temperature
- Prefers rocks and cobble but may be found in soft sediments and other habitats

1 2 3 4 5 6 7 8

GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Hemigrapsus sanguineus
Asian shore crab

INVASION STATUS & ECOLOGICAL CONCERNS
Abundant in rocky intertidal habitats, *Hemigrapsus sanguineus* is a native of the western Pacific Ocean ranging from Russia, the Korean and Chinese coasts to Hong Kong, and Japan. It was first recorded in the United States in 1988 at Townsends Inlet, Cape May County, New Jersey. It is now well established and rapidly expanding its range along the Atlantic coast from Maine to North Carolina. Female *H. sanguineus* produce up to 50,000 eggs three to four times from May to September, compared to native crabs that reproduce twice a season. The larvae are free-floating for nearly a month before becoming juvenile crabs, increasing the possibility of being transported to new areas. An opportunistic omnivore, it feeds on salt marsh grass, algae, invertebrates, and larval and juvenile fishes.

SIMILAR SPECIES
Hemigrapsus sanguineus may be mistaken for several other crabs in New England, including the European green crab (*Carcinus maenas*), the Atlantic mud crab (*Panopeus herbstii*) and others. To differentiate the region's crabs, it is helpful to take careful note of the carapace (shell), particularly its shape and the number of marginal spines on each side (see figure on right).

Carapaces of Selected Crabs of the New England Coast

This identification card is one of a series produced by Salem Sound Coastwatch (www.salemsound.org) highlighting introduced species that pose a threat to the marine environments of Massachusetts and the Gulf of Maine. The original development of these cards was funded by the MA EOEEA Office of Coastal Zone Management with funding from the U.S. Fish and Wildlife Service.
For additional species information or to report sightings, please visit www.mass.gov/czm/invasives/monitor/reporting.htm.

CZM

Figure 88. Invasive species identification card for the Asian shore crab, developed by Massachusetts CZM.

If a new introduced species is perceived to be an ecological or economic threat, a rapid response is critical for a possible successful eradication. Such an attempt is occurring in the case of the Asian Longhorn beetle where large tracts of infected forest in the Worcester area are being deforested and the wood burned to prevent the spread of the beetle. No such model has been found or implemented in the marine environment, and continued control may be a viable option only for a few species.

Major Issues

Where an invasive can be controlled or eliminated, the costs are often high, and the restoration itself may have ecological impacts. For example, the Eurasian watermilfoil (EWM) affects 14% of the roughly 700 lakes and ponds in Massachusetts, with the affected systems totaling more than 19,000 acres (DCR, 2006). To control EWM, DCR estimated the three different treatment option to have the following costs: chemical control using herbicides= $550-$750 per acre, biological control using weevils= $3,000 per acre, and mechanical control using diver-assisted, suction harvesting=$10,000 per acre, for a total cost of $7 to $120 million for this one invasive.

For the most part, once an invasive marine species has entered a region, little can be done to reverse its presence or control its population. Therefore, management action should focus on preventing new introductions and monitoring existing conditions. Monitoring can also document trends and help discern pathways of invasive migrations. Currently, the lack of data and information on propagation pathways and ecological relationships is so profound, that it may take many years of research to fully understand the impacts of introductions or the biology of introduced species so that effective control measures can be developed. Identifying solutions will therefore depend in part on commitments to funding long-term research.

Part of a solution will also depend on increased coordination of federal agencies with foreign agencies on matters of shipping procedures, ballast water handling, and the importation of produce, lumber, live animal products, and ornamental species. For example, in 2010, the U.S. EPA promulgated new rules regulating the discharge of ballast water under its NPDES discharge permit program, but the efficacy of the proposed strategy was challenged. In March 2011, the EPA announced it would promulgate new stricter rules regulating ballast water discharges. Under a settlement filed in the D.C. Circuit Court of Appeals, by 2014, the EPA will devise limits for the discharge of plankton and microbes in ballast water[142]. Neighboring states could also coordinate and implement complimentary measures on non-native garden plants that could become nuisance species.

Figure 89. Various public education graphics and signs relating to introducing exotic species.

Don't Release A Pest. Film by S. Zaleski, L. Walters, and P. Grifman. USCSG-ME-03-2007(N/C).

Don't move a mussel – now it's the law, AZGFD.gov.

Look for Mussels Here, Minnesota Department of Natural Resources Invasive Species Program.

Stop Aquatic Hitchhikers, protectyourwaters.net.

Don't move firewood, massnrc.org.

Tracking and facilitating these efforts are beyond the scope of a National Estuary Program.

Management Approaches

With respect to monitoring marine species, Coastal Zone Management and the Buzzards Bay NEP should work with federal agencies and scientists to monitor sen-

142 www.upi.com/Science_News/2011/03/10/EPA-will-regulate-ballast-water-discharge/UPI-96031299798613/#ixzz1MAEhJnfk. Last accessed October 11, 2013.

tinel stations at least every three years. Buzzards Bay was surveyed through the Rapid Assessment Survey Program in 2000, 2003, 2007, and 2010 with two to four of the following sites surveyed in any particular year: Buzzards Bay Village, New Bedford Harbor, Westport Harbor, and Woods Hole.

The escape of exotics by research institutions and commercial entities may have resulted in some past introductions of marine, freshwater, and terrestrial species. Residents may have contributed to the introduction of some freshwater and terrestrial invasives. For these reasons, education of the public, businesses, and educational institutions is an important part of any strategy to prevent new introductions. Agencies could offer special certifications for businesses that implement certain practices.

The Department of Environmental Protection and the Massachusetts Department of Food and Agriculture have ongoing programs to educate the public about freshwater and terrestrial invasives, but more effort may be needed to educate the public and nurseries about that list. These agencies also have regulatory responsibilities, and they should review the effectiveness of implementation and enforcement of past efforts and recommend new laws, regulations, and policies to prohibit or regulate the sale of prohibited species or regulate other activities that are likely to lead to introduction of exotics. Agencies should enable a streamlined permitting process for rapid response control methods.

The USDA NRCS program has several initiatives that address the spread of plants that have been classified as noxious or invasive. Activities include technical and financial assistance to manage invasive species and pests; Conservation Innovation Grants that support development and implementation of innovative approaches, a Plant Materials Center that funds research and restores areas where invasive species have been removed, and programs to assist with detection, inventorying, and monitoring on private lands as part of the conservation planning process. NRCS's work to restore salt marshes assists with *Phragmites* control, and a Buzzards Bay example includes their 2005 partnership with Mass Audubon partner to restore salt marsh at Allens Pond Wildlife Sanctuary, South Dartmouth.

The Massachusetts Department of Conservation and Recreation (DCR) has several programs that address invasives (DCR, 2006) that could be expanded in the Buzzards Bay watershed. For example, the goal of DCRs Lakes and Ponds Program is to prevent further infestation of Massachusetts' lakes and ponds by exotic invasive aquatic plants, and to work towards controlling and removing existing populations of exotic invasive plants. To meet this goal DCR has implemented a Weed Watchers program where a volunteer team receives training in the identification and removal of invasive species, signs to post on boat ramps, and informational materials to distribute. The volunteers patrol their lake every other week during the summer for the presence of invasive species in key locations. If a potential infestation is found, the Weed Watchers group will work with the Invasive Species Task Force to identify the species and to develop and implement a removal plan. Results of the program and a list of monitored ponds should be made available online.

On Cape Cod, Barnstable County has several initiatives relating to invasive controls, one of which has involved AmeriCorps staff overseeing other volunteers in the physical removing invasives[143]. In the Buzzards Bay watershed, only Bourne and Falmouth are covered and there is no comparable county agency doing similar work in Bristol and Plymouth counties.

These efforts will only succeed if there are also programs to educate residents, businesses, and educational institutions on the dangers of releasing non-native species into the environment (examples in Figure 89). There is a special need to provide more education and outreach to the nursery, aquaculture, water garden, bait, and pet trades. Where population control of invasives can be implemented (e.g. *Phragmites*), better informational materials should be provided by agencies on the best practices to control invasives or restore native species, and the permitting requirements for these activities.

Residents should be educated about actions they can take such as cleaning boats and boat trailers prior to leaving a waterway, and never releasing live organisms including aquarium pets and unused live bait and bait packing materials. Residents should also be encouraged to landscape with native plants. Publications like the A Citizen's Guide to Monitoring Marine Invasive Species (Salem Sound Coastwatch, 2005) is a good model of a publication to help the public get involved with tracking invasives.

The online dissemination of information about invasive species and their distribution, together with online reporting forms can help achieve some of the objectives of this action plan in a cost-effective way. CZM and the MassBays Program have already established a website[144] for information on marine aquatic invasives in Massachusetts, and residents and municipal officials around Buzzards Bay should be encouraged to use the available online tracking and reporting forms.

[143] For example, as part of Harwich, MA "Blitz Week," over the course of a week, April 2008, 370 volunteers used loppers to remove invasive plants on a portion of conservation land, specifically removing olive shrubs, bittersweet, and honey suckle. See www.americorpscapecod.org/wordpress/wp-content/misc/Waypoint_July2008.pdf.

[144] At www.mass.gov/eea/agencies/czm/program-areas/aquatic-invasive-species/ and mit.sea-grant.net/mitis/.

Financial Approaches

The financial costs of monitoring and tracking of key species could be undertaken with modest funding if online volunteer reporting by residents and volunteers were utilized and periodic participation by scientists. The statewide cost of the periodic marine aquatic invasive species monitoring and reporting is approximately $10,000 every 3 years. The implementation of more rigorous monitoring and research efforts will require millions of dollars, especially from federal agencies. In some cases, existing agencies grant programs can be utilized. Expanded state and federal funding will be needed to evaluate the effectiveness of past abatement and control efforts.

Monitoring Success

Monitoring is needed not only to evaluate the success of control measures, but is also fundamental to better define the extent of the problem and the viability of proposed solutions. Rapid assessments like those undertaken by Pederson et al. (2005) and McIntyre et al. (2010) should be continued and repeated at least every three years. For any given site or watershed, the extent and abundance of introduced species should be mapped and the information posted on the internet. Programmatic measures, like the adoption of new regulations, should also be tracked.

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Action Plan 12 Protecting Open Space

Problem[145]

There are many different land uses within the Buzzards Bay watershed, but much of the watershed remains undeveloped. However, undeveloped land has been disappearing at a rapid rate. In 1971, 64.5% of the watershed consisted of open and unperturbed forestlands and only 12.9% was developed[146]. By 1999, open and unperturbed forested lands decreased to 56.5% of the watershed, while developed lands increased to 19.8%. The percent of lands classified as developed continues to increase, especially in the more rapidly growing communities.

There are ecological, cultural, and aesthetic reasons to protect open space. Naturally vegetated landscapes control flooding, can protect water supplies, reduce erosion, reduce pollutants from watersheds, and provide upland and wetland habitat. Despite these and other benefits, protection of open space and habitat is a financial and political challenge for most municipalities; several communities in the Buzzards Bay watershed still have not identified protection needs through open space and master plan development and updates. Some municipalities have considerable amounts of open space; some have modest amounts of open space.

Goal

Goal 12.1. Preserve the ecological integrity of Buzzards Bay and its watershed by increasing the amount of permanently protected open space.

Objectives:

Objective 12.1. Improve and protect coastal and inland surface water quality through land protection.

Objective 12.2. Protect biodiversity in the watershed.

Objective 12.3. Protect the region's groundwater supplies.

Objective 12.4. Improve the land conservation community's ability to protect open space.

[145] This is a new action plan not in the 1991 CCMP, although the earlier document did have specific recommendations to protect open space and valuable habitat. Related recommendations are contained in the LID, Stormwater, and Nitrogen Management Action Plans.

[146] Estimated from the MassGIS coverage "Land Use (1951-1999)" using the categories of Mining, Residential, Commercial, Industrial, Transportation, and Waste Disposal land uses for "developed land." Land use for 2005 is available, but a different methodology was used, so it is not directly comparable. Other methodologies can yield higher estimates of forested land, especially if tree cover on developed lots is included.

Approaches

Meeting the goals of this action requires that towns and land trusts acquire properties for conservation purposes, or property owners agree to protect permanently their properties for conservation purposes, or in the case of farmlands and surrounding habitat, for farming purposes. Because the acquisition of open space can be expensive, even for properties mostly wet, the use of conservation restrictions and agricultural preservation restrictions are important tools to encourage private open space protection. These private land protection strategies are driven by financial and tax benefit incentives offered by government.

Because the purchase of open space can be costly, and state and local governments typical have limited funds for these purchases, it is important that municipalities develop broad strategies and goals for open space protection. These can be articulated in municipal open space plans. These plans must be updated every seven years to remain valid and ensure that the municipality is eligible to receive state grants for open space protection.

Another mechanism to generate local funds is for municipalities to adopt the Community Preservation Act. By adopting this legislation, municipalities can levy a tax fee on property transfer, and some of this revenue is matched by a state fund.

Finally, open space can be protected at no cost to government by allowing cluster development and transfer of development rights. These innovative approaches require approval by the municipal legislative body and planning boards.

Costs and Financing

The preparation and updating of open space plans can be done in-house by municipalities with assistance from the Buzzards Bay NEP or land trusts, or completed by a contractor to the municipality (perhaps a cost of $20,000). Raising money for land acquisitions can be met by donations, municipal appropriations, or by grants. Local adoption of the Community Preservation Act is the best approach to ensure a local revenue stream. Often land acquisitions are complex and may involve funding from multiple sources.

Measuring Success

Ultimately, the number of acres of wetlands and habitat protected (by communities and in the watershed) is the principal mechanism of tracking the success of this action plan. Programmatic tracking of municipal actions, like the approval of open space plans, adopting the Community Preservation Act, and tracking the number of towns without valid open space plans may also be used.

Background

Preserving open space make sense from both an ecological and cultural point of view. Naturally vegetated landscapes reduce erosion by slowing the rate of water runoff; control flooding by regulating water levels in rivers and streams; provide habitat for diverse species; and protect our inland and coastal water resources by acting as filters for nitrogen and sediment. Additionally, protected lands provide areas for recreational activities, protect historically significant places, and preserve the charm and character of the areas in which we live. Open space also makes sense for a town's tax base because undeveloped, protected land does not require costly community services, such as schools, police, and road maintenance. Many reports have documented the value of open space when compared to the high costs of community services.

Poorly planned development, on the other hand, pollutes the environment through stormwater runoff from roads and lawns and contamination from onsite septic systems; impedes natural water flows; reduces groundwater recharge; fragments and degrades habitat; acts as a physical barrier to wildlife migration; and leads to the loss of our sense of place.

Over 66,000 acres, (25% of the total land area, see Table 39, Figure 90) of the Buzzards Bay watershed, from Fall River to Gosnold, exists as permanently protected open space. The amount of protected acreage within each watershed town varies and is dependent on many factors. Local dedication to land protection, availability of affordable land, eminent threats from development, and socio-economic factors all contribute to the culture of land conservation in each municipality. Municipalities with the highest percentage of open space are those that contain a state forest, wildlife management area, or water supply reserve. Overall, there have been continued successes in the efforts to protect open space in the Buzzards Bay watershed (Figure 91).

Table 39. Protected lands in the watershed summarized by municipality (as of September 2011).

Town	Protected Acres in Watershed [a]	Total Acres in Watershed	Percent OS in Watershed [b]
Acushnet	1,040	12,082	9%
Wareham	2,428	23,772	10%
Carver	2,398	21,248	11%
New Bedford	2,027	12,456	16%
Freetown	523	3,101	17%
Rochester	3,591	21,092	17%
Westport	4,864	28,399	17%
Falmouth	2,332	13,417	17%
Fairhaven	1,538	7,942	21%
Mattapoisett	2,835	11,196	25%
Dartmouth	10,144	39,639	27%
Gosnold	1,250	4,320	28%
Middleborough	3,187	11,023	30%
Marion	3,172	9,036	37%
Plymouth	10,738	24,102	45%
Bourne	10,589	21,904	48%
Lakeville	73	136	54%
Fall River	4,918	6,802	73%
Sandwich	1,201	1,636	73%

a Acres of protected open space includes only protected land that falls within the Buzzards Bay watershed area and includes surface water in the parcel. The actual acreage within an entire town may be much greater.

b Percentages of protected open space is defined here as the area of protected land that falls within the Buzzards Bay watershed area divided by the municipal area including freshwater ponds in the watershed.

An Open Space Protection Success Story

The Buzzards Bay NEP is a key partner with the Buzzards Bay Coalition, preparing hundreds of maps and conducting GIS land use evaluations for targeted acquisitions. Our support is integral in the Coalition's outreach for their program, and has helped the passage of municipal town meeting legislative articles in support of conservation land acquisitions.

An example of the success of the Coalition is the fact that they helped secure 274 acres of the Mattapoisett River Valley in 2004. Building upon a Department of Environmental Protection grant that funded 60% of the acquisition cost, the Coalition brought together an array of conservation partners involving the Mattapoisett River Valley Authority and the Rochester Land Trust. In April 2004, the arduous task of piecing together funding sources came to a finish when a Rochester resident stepped forward and pledged $10,000 to close the gap. An additional acquisition the following year protected 13 adjoining parcels of land near the drinking water supply wells for the towns of Fairhaven, Mattapoisett, and Marion. These parcels include mature pine and oak forests, floodplain wetlands, vernal pools, and wet meadows. The final phase of conservation occurred in 2006 by the Rounseville family protecting more than 2.6 miles of river shoreline between Mill Pond and Wolf Island in the Mattapoisett River Valley.

The Commonwealth of Massachusetts

The Commonwealth of Massachusetts is an important player in land protection in southeastern Massachusetts and owns more than 36,000 acres - 55% of all the protected land - in the Buzzards Bay watershed. The Commonwealth generally purchases land that has extraordinary natural resource features and prefers to buy lands that build on its existing wildlife management areas and reserves. Some of the Commonwealth's most notable properties include the southeastern Massachusetts Bioreserve, Rocky Gutter Wildlife Management Area, Myles Standish State Forest, Haskell Swamp Wildlife Management Area, Nasketucket Bay State Park, Demarest Lloyd State Park, Horseneck Beach State Park, and the Upper Cape Water Supply Reserve. The Commonwealth's large landholdings form an arc across the watershed and are critical to maintaining the region's biodiversity.

Figure 90. Protected open space in the Buzzards Bay watershed as of 2011.

The Commonwealth protects an additional 5% of the watershed's open space through the Agricultural Preservation Restriction (APR) program. Administered by the Massachusetts Department of Agricultural Resources (MDAR), the APR program is a voluntary program aimed at protecting the state's most significant farmland soils. It offers a non-development alternative to owners of important agricultural lands by purchasing the development rights to the land. The program offers to pay farmers the difference between the fair market value and the agricultural value of their land. In exchange, the farmer agrees to place a permanent deed restriction on the property that limits any future development. The APR program is highly competitive with preference given to working farms located in agriculturally productive regions of the state with highly productive agricultural soils.

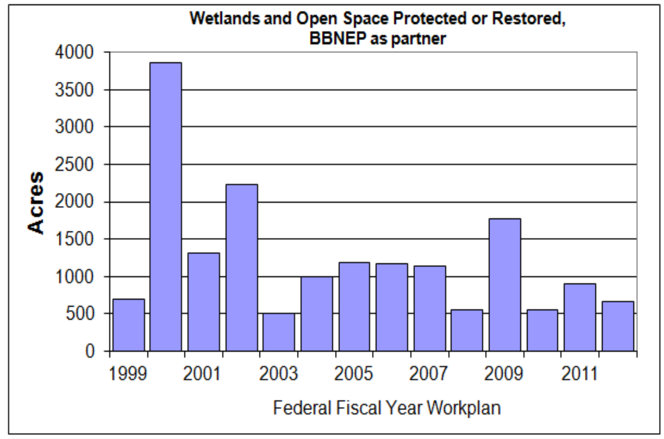
In the Buzzards Bay watershed, the majority of working farms (not including cranberry bog operations) exist in the towns of Westport and Dartmouth. Westport in particular is one of the top-producing farm communities, and the leading dairy producing area, in the Commonwealth. The APR program has been actively working with these towns and local land conservation organizations to protect hundreds of acres of farmland.

Role of Municipalities

Municipalities play the most critical role in watershed land preservation. Conservation commission owned or other deed-restricted municipal lands account for the second largest percentage of open space in the watershed – nearly 13,000 acres or 18%.

Finding sufficient funding for open space acquisitions is often an issue for towns. However, with the enactment of the Community Preservation Act (CPA) [G.L. Ch. 44B] in September 2000, municipalities were provided with a new source of land protection funding. This statewide enabling legislation allows communities to establish a local Community Preservation Fund, to buy open space, protect historic sites, or provide affordable housing. A local surcharge of up to 3% of the real estate tax on real property supports this local fund (surcharge level selected by the municipality). Additionally, the state committed to a matching fund generated by fees charged on certain transactions filed at county registries of deeds. From 2001 to 2007, each CPA community received a distribution from the CPA Trust Fund equal to 100% of its locally raised revenue. Beginning in October 2008 however, the CPA Trust Fund could not sustain the 100% match due to the popularity of the program and reduced real estate activity. The distribution rate fell to 67% for many communities in 2008, and has declined each year since, to a projected 25% in 2011.[147].

[147] CPA Trust Fund receipts from September 2010 to March 2011 totaled $16.8 million CPA Trust Fund receipts information Retrieved from www.communitypreservation.org/, see CPA News.



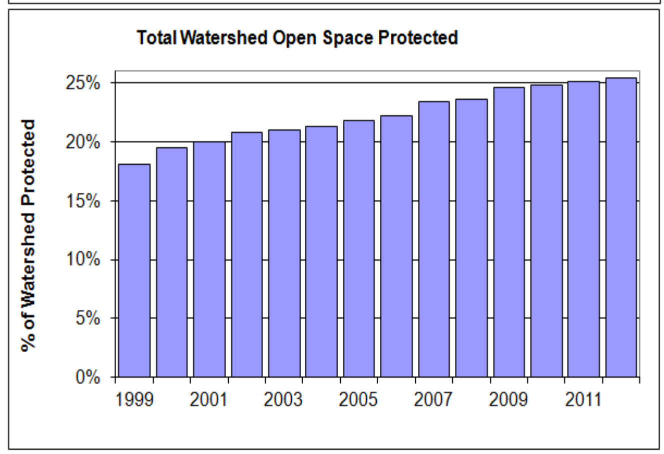


Figure 91. Top: Open space protected annually with some level of assistance from the Buzzards Bay NEP or Coalition as reported in GPRA reports to EPA. Bottom: Total Buzzards Bay open space as % of watershed.

Adopted by municipalities through a ballot referendum, the CPA requires that communities distribute at least 10% of the community's funds to each of the three categories: open space acquisition, historic preservation, and low- to moderate-income housing. Municipalities may distribute the remaining 70% in any combination within the three categories. The selectmen in each municipality appoint a committee, which decides how the funds will be used, and expenditures must be approved by a town meeting vote.

The CPA is an excellent tool to use for open space preservation and 11 Buzzards Bay towns have adopted the Act. They include Acushnet, Bourne, Carver, Dartmouth, Falmouth, Fairhaven, Marion, Mattapoisett, Plymouth, Wareham, and Westport. Three towns (Fall River, Gosnold, and New Bedford) have yet to bring a CPA ballot to the polls. The CPA ballot failed in Rochester and Middleborough.

Non-profit Land Conservation Organizations

Dating back to the early 1970s, land trusts have a long history of protecting land in southeastern Massachusetts. There are currently 10 local and 3 regional land trusts working to protect the southeastern Massachusetts landscape. Land trusts protect, through acquisitions and conservation restrictions, 20% of the watershed or nearly 14,000 acres.

While the land trust community has made great strides in open space protection, few area land trusts can afford to fund full-time staff members, and most function with only a dedicated board of volunteers. To help the land trust community with their endeavor, the Buzzards Bay Coalition has focused attention on enhancing the land acquisition capabilities of area land trusts by serving as a coordination and service arm to land trusts and property owners. The Coalition develops land protection strategies, provides staff for assistance, and maintains contact with large landowners. The Buzzards Bay NEP works cooperatively with the Coalition by maintaining an open space database and providing high quality Geographic Information System (GIS) maps to the Center.

Buzzards Bay Greenway

First proposed in 1995, the Buzzards Bay Greenway (Figure 92) is a proposed protected land corridor and walking trail that will connect Fall River to Plymouth. The planned greenway would cross 10 town lines and 8 rivers and would connect more than 30,000 acres of protected land with a nearly 75-mile long trail corridor.

This regional land protection initiative received outreach assistance from the National Park Service Rivers & Trails Program and funding assistance from a Massachusetts Department of Environmental Management Greenways and Trails grant and from the Massachusetts Department of Conservation and Recreation.

In 1999, the Buzzards Bay Coalition dedicated the first 5 miles of the Greenway, located on western side of the watershed. In 2000, 10 additional miles were added (see Figure 92).

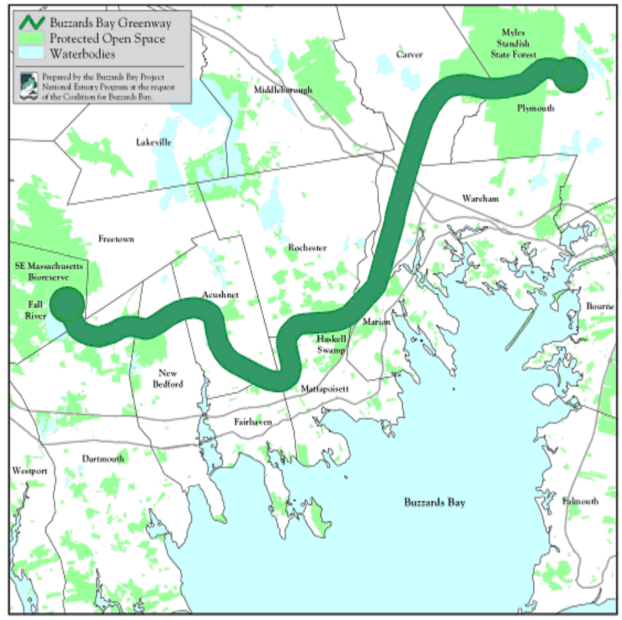


Figure 92. Greenway proposed by the Coalition in 1995.

The acquisitions of contiguous open space properties and creation of wildlife corridors remains a high priority to open space committees and lands trusts.

Major Issues

Municipal Open Space Plans and the Commonwealth Capital Policy

To be eligible for several state grant programs, including open space funding under the Commonwealth's Land Acquisition for Natural Diversity (LAND) Program (formerly called Self-Help), Parkland Acquisitions and Renovations for Communities (PARC) Program (formerly called Urban Self-Help), and Land and Water Conservation Fund grants, municipalities are required to have an approved open space and recreation plan on file with the Division of Conservation Services. These plans must follow an established outline and discuss issues related to population characteristics, growth and development patterns, natural resources, and protection of open space. Towns must update and resubmit their plans to the Division of Conservation Services every seven years to remain eligible for funding.

Municipal open space plans in Massachusetts typically identify the protection of natural resources as among the highest priorities. Specifically, irrespective of the municipality, there is recurring emphasis on the protection of wetlands, wildlife habitat, drinking water supplies, rare species habitat, wetlands, riparian corridors, and linking open space in the region. These goals echo the collective understanding that natural resources are limited, and more importantly, that they are threatened.

Because municipal open space plans provide an opportunity to protect natural resources, and because the plans are a requirement for obtaining land acquisition and protection grants, for more than 15 years, a major focus of the Buzzards Bay NEP has been to assist Buzzards Bay municipalities in developing open space plans. This assistance has ranged from preparing the entire document to preparing sections or maps in support of plan development by municipal open space committees.

The Commonwealth of Massachusetts imposes other requirements besides valid open space plans to be able to receive state funding. The most important of these requirements, adopted in 2005, is that towns must complete and submit annually a "Commonwealth Capital" application.[148] In most grant programs, Commonwealth Capital scores account for 30% of the evaluation score. A summary of Buzzards Bay watershed municipal com-

[148] The Commonwealth Capital application is now an important criterion for dozens of state-funded environmental grant programs. Although the application is technically a requirement, failure of the town to score itself using the state criteria will place that municipality at a competitive disadvantage over communities that do complete the form.

monwealth scores for 2005 - 2009, and environmentally relevant actions completed and the relative ranking of each (as characterized on the Buzzards Bay website) are shown in Table 40 and Table 41.

As noted in state documents, the Commonwealth Capital Policy seeks to "encourage municipalities to work in partnership with the Commonwealth to achieve smart growth. Commonwealth Capital explicitly endorses planning and zoning measures that are consistent with sustainable development principles and encourages municipalities to implement them by using state funding as an incentive." That is, smart growth does not stop growth, but seeks to redirect it to places that are more appropriate. Sustainable practices include zoning techniques such as transfer of development rights (TDRs), cluster or open space residential design, and agricultural preservation district zoning, as well as water resource management, low impact development (LID), and traditional neighborhood development.

Nearly half of the Commonwealth Capital Policies focus on achieving environmental actions, or actions that achieve or support smart growth. Therefore, if municipalities can improve their Commonwealth Capital scores, they not only improve their chances of receiving discretionary state funds, but will also protect or enhance the environment or natural resources.

Because there is such variability in municipalities achieving the environmental goals specified in the Commonwealth Capital application, in 2004, the Buzzards Bay NEP began tracking those actions in the Commonwealth Capital application that also achieve goals in the Buzzards Bay CCMP. Buzzards Bay NEP's website status and trends webpage (buzzardsbay.org/tracking-town-actions.htm) highlights the success of the towns in undertaking key Commonwealth Capital actions as shown in Table 41. The Buzzards Bay NEP continues to encourage municipalities to adopt Commonwealth Capital goals to improve their scores and thus their chances to receive state grant funds.

Developing Regional Open Space Plans

In the 2000s, the EEA began promoting the development of regional open space plans. The purpose of the regional open space plan is to encourage communities and land conservation organizations in the watershed to work cooperatively toward land acquisition and protection goals on a regional scale; to protect biodiversity and safeguard water resources through the protection of undeveloped lands in their natural state; and to help leverage funding and resources for open space protection. In a more pragmatic sense, the regional open space plans help guide state funding by identifying areas that have regional significance, or have significance as part of a watershed priority, and not just an individual municipal priority. In other words, these plans provide a regional context for evaluating town requests for land protection funding.

Because the Buzzards Bay NEP had assisted in the development of numerous open space plans, in 2008 the program created the first Buzzards Bay Watershed Regional Open Space Plan.

Regional Open Space Principles and Recommendations

Today, 25% of the watershed exists as protected open space. However, without a long-term land preservation commitment by watershed towns, new open space acquisitions will diminish in the face of competing expenditures. To ensure continued progress toward open space protection, the Buzzards Bay NEP included in the regional open space plan a series of general recommendations to meet the resource protection needs identified by the Commonwealth, and recommendations already included in existing municipal open space and recreation plans, and recommendations of regional conservation organizations. These recommendations provide guidance for land protection efforts in the watershed and are applicable to municipalities, state, and federal agencies, and land conservation organizations. They also provide the basis of many recommendations contained in this action plan.

Table 40. Commonwealth Capital scores for 2005 - 2009.

(as reported on the status and trends page of the Buzzards Bay NEP's website.)

Town	2005 Score	2006 Score	2008 Score	2009 Score	Relative 2009 Rank
Acushnet	50	44	0	0	☹
Bourne	0	62	46	0	☹
Carver	51	48	0	0	☹
Dartmouth	94	90	0	66	😐
Fairhaven	57	70	64	72	☺
Fall River	92	98	68	69	😐
Falmouth	0	90	0	105	☺
Gosnold	0	0	0	0	☹
Lakeville	53	39	0	39	😐
Marion	48	62	55	0	☹
Mattapoisett	34	43	0	40	😐
Middleborough	0	109	96	90	☺
New Bedford	92	98	0	91	☺
Rochester	22	35	0	43	😐
Wareham	53	82	81	0	☹
Westport	67	78	81	0	☹

KEY (Based on 188 scores statewide for 2005):
☹ = in bottom 50% statewide (score <50)
😐 = in mid 25% statewide
☺ = in top 25% statewide (score>78)
NS = No Municipal Applications for Funds

Table 41. Commonwealth Capital scores that achieve goals in the Buzzards Bay CCMP (2006 status).

Municipality	Current Open Space Plan (4 pts)	TDRs (5 pts)	Cluster Zoning or OSRD (11 pts)	Water Resource Mgmt. (5 pts)	Water Resource Protection (5 pts)	Water Conservation Plan (included in WR Mgmt.)	Open Space Protected (3 pts)	CPA (3 pts)
Acushnet	Failed	Failed	Failed	Pending	Adopted	Pending	Failed	Adopted
Bourne	Failed	Failed	Adopted, not used	Failed	Adopted	Failed	Adopted	Adopted
Carver	Adopted	Failed	Adopted	Failed	Adopted	Failed	Failed	Pending
Dartmouth	Adopted	Pending	Adopted	Pending	Adopted	Adopted	Pending	Adopted
Fairhaven	Failed	Pending	Pending	Failed	Adopted	Pending	Failed	Adopted
Fall River	Adopted	Failed	Failed	Failed	Adopted	Failed	Adopted	?
Falmouth	Adopted	Adopted, not used	Adopted, not used	Failed	Adopted	Failed	Pending	Adopted
Gosnold	?	?	?	?	?	?	Pending	?
Marion	Adopted	Failed	Adopted, not used	Failed	Failed	Failed	Pending	Adopted
Mattapoisett	Failed	Failed	Adopted, not used	Failed	Adopted	Adopted	Pending	Failed
Middleborough	Failed	Failed	Adopted	Failed	Adopted	Failed	Pending	Failed
New Bedford	Failed	Adopted	Pending	Pending	Adopted	Pending	Failed	?
Plymouth	Adopted	Failed	Adopted	Adopted	Adopted	Failed	Pending	Adopted
Rochester	Failed	Failed	Adopted	Adopted	Adopted	Failed	Pending	Failed
Wareham	Adopted	Failed	Adopted	Failed	Adopted	Failed	Failed	Adopted
Westport	Failed	Failed	Failed	Failed	Adopted	Failed	Failed	Adopted

KEY

Adopted = Measure, regulation, or policy adopted.

Adopted, not used = Adopted, but not used since 2003 because of disincentives, contradictory laws, or other hindrances.

Pending = Measure, regulation, or policy pending or committed to in Commonwealth Capital Application.

Failed = Failed, never attempted, or not committed to in Commonwealth Capital Application.

? = Failed, never attempted, or committed to, but suitability questionable for community.

From buzzardsbay.org/tracking-town-actions.htm.

A. Protect Critical Natural Resources

Saltwater and Freshwater Wetlands

Wetlands serve many important purposes including flood control, prevention of pollution and storm damage, protection of public and private water supplies, and protection of fisheries, shellfisheries, and wildlife habitat. Wetlands are afforded substantial protection under state wetlands regulations. However, municipalities are encouraged to continue efforts to strengthen local wetlands bylaws to provide greater protection to these important resources. Land conservation organizations should work to establish connections between major wetland systems through protected land corridors.

Endangered Species Habitat/Core Habitat

For millions of years, species have been evolving into a complex intertwined web, but as viable habitats are lost and species diversity decreases, the danger of a collapse of whole ecosystems becomes very real. The U.S. Fish and Wildlife Service estimates that losing one plant species can trigger the loss of up to 30 other insect, plant, and animal species. It is critical to the region's biodiversity to protect habitat for endangered species. Managers should give priority to conserving core habitats and supporting natural landscapes and their surrounding watersheds as identified by the Natural Heritage and Endangered Species Program.

Groundwater Resources

Drinking water, our most precious natural resource, is often taken for granted. Protected lands in the form of woods and wetlands are vital to the region's water supply because of their ability to recharge groundwater and act as filters for pollution. Municipalities can protect groundwater resources by using aquifer protection overlay districts and land acquisitions. Protection of land within the recharge areas to aquifers (Zone IIs and Interim Wellhead Protection Areas), as well as land immediately surrounding existing wells, is especially important.

Coastal Shorelines and Resources

Coastal shorelines support an abundance of life, are key to the region's economy, and important to our quality of life. However, shoreline habitat is rapidly diminishing due to irresponsible development, which compromises ecological functions by reducing habitat availability and negatively affecting water quality. Communities are strongly encouraged to protect natural shoreline conditions by minimizing the effects of shoreline use/development, restricting harmful activities, and reducing stormwater impacts. Degraded shoreline habitat should be restored where possible.

Surface Waters and Riparian Corridors

Surface waters provide wildlife habitat, drinking water, flood control, and areas for recreation. Riparian corridors, the vegetated lands that border surface waters, are particularly important to the health of freshwater ecosystems because they act as buffers to surrounding land uses. Protection of surface waters and adjacent riparian lands should be a land conservation priority as these areas build the foundation of open space corridors.

Forestlands

Contiguous, intact, mature forests provide habitat for many species, but they also protect our water supplies by acting as filters for nitrogen and sediment. Forests reduce erosion by slowing the rate of water runoff; regulate water levels in rivers and streams; moderate the Earth's climate by removing greenhouse gasses and producing large amounts of oxygen; and they provide areas for community recreation. Some of the most important forest areas to protect include large contiguous blocks, riparian areas, unique communities, and habitat for rare or endangered species.

Scenic & Historic Areas

Scenic open spaces maintain an area's rural character, contribute to quality of life and provide visual relief; and historic places give each community unique character. Visual quality affects how people feel about a community and influences whether they would want to live in, visit, or locate a business in a particular area. Residents and visitors alike see the majority of a community while riding in their vehicles, making scenic vistas from roadways particularly important to protect. Views from sidewalks, hiking trails, bike paths, and recreational areas also contribute to a community's desirability.

Agricultural Lands

Active agricultural lands not only provide food and contribute to the local economy, but they hold aesthetic qualities and bring a sense of place to the region. Well-managed farmland can also benefit the environment by filtering wastewater and providing groundwater recharge. Development located too close to farming operations often results in conflicts when normal farming practices are perceived to interfere with residential uses. Municipalities with prime or locally important farmland should review their regulations to ensure they support the continued operation of active farms.

B. Promote Interconnectedness of Protected Lands

Development in the watershed is fragmenting habitat and disrupting critical ecological processes. Fragmentation limits habitat, destroys wildlife corridors, and genetically isolates members of a species. Connecting and maintaining large tracts of a diverse assortment of high quality interconnected habitat types, such as forests, fields, riparian corridors, and inland and coastal wetlands is crucial to protecting biodiversity in the watershed. From a regional perspective, it is important to examine the quality and location of existing protected lands to determine if it is feasible to make connections when planning future conservation activities.

C. Protect Natural Resources through Improved Regulations and Zoning

Single-use zoning has made it impossible to recreate traditional mixed-use villages, and it has lead to sprawl development and dependence on automobiles. Most planners would agree that concentrated, walkable communities re-invigorate economically depressed areas and protect natural resources, and there is now a shift toward replacing sprawl growth with mixed-use development. Referred to as smart growth, it seeks to combine certain types of commercial uses with residential units, usually close to a public transportation source.

D. Promote Regional Cooperation in Land Protection

Critical resources, such as aquifers, river corridors, and coastlines, all cross municipal boundaries, and regional efforts to protect these areas need to be more strongly encouraged, as these shared resources are better protected when towns and land trusts work together toward a common goal. When planning future conservation efforts, contact should be made between neighboring municipalities and their respective local conservation organizations.

Non-Regulatory Land Protection Tools

Conservation Restrictions

A conservation restriction, also called a conservation easement, is one of the most promising techniques available for promoting land conservation. A conservation restriction is a strategy that allows the landowner to maintain ownership and use of the land while limiting development on the property, ensuring that the land remains in the condition the landowner wishes. A conservation restriction is an addition to the existing property deed and the conditions in the conservation restriction are binding on all future owners.

There is great flexibility in creating a conservation restriction. Activities such as farming, forest management, and other land uses that the property owner wishes to pursue are often allowed. A conservation restriction can even be tailored to exclude a portion of the property so that a future home may be built. The landowner’s ability to sell the property or bequeath it to heirs remains. The tax benefits, including a reduction in estate and property taxes, are often substantial.

Land Donations

A. Gifts in Fee Simple

Most of the land protected by conservation groups and municipal conservation commissions has been acquired through outright gifts of land by generous and willing donors. If land is given for the purpose of conservation, the receiving organization is required to maintain the land in its natural state in perpetuity. However, the donor may make specific stipulations as to the use of the land such as “forever wild” or passive recreational use only. The tax benefits of gifting land are numerous – donors are entitled to an income tax deduction of the value of the property. The deduction is allowed to be up to 30% of the donor’s taxable income each year for a period of five years, up to the value of the donation. In addition, this strategy eliminates both property taxes and estate taxes on the land. Land donation is a simple and highly effective means of conserving land. Much of our open space is the result of generous land donations.

B. Gift of a Remainder Interest

A landowner can give property to a conservation organization or municipal conservation commission but retain the right to live on it. At the death of the landowner, the full ownership of the land transfers to the conservation organization. A gift of a remainder interest will include mutually agreeable conditions concerning the maintenance and management of the land during the landowner’s lifetime. The donor of a remainder interest can generally claim a related income tax deduction and eliminate potentially high real estate taxes.

C. Bequests

A landowner can convey land to an organization such as a land trust in their will. A deduction from the value of one’s taxable estate is allowed for land bequeathed for public purposes.

D. Limited Development

Landowners may wish to protect property that has conservation value, but are not able to sacrifice what may be their most valuable asset. Limited development can serve as a workable alternative for landowners seeking to preserve their land that are in need of some direct financial gain from their property. On appropriate parcels of land, and with a cooperating developer, some development can occur while the remaining land is permanently protected through one or more of the methods described here. The new development should be strategically located to preserve the property’s most critical scenic and natural resources, and the landowner will receive a cash return from the property. This land conservation method is sometimes called Conservation or Open Space Development.

E. Purchases

1. Fair Market Value

Small local land trusts and municipal conservation commissions are generally unable to purchase conservation land at fair market value. Larger regional organizations such as the Trust for Public Lands, The Trustees of Reservations, and The Nature Conservancy, are often more effective at raising large sums of money to purchase exceptional conservation land at fair market value. The Commonwealth of Massachusetts has several land conservation programs that occasionally purchase land with significant resources characteristics worth preserving. The Commonwealth prefers to acquire lands that build on its existing open space reserves. A regional land trust can act as a liaison for owners of land with outstanding resources that are competitive candidates for acquisition by other organizations and agencies.

2. Bargain Sale

Under this method, the landowner sells the property to a charitable organization for less than fair market value. The land trust benefits from the reduced costs and the “loss” can qualify the seller for income tax deductions, with an overall result comparable to a sale at market value. Bargain sales are a standard open space acquisition tool for large private land conservation organizations and the Commonwealth of Massachusetts. A small local land trust is generally unable to purchase conservation land, even at bargain sale prices. Some regional or statewide land trusts are able to use this option to protect open space deemed critical to a region’s scenic and natural heritage.

3. Agricultural Preservation Restrictions

Administered by the Massachusetts Department of Agricultural Resources, the Agricultural Preservation Restriction (APR) program protects farmlands by purchasing the development rights to the land. A permanent deed restriction is placed on the property, ensuring that the farm is never developed, while the farmer is provided with cash from the sale of the development rights and the ability to continue farming. The APR program is highly competitive, with preference given to working farms, located in agriculturally productive regions of the state, with highly productive agricultural soils. Acceptance of a farm into the APR program is typically supported by a financial contribution from the local municipality

E. Establish Consistent Funding For Open Space Protection

All watershed communities need to establish a dedicated and significant funding source for land protection initiatives. The Community Preservation Act is an excellent tool for this purpose, yet only 11 of the towns in the watershed have adopted it. Public education efforts must be made before attempting to initiate a new funding source. The case can be made for land protection by highlighting the success of neighboring towns and discussing the cost saving benefits of open space versus development.

F. Increase Public Access to Protected Lands

Providing access gives the public a feeling of ownership of the land, which in turn leads to greater support for the protection of open space. Public access is an important aspect in open space planning, however, each situation requires careful consideration. Managers must consider the fragility and uniqueness of the natural resources contained therein when determining the type or degree of access allowed. In certain cases, allowing access may be detrimental. Protection efforts within each community should include planning for an assortment of property types (e.g. forests, fresh water, coastlines) that will serve as dedicated access areas.

G. Strategize For Large and Continuous Tracts of Land

Conserving large tracts of contiguous land not only protects the genetic viability and long-term survival rate of many diverse species, but it also protects fragile ecological processes. Regional planners should identify and protect the remaining areas of the watershed that contain sizable and undeveloped blocks of land.

Management Approaches

As illustrated by the discussion above, numerous entities have important roles in meeting the goals and objectives of this action plan, and numerous strategies can be implemented. Because the purchase in fee of open space can be costly, and state and local government typical have limited funds for these purchases, it is important that municipalities, open space committees, and land trusts develop broad strategies and goals for open space protection that go beyond acquisition alone. These strategies should be articulated in municipal open space plans, master plans, and reflected in town laws, regulations, and policies.

Towns and land trusts need to acquire the most important properties, or work with property owners to permanently protect their properties for conservation purposes. The best agricultural lands should also be preserved for future agricultural purposes. Because the acquisition of open space can be expensive, even for properties mostly wet, the use of conservation restrictions and agricultural preservation restrictions are important tools to encourage private open space protection. These private land protection strategies are driven by financial and tax benefit incentives offered by government.

Each municipality should ensure it has a valid open space and recreation plan on file with the Division of Conservation Services, and these must be updated every seven years. In 2011, about a third of Buzzards Bay communities were without a valid plan, and some have never prepared a plan. Communities without an up-to-date open space plan are ineligible for state grants under the Commonwealth’s land protection programs. These plans should target the most important core endangered and threatened species habitats and supporting biohabitats as identified by the Natural Heritage and Endangered Species Program.

Municipalities with approved open space plans also need to take advantage of state and federal grant programs so that local dollars can be more effectively available to leverage state and federal funds. Too often municipalities fail to seek state or federal funding because of insufficient local planning. The Commonwealth of Massachusetts and state legislature should also ensure that sufficient funds are dedicated to land protection grant programs and Community Preservation Act matching. EEA should consider $500,000 annually as a minimum target for land acquisition and protection in the Buzzards Bay watershed. This funding could also be used to help match and leverage federal and local grants. This approach would require either special legislation, or inclusion in the Governor’s budget.

In the case of state grant programs, municipalities must also annually participate in the Commonwealth Capital reporting program. Municipal Commonwealth Capital scores are now used in dozens of state grant programs, often accounting for up to a third of the grant scoring criteria. Because of the importance of Commonwealth Capital scoring, the Office of Community Preservation, which oversees the evaluation program, should revise its Commonwealth Capital scoring formula to weigh more heavily environmental protection measures in communities, such as integrated water management plans, in its scoring.

To assist with these efforts, the Buzzards Bay NEP should continue to assist municipalities with the development of open space and recreation plan updates, natural resource mapping, and the development of grant applications.

Similarly, all Buzzards Bay municipalities should consider adopting the Community Preservation Act to create a dedicated fund for open space protection and other program goals. This approval requires a majority vote by residents in a general election. Currently eleven of the seventeen principal municipalities in the watershed have adopted the law. Outreach to and education of the municipal legislative branch and the public is required to build support for passage.

Table 42. Sample parcel acquisition rating matrix proposed in the Buzzards Bay NEP's Regional Open Space Plan.

SCORE:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Score Descriptor:		Barely Acceptable		Below Average		Average		Above Average		Exceptional	
1. Salt marsh		10% of parcel		30%		50%		70%		90%	
2. Endangered Species Habitat		"Watch list" habitat,1 species		"Watch list" habitat,2 species		"Watch list" or threatened breeding habitat,1 species		Threatened breeding, 2 species, endangered habitat		Endangered breeding	
3. Water Supply Protection		Within watershed to well (Zone III)		No well, but low yield aquifer		No well, but high-med yield aquifer		Within 1000-2000 ft. of wetlands or glacial outwash		Within 400-1000 ft. of existing well	
4. Coastal Water Quality		The location of the parcel in the watershed relative to receiving waters and existing or potential pollution sources is of key importance. Sliding scale with land directly abutting water body receiving a 10.									
5. Coastal Habitat		100 ft. of shoreline		300 ft.		500 ft.		700 ft.		900 ft.	
6. Freshwater Resources		50 ft. along water body		150 ft.		250 ft.		350 ft.		450 ft.	
7. Habitat Restoration		One point for each of the following criteria met: herring run restoration, remove fill from salt marsh or freshwater wetland, wetland restoration (no fill), remediate tidal restriction, or dam removal.									
8. Core Habitat		10% of parcel		30%		50%		70%		90%	
9. Fix Environmental Problem		Multiple options available to solve problem				Use of conservation restriction will solve problem				Purchase only way to solve problem	
10. Expanding Conservation Areas		Within 300 ft of existing protected area		Within 100 ft.		Directly abutting boundary		50% of one boundary		All of one boundary	
11. Fresh Water Quality		The location of the parcel in the watershed relative to receiving waters and existing or potential pollution sources is of key importance. Sliding scale with land directly abutting water body receiving a 10.									
12. Freshwater Wetlands		10% of parcel		30%		50%		70%		90%	
13. Size		5 acres		15 acres		25 acres		35 acres		50 acres	
14. Coastal Resources		10% of parcel		30%		50%		70%		90%	
15. Adjacent to Salt marsh		30 ft. buffer provided		60 ft. buffer		90 ft. buffer		120 ft. buffer		150 ft. buffer	
16. Development Threat-must have frontage on existing or approved road		for sale sign posted				Ch. 61, 61A, 61B release notice given				approved subdivision	
17. Supporting Landscapes/ Watersheds		10% of parcel		30%		50%		70%		90%	
18. Linkages		narrow connection				narrow, but connects large (20+ ac) blocks				wide, connects large blocks	
19. Adjacent to Freshwater Wetlands		30 ft. buffer provided		60 ft. Buffer		90 ft. buffer		120 ft. buffer		150 ft. buffer	
20. Passive Recreation		Next to existing trail or shore access				Existing trail or shore access				existing trail/ shore access & next to more trail land/ shore access	
21. Aesthetics		scenic vista w/ views from public road								scenic vista with parking	
22. Agricultural Lands		5 acres		10 acres		15 acres		20 acres		25 acres	

To supplement government driven land acquisitions, all municipalities should adopt various smart growth planning techniques that best protect their critical resources and minimize growth impacts on water quality and habitat. These techniques could include mandatory cluster zoning; transfer of development rights; water resources protection overlay districts; and prohibitions on building in the velocity zone. Each municipality must decide what technique works best in their community. These approaches are achieved through the passage of municipal laws (bylaws or ordinances) and regulations.

Sufficient models exist for the development of laws and regulations to promote open space protection, and the Buzzards Bay NEP could disseminate, and where needed refine, model bylaws to meet local needs. The greatest challenge in adopting local strategies is building public support for passage at town meeting and in general municipal elections. Citizens groups and land trusts often help with these efforts and general public outreach efforts.

Municipalities could also protect the most valuable open space and wetlands, by adopting local wetlands bylaws and regulations to address current weaknesses in state and federal wetlands laws and regulations. A fuller explanation of these approaches is described in Action Plan 7 Protecting and Restoring Wetlands.

In the Buzzards Bay watershed, the Buzzards Bay Coalition has shown strong leadership in protecting open space, and coordinating with local, regional, and national land trusts to protect some of the most vital resources of Buzzards Bay. The Coalition needs to continue this effort and expand their support for regional open space protection goals. The Coalition should continue to provide technical assistance to communities, area land trusts, and landowners with land protection projects.

Each of the more than a dozen land trusts that operate in the Buzzards Bay watershed need to maintain and in some cases expand their efforts to protect open space. Collectively these groups will have the greatest impact on protecting water quality and living resources in the Buzzards Bay watershed including: freshwater and saltwater wetlands, naturally vegetated riparian areas, interconnected forested areas, undeveloped coastal habitat, ground and surface water resources, and "core habitats" as identified by the Natural Heritage and Endangered Species Program. Land trusts should provide greater public access to protected lands, which allows the public to feel a sense of ownership, leading to increased support for land protection initiatives.

In 2008, working with Buzzards Bay municipalities and area land trusts, the Buzzards Bay NEP developed a regional open space plan for the Buzzards Bay watershed. DCR and other state agencies should utilize the information on priority areas in this open space plan as part of their criterion for land grant awards.

With respect to agricultural lands, DAR should establish broader environmental resource protection criteria such as ancillary ecological benefits, proximity to NHESP priority habitats, and organic farming in its criteria for selecting properties to receive APR funding. Similar criteria should be considered in federal programs administered by USDA.

Financial Approaches

Adoptions of laws and regulations that promote open space generally have little direct costs. In fact, many growth techniques save developers and the taxpayer money by reducing infrastructure construction and maintenance costs. Development and update of open space plans can be done in-house by municipalities with assistance from the Buzzards Bay NEP or land trusts, or completed by a contractor to the municipality (an expenditure perhaps totaling $20,000).

The most substantial cost for open space protection is the acquisition of lands in fee by municipalities or land trusts. Towns and land trusts can acquire open space through land or cash donations, municipal appropriations, or by grants. Often land acquisitions are complex, and may involve funding from multiple sources.

Land trusts often encourage donations by educating property owners of tax write-off opportunities of making donations of land or of conservation restrictions. The placement of conservation restrictions can also reduce a property's assessed value, which in turn lowers annual property taxes. More widespread efforts to make property owners aware of these strategies could help meet local goals of open space protection.

Monitoring Progress

Ultimately, the number of acres of wetlands and habitat protected (by a community and in the watershed) is the principal mechanism of tracking the success of this action plan. Programmatic tracking of municipal actions, like the approval of open space plans, adopting the Community Preservation Act, or adoption of smart growth laws and regulations are all meaningful measures of success. Elements of existing state tracking programs like the municipal Commonwealth Capital score could also provide a metric for tracking municipal actions.

Action Plan 13 Protecting and Restoring Ponds and Streams

Problem[149]

Many rivers and ponds in the Buzzards Bay watershed are impaired because of toxic contaminants, bacteria, nutrients, sediments, nuisance species, temperature changes, barriers to fish migration, water withdrawals, alterations of flow, and other problems. The Massachusetts Department of Environmental Protection (DEP) reports these impairments to the U.S. EPA as required by the Clean Water Act, in its "Integrated List of Waters" reports. These integrated lists classify bodies of waters into different categories. For example, Category 5 waters are impaired, and Category 3 waters are unassessed. As shown in Table 45, these impaired freshwaters (Category 5) total 959.8 acres (of the 4,376 acres listed) and 16.0 linear miles of streams (of the 64.9 miles listed).

To restore these waters will require considerable effort. The Clean Water Act requires that states identify those waterbodies that are not expected to meet surface water quality standards after the implementation of technology-based controls and to prioritize and schedule them for the development of a total maximum daily load (TMDL). These TMDLs establish the maximum amount of a pollutant that may be introduced into a water body and still ensure attainment and maintenance of water quality standards. TMDLs and restoration of these bodies of waters may require a local watershed plan. The effort to characterize and assess all these bodies of water, and to restore impaired ones, represents an immense challenge to both local and state managers.

Goals

Goal 13.1. Ensure that beneficial water uses[150] will not be lost, nor ecosystems adversely affected, by pollution discharges, nuisance species, or alterations of flow to fresh surface waters in the Buzzards Bay watershed.

Goal 13.2. Restore any beneficial water uses and ecosystem functions lost in watershed freshwater systems caused by pollution discharges, nuisance species, or alterations of flow and volume.

Objectives

Objective 13.1. Help adopt TMDLs for all freshwaters.

Objective 13.2. Help ensure that plans are developed and implemented to meet recommended TMDLs.

Objective 13.3. Help restore impaired wetlands habitat.

Objective 13.4. Protect open space that enhances and protects lakes, ponds, and streams.

Approaches

This action plan requires complying with the Clean Water Act. To achieve its goal, pollution sources in the watershed of each impaired body must be characterized, and where appropriate, a site-specific TMDL adopted. This is complex, and an immense task, because dozens of local subwatershed plans need to be developed. Moreover, many bodies of waters and tributary segments have never been assessed, so the scope of the environmental challenge remains unresolved.

DEP will need to develop TMDLs for each impaired water body identified on the 303(d) and Integrated Lists in a timely way. Similarly, DEP will need to evaluate eventually all unassessed waters (those not included on the integrated list).

Despite these challenges and prolonged timeline, and the lack of funds and staffing to solve this problem, municipalities should establish local priorities and implement common sense measures to reduce existing impairments. Municipalities should establish water quality task forces for priority freshwater systems and have these workgroups develop management strategies. Municipal legislative bodies (town meeting or city council) should authorize new funding to evaluate and develop priorities for restoration, and to implement specific remedial actions, like treating or eliminating stormwater discharges. Interested residents should become involved in protecting and monitoring these freshwater systems. Local laws and regulations are also needed to reduce the impacts of new development and to prevent new impairments.

Costs and Financing

The development of watershed characterizations, local watershed plans, and TMDLs for impaired waters, all have substantial costs (possibly millions over a decade). State, federal, and local government must all contribute. Costs that are more substantial will be borne by local government and property owners, and state and federal government funds could leverage action.

Measuring Success

The percent of systems impaired, the total number of impaired systems, and the percent of unimpaired systems are all key measures for tracking progress towards the goals of this action plan. Development of local watershed plans and strategies; TMDLs, and number of systems removed from the impaired waters list are other metrics for tracking progress.

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[149] This action plan was not in the 1991 CCMP, but elements were broadly covered in the original Wetlands Protection action plan. Impairments of marine waters are addressed in several other action plans. Other action plans support the goals and objectives here, especially the Action Plans Managing Stormwater Runoff, and Protecting Wetlands.

[150] Beneficial uses are those listed in Massachusetts Water Quality Standards, see entry in Glossary.

Background

The 412 square mile Buzzards Bay watershed includes 7,594 acres of open waters and 1,684 acres of deep marsh[151]. The open waters consist of ponds of various sizes with only 64 larger than 10 acres. These 64 ponds total 2,241 acres.[152] The numerous small and large perennial streams in the watershed total roughly 700 miles, although major streams, including the rivers, total roughly 100 miles[153].

Many of the streams and ponds in the Buzzards Bay watershed are impaired because of toxic contaminants, bacteria, nutrients, sediments, nuisance species, and other problems[154]. The Massachusetts Department of Environmental Protection (DEP) reports these impairments to the U.S. EPA as required by the Clean Water Act, in its "Integrated List of Waters" reports. These impaired waters are also known as "Category 5" waters on the state's "Integrated List" of waterbodies and as "303(d)" listed waters, named after a section of the Clean Water Act. In 2001, the EPA released guidance for the preparation of an optional integrated list of waters that would combine reporting elements of both sections 305(b) and 303(d) of the CWA. The integrated listing format allows states to provide the status of all their assessed waters in a single, multi-part list. These integrated lists classify bodies of water into different categories. For example, Category 5 waters are impaired, and Category 3 waters are unassessed[155].

Figure 93 shows the category classification of all the freshwaters in the Buzzards Bay watershed [156] and Table 45 shows the impaired (category 5) freshwaters that total 959.8 acres (of the 4,376 acres listed) and 16.0 linear miles of streams (of the 64.9 miles listed).

To restore these waters will require considerable effort. Section 303(d) of the CWA[157] require states to identify those waterbodies that are not expected to meet surface water quality standards after the implementation of technology-based controls and to prioritize and schedule them for the development of a total maximum daily load (TMDL).

Massachusetts DEP is responsible for assessing water quality and wetland conditions in Massachusetts as to whether they meet federal Clean Water Act goals. In its Integrated List of Waters reports, DEP assesses whether or not conditions support the designated uses of the water body as defined in the Massachusetts Surface Water Quality Standards[158]. DEP will classify the conditions as "support," "impaired," or "not assessed." They also identify information needed to develop resource protection and remediation strategies. This information is critical for watershed management planning.

As shown in Table 43 and Table 44 many streams and ponds are unassessed or not fully assessed as to their condition (Categories 2 and 3). For example, in the 2000 list, for lakes and ponds in DEP's Buzzards Bay watershed, 53% were not assessed for primary use, 56% were not assessed for secondary use, and 83% were not assessed for aesthetics. Besides these listed unassessed bodies of freshwater, there are many small streams and ponds not included (unlisted) in the DEP integrated lists (colored purple in Figure 93). The actual total length of all streams and tributaries in the watershed is 479 miles[159], of which 365 miles are "major streams." The nine major rivers are the Westport River (East Branch), Paskamanset River, Acushnet River, Mattapoisett River, Sippican River, Weweantic River, Wankinco River, Agawam River, and Red Brook (see Figure 93). Similarly, the total acreage of the 717 ponds in the watershed over 1 acre is 8,920 acres.

DEP periodically updates these water-quality assessment reports to publish data available to the public, review new data, determine changes in the use support status of surface water bodies, determine the causes and sources of any use impairments, and to meet reporting requirements to the U.S. EPA.

Major Issues

One of the core goals of this action plan is to remove freshwater rivers and ponds from the list of impaired waters of the Commonwealth, one of the underlying goals of the Clean Water Act. However, to achieve such a goal, pollution sources in the watershed of each impaired body, and other impairments must be characterized. In many cases, a site-specific TMDL will need to be adopted. This is complex, and an immense task, and will require dozens of local watershed plans, including plans for watersheds not previously assessed.

[151] This is based on the Mass GIS DEP 2001 wetlands coverage, and modified by the Buzzards Bay NEP to exclude salt pond and estuary areas.

[152] Herring Pond in Plymouth is bisected as per Figure 1

[153] MassGIS "major stream" coverage including small pond connections.

[154] Impairments of marine waters are addressed in several other action plans.

[155] Impaired waters (Category 5) on the integrated list are the "303(d)" listed waters, named after a section of the Clean Water Act In 2001 the EPA released guidance for the preparation of an optional integrated list of waters that would combine reporting elements of both sections 305(b) and 303(d) of the CWA. The integrated listing format allows states to provide the status of all their assessed waters in a single, multi-part list.

[156] DEP includes the Cape Cod portion of the Buzzards Bay National Estuary Program watershed within a separate "Cape Cod" jurisdictional watershed. Sites within DEP integrated lists on Cape Cod in the true Buzzards Bay watershed are included in the map and table.

[157] The federal implementing regulation is 40 CFR 130.7.

[158] Uses include aquatic life, fish consumption, drinking water, shellfish harvesting (where applicable), primary and secondary contact, recreation, and aesthetics.

[159] This is based on the Mass GIS 2001 25K Hydro coverage which, but modified by the Buzzards Bay NEP to exclude cranberry bog ditches and salt marsh and estuary ditches and creeks.

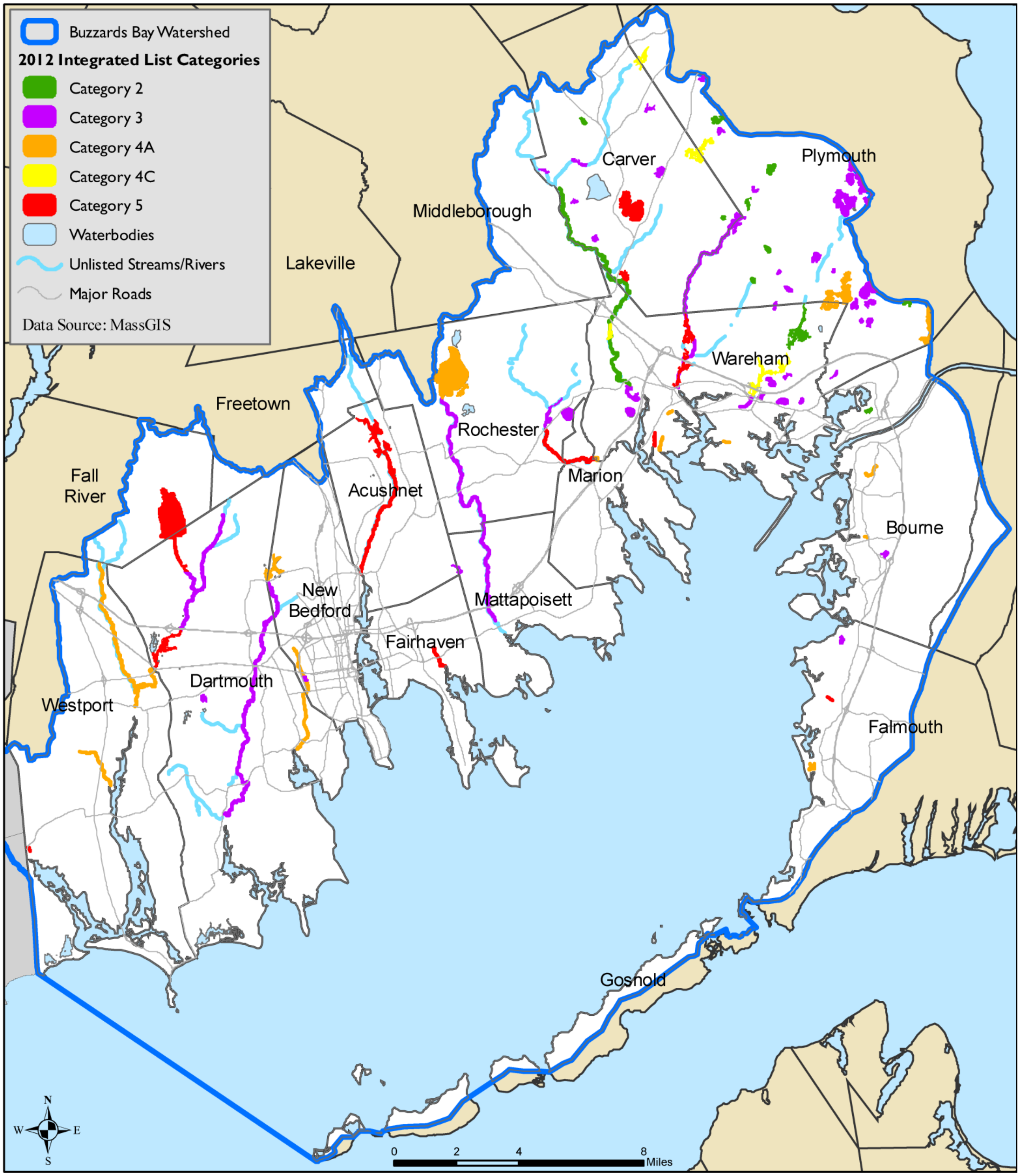

Figure 93. Water bodies included in the integrated list five categories.

Abbreviated explanation of categories: Category 1= Attaining the water quality, Category 2 =Attaining some of the designated uses, unassessed for others, Category 3 - Unassessed, Category 4 - Impaired or threatened, but does not require the development of a TMDL, Category 5 = impaired or threatened and requires a TMDL. Waters (streams and ponds) colored blue are not included (unlisted) in the integrated list. From a MassGIS coverage based on DEP's *Massachusetts Year 2012 Integrated List of Waters, Proposed Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act.*

Table 43. Water quality assessment for Category 2 Freshwaters in the Buzzards Bay watershed.

Name	Segment ID	Category	Description	Size	Uses Attained
Barrett Pond (95004)	MA95004_2008	2	Carver	11.3 acres	Primary Contact, Secondary Contact
Charge Pond (95025)	MA95025_2008	2	Plymouth	16.4 acres	Primary Contact, Secondary Contact
College Pond (95030)	MA95030_2008	2	Plymouth	46.8 acres	Primary Contact, Secondary Contact
Curlew Pond (95034)	MA95034_2008	2	Plymouth	42.6 acres	Primary Contact, Secondary Contact
Fearing Pond (95054)	MA95054_2008	2	Plymouth	22.5 acres	Primary Contact, Secondary Contact
Glen Charlie Pond (95061)	MA95061_2008	2	Wareham	157 acres	Primary Contact, Secondary Contact
Megansett Harbor (95910)	MA95-19_2008	2	Falmouth, Bourne	1.5 sq mi	(unassessed and some uses attained)
New Long Pond (95112)	MA95112_2008	2	Plymouth	21.0 acres	Aquatic Life, Aesthetics
Queen Sewell Pond (95180)	MA95180_2008	2	Bourne (previously reported with PALIS # 96253).	17.6 acres	Primary Contact, Secondary Contact
Vaughn Pond (95153)	MA95153_2008	2	Carver	19.6 acres	Primary Contact, Secondary Contact
Weweantic River (9558900)	MA95-04_2008	2	South Meadow Brook, Carver to Horseshoe Pond, Wareham.	11.3 miles	Aesthetics

Management Approaches

Despite the immense challenge of characterizing and developing TMDLs and developing and implementing restoration plans for dozens of subwatersheds, and the current reduced agency funding for staff and restoration projects, work must proceed to restore impaired waters. This means the highest priorities must be tackled first, and that meeting the goals of this action plan could take decades. However, how quickly goals can be achieved; will also depend in part on watershed groups being active partners to advocate for the development of TMDLs and restoration plans for rivers and ponds, to press for public and private funding, and to energize residents and abutters in each subwatershed.

As required by the Clean Water Act, DEP will need to develop TMDLs for each impaired water body identified on the 303(d) and integrated list. In some cases, like the bacteria TMDL for Buzzards Bay, the TMDL might represent a specific bacteria concentration limit for all discharges, or like the nitrogen TMDLs for coastal waters, a mass loading limit based on a watershed characterization and source allocation. Although this action is already required by EPA, there is no timeline for its completion. Because the effort requires considerable staffing and would require tens of millions of dollars to develop TMDLs for all impaired freshwaters in the Buzzards Bay watershed, neither of which is available, developing TMDLs for all impaired freshwaters will take many years.

Most freshwater systems in the Buzzards Bay watershed have never been assessed. This effort is also costly, and will likely take decades to achieve. The most effective strategy in moving forward on this task is to empower municipalities and involve residents of each respective subwatershed. Municipalities should establish water quality task forces for these freshwater systems and have these workgroups develop management strategies. The board of selectmen should show leadership in establishing committees, and moving forward on remedial actions. Municipal legislative bodies (town meeting or city council) should authorize new funding to tackle priority freshwater systems. State and federal agencies and municipalities should empower watershed groups, land trusts, and resident volunteers to become involved with monitoring and tracking these systems, documenting problems with photographs and data collection, and helping develop management approaches.

Municipalities and dam property owners also need to recognize that ignoring impairments is not always a solution. In the case of dams, obstruction migratory fish passage (see also Action Plan 8 Restoring Migratory Fish Passage), and failing dams represent a financial liability, and the cost of dam removal may be less expensive than dam restoration. In the case of phosphorus discharges from agricultural lands, municipalities could work proactively with a grower.

These efforts can and should move forward even before TMDLs are approved by DEP and EPA. This is because adoption of TMDLs for every pond and river could take years or decades, and many common sense actions can be taken to remove or treat pollution discharges and improve habitat or water quality. For example, when undertaking road work or improving drainage systems, municipalities should eliminate or reduce and treat stormwater discharges to impaired water bodies, and treat for specific pollutants, floatables, and debris. Such efforts would also meet goals contained in municipal stormwater plans to comply with MS4 permits. Other recommendations addressing elements of MS4 permit plans are discussed in Action Plan 3 Managing Stormwater Runoff and Promoting LID.

Financial Approaches

Development of TMDLs, watershed characterizations, and local watershed plans for all freshwater in the Buzzards Bay watersheds will likely cost tens of millions of dollars. EPA's 604(b) watershed grant funding has assisted with this effort, but funding to Massachusetts would need to be increased many fold. State bond funds have assisted with watershed planning in previous years, and should again be considered. Municipalities will need to seek restoration funds at town meeting, or through programs like the Community Preservation Act. Additional federal funding and private donations will also be essential.

Monitoring Progress

The percent of systems impaired, the total number or area of impaired systems, and the percent of unimpaired systems are all key measures for tracking progress towards the goals of this action plan. Development of local watershed plans and strategies, TMDLs, and number of systems removed from the impaired waters list are other metrics for tracking progress.

Table 44. Water quality assessment for Category 2 and 3 Freshwaters in the Buzzards Bay watershed.

Name	Segment Id	Category	Description	Size	Uses Attained
Abner Pond (95001)	MA95001_2008	3	Plymouth	8.9 acres	Not Assessed
Agawam River (9558725)	MA95-28_2008	3	Outlet Mill Pond, Wareham to Wareham WWTP, Wareham.	0.61 miles	Not Assessed
Bates Pond (95007)	MA95007_2008	3	Carver	19.0 acres	Not Assessed
Big Rocky Pond (95119)	MA95119_2008	3	(Rocky Pond) Plymouth	18.1 acres	Not Assessed
Big Sandy Pond (95011)	MA95011_2008	3	Plymouth	133 acres	Not Assessed
Blackmore Reservoir (95015)	MA95015_2008	3	Wareham	42.8 acres	Not Assessed
Buttonwood Park Pond (95020)	MA95020_2008	3	New Bedford	11.5 acres	Not Assessed
Cedar Dell Lake (95021)	MA95021_2008	3	Dartmouth	22.9 acres	Not Assessed
Deer Pond (95036)	MA95036_2008	3	Plymouth	8.7 acres	Not Assessed
Dicks Pond (95038)	MA95038_2008	3	Wareham	41.8 acres	Not Assessed
Dunham Pond (95044)	MA95044_2008	3	Carver	42.8 acres	Not Assessed
East Head Pond (95177)	MA95177_2008	3	Carver/Plymouth	91.5 acres	Not Assessed
Ezekiel Pond (95051)	MA95051_2008	3	Plymouth	35.6 acres	Not Assessed
Fawn Pond (95053)	MA95053_2008	3	Plymouth	43.7 acres	Not Assessed
Five Mile Pond (95056)	MA95056_2008	3	Plymouth	21.8 acres	Not Assessed
Gallows Pond (95059)	MA95059_2008	3	Plymouth	49.1 acres	Not Assessed
Halfway Pond (95178)	MA95178_2008	3	Plymouth	215 acres	Not Assessed
Horseshoe Pond (95075)	MA95075_2008	3	Wareham	59.1 acres	Not Assessed
Kings Pond (95078)	MA95078_2008	3	Plymouth	22.2 acres	Not Assessed
Leonards Pond (95080)	MA95080_2008	3	Rochester	49.4 acres	Not Assessed
Little Long Pond (95088)	MA95088_2008	3	Plymouth	47.7 acres	Not Assessed
Little Long Pond (95089)	MA95089_2008	3	Wareham/Plymouth	12.4 acres	Not Assessed
Little Rocky Pond (95091)	MA95091_2008	3	Plymouth	9.5 acres	Not Assessed
Little Sandy Pond (95092)	MA95092_2008	3	Plymouth	28.9 acres	Not Assessed
Little West Pond (95093)	MA95093_2008	3	Plymouth	24.5 acres	Not Assessed
Long Duck Pond (95095)	MA95095_2008	3	Plymouth	21.8 acres	Not Assessed
Long Pond (95096)	MA95096_2008	3	Plymouth	208 acres	Not Assessed
Mare Pond (95172)	MA95172_2008	3	Plymouth	12.5 acres	Not Assessed
Marys Pond (95100)	MA95100_2008	3	Rochester	81.2 acres	Not Assessed
Mattapoisett River (9559425)	MA95-36_2008	3	Outlet Snipatuit Pond, Rochester to Mattapoisett Rt6 bridge.	10.1 miles	Not Assessed
Micajah Pond (95102)	MA95102_2008	3	Plymouth	20.2 acres	Not Assessed
Paskamanset River (9559900)	MA95-11_2008	3	Turners Pond Dartmouth/N.Bed. to Slocums River Dartmouth.	10.5 miles	Not Assessed
Rocky Meadow Br Pnd (95118)	MA95118_2008	3	Carver	11.0 acres	Not Assessed
Rocky Pond (95179)	MA95179_2008	3	Plymouth	20.4 acres	Not Assessed
Round Pond (95123)	MA95123_2008	3	Plymouth	20.2 acres	Not Assessed
Sand Pond (95127)	MA95127_2008	3	Wareham	14.4 acres	Not Assessed
Sandy Pond (95128)	MA95128_2008	3	Wareham	15.3 acres	Not Assessed
Shingle Island River (9560175)	MA95-12_2008	3	Flag Swamp Road to Noquochoke Lake, Dartmouth.	5.0 miles	Not Assessed
Sippican River (9558950)	MA95-06_2008	3	Leonards Pond, Rochester to County Road, Marion/Wareham.	2.9 miles	Not Assessed
So. Meadow Brook Pond (95139)	MA95139_2008	3	Carver	24.8 acres	Not Assessed
South Meadow Pond (95140)	MA95140_2008	3	Carver	22.2 acres	Not Assessed
SW Atwood Bog Pond (95141)	MA95141_2008	3	Carver	11.6 acres	Not Assessed
Spectacle Pond (95142)	MA95142_2008	3	Wareham	41.5 acres	Not Assessed
Three Cornered Pond (95145)	MA95145_2008	3	Plymouth	12.3 acres	Not Assessed
Tinkham Pond (95148)	MA95148_2008	3	Mattapoisett/Acushnet	16.6 acres	Not Assessed
Union Pond (95152)	MA95152_2008	3	Wareham	17.0 acres	Not Assessed
Unnamed Tributary (9560180)	MA95-57_2008	3	Outlet Cornell Pond, to Shingle Island River, Dartmouth	1.0 miles	Not Assessed
Wankinco River (9558800)	MA95-30_2008	3	East Head Pond, Carver/Plymouth to Elm Street Wareham	6.5 miles	Not Assessed
Whites Pond (95168)	MA95168_2008	3	Plymouth	33.7 acres	Not Assessed

Table 45. Category 5 Freshwaters from the MA 2008 Integrated List of Waters in the Buzzards Bay watershed.

Category 5 are impaired requiring a TMDL, and equivalent to the 303(d) list. No listed freshwater areas on Cape Cod and the Elizabeth Islands chain are within the true Buzzards Bay watershed.

Name	Segment Id	Description	Size	Pollutant Needing Or Having A Tmdl
Acushnet River (9559625)	MA95-31_2008	Outlet New Bedford Reservoir, Acushnet to Hamlin Street culvert, Acushnet.	3.1 miles	-Nutrients, Siltation, Organic enrichment/Low DO, Pathogens
Acushnet River (9559625)	MA95-32_2008	Hamlin Street culvert, Acushnet to culvert at Main Street, Acushnet.	1.1 miles	-Nutrients, Organic enrichment/Low DO, Pathogens
Agawam River (9558725)	MA95-29_2008	Wareham WWTP, Wareham to confluence with Wankinco River at Route 6 bridge, Wareham.	0.17 sq mi	-Unknown toxicity, Unionized Ammonia, Nutrients, (Other habitat alterations*), Pathogens, Noxious aquatic plants
Beaverdam Creek (9558925)	MA95-53_2008	Outlet from cranberry bog southeast of Route 6, Wareham to confluence with Weweantic River, Wareham.	0.04 sq mi	-Nutrients, Other habitat alterations, Pathogens
Bread and Cheese Brook (9560150)	MA95-58_2008	Headwaters north of Old Bedford Road, Westport to confluence with East Branch Westport River, Westport.	4.9 miles	-Pathogens
Buttonwood Brook (9559750)	MA95-13_2008	Headwaters, at Oakdale Street, New Bedford to mouth at Apponagansett Bay, Dartmouth.	3.8 miles	-Pathogens
Cedar Island Creek (9558625)	MA95-52_2008	Headwaters near the intersection of Parker Drive and Camardo Drive, Wareham to the mouth at Marks Cove, Wareham.	0.01 sq mi	-Pathogens
Copicut River (9560200)	MA95-43_2008	Outlet of Copicut Reservoir, Fall River to the inlet of Cornell Pond, Dartmouth.	1.3 miles	-Priority organics, Metals
Cornell Pond (95031)	MA95031_2008	Dartmouth	12.4 acres	-Priority organics, Metals [12/20/2007-NEHgTMDL]
Crane Brook Bog Pond (95033)	MA95033_2008	Carver	37.3 acres	-Nutrients, Noxious aquatic plants, (Exotic species*)
Crooked River (9558650)	MA95-51_2008	Outlet of cranberry bog east of Indian Neck Road, Wareham to the confluence with the Wareham River, Wareham.	0.04 sq mi	-Pathogens
New Bedford Reservoir (95110)	MA95110_2008	Acushnet	211 acres	-Pesticides, Metals, Nutrients, Organic enrichment/Low DO, (Exotic species*)
Noquochoke Lake (95170)	MA95170_2008	(South Basin) Dartmouth	12.8 acres	-Priority organics, Metals [12/20/2007-NEHgTMDL], Noxious aquatic plants, Turbidity, (Exotic species*)
Noquochoke Lake (95171)	MA95171_2008	(North Basin) Dartmouth	16.7 acres	-Priority organics, Metals [12/20/2007-NEHgTMDL], Noxious aquatic plants, Turbidity, (Exotic species*)
Sampson Pond (95125)	MA95125_2008	Carver	296 acres	-Pesticides, Metals, (Exotic species*)
Sippican River (9558950)	MA95-07_2008	County Road, Marion/Webster to confluence with Weweantic River, Marion/Wareham.	0.08 sq mi	-Pathogens
Snell Creek (9560075)	MA95-44_2008	Headwaters west of Main Street, Westport to Drift Road, Westport.	1.5 miles	-Pathogens
Snell Creek (9560075)	MA95-45_2008	Drift Road, Westport to 'Marcus' Bridge', Westport	0.36 miles	-Pathogens
Snell Creek (9560075)	MA95-59_2008	'Marcus' Bridge', Westport to confluence with East Branch Westport River, Westport.	0.01 sq mi	-Pathogens
Tihonet Pond (95146)	MA95146_2008	Wareham	86.6 acres	-Organic enrichment/Low DO
White Island Pond (95166)	MA95166_2008	(East Basin) Plymouth/Wareham	165 acres	-Nutrients, Organic enrichment/Low DO, Noxious aquatic plants, Turbidity, (Exotic species*)
White Island Pond (95173)	MA95173_2008	(West Basin) Plymouth/Wareham	122 acres	-Nutrients, Organic enrichment/Low DO, Noxious aquatic plants, (Exotic species*)

Action Plan 14 Reducing Beach Debris, Marine Floatables, and Litter in Wetlands

Problem

Each year, thousands of residents and visitors enjoy Buzzards Bay for boating, swimming, fishing, hiking, and birding. Many also visit the extensive inland wetlands, waterways, and open space throughout the watershed. Increasingly, litter, marine debris, and disposal of hazardous and non-hazardous waste have degraded these areas. Litter and debris may be conveyed by stormwater systems (Figure 94), and debris can wash ashore with tide (Figure 95). Although litter and debris in wetlands and the marine environment may seem to be a less serious problem than some others facing Buzzards Bay, it is in fact a problem that cuts across many action plans, and contributes to the ever growing garbage patches appearing in ocean gyres, consisting of fine plastic particles and other materials. Litter collection also involves residents and visitors in assuming responsibility and ownership of open space and wetlands they use.

<u>Goal</u>

Goal 14.1. To ensure that Buzzards Bay beaches, coastal waters, and inland wetlands habitat are clear of harmful and degrading levels of marine debris.

<u>Objectives</u>

Objective 14.1. Ensure an adequate number and capacity of waste disposal barrels be provided at public beaches and public and private marinas, and boat haul-outs.

Objective 14.2. Stormwater discharge BMPs should include strategies to reduce or eliminate discharges of debris and floatables.

Objective 14.3. Encourage fishermen to not dispose of fishing lines, nets, cables, and trash at sea or on shore.

Objective 14.4. Educate the public and businesses on the importance of reducing litter and marine debris discharges and involve them in the potential solutions.

Objective 14.5. Ensure that state and local officials work in concert to reduce litter on public lands, beach debris, and marine floatables.

Objective 14.6. Identify and map important debris location sites, natural collection points, and potential remediation strategies.

Approaches

Reducing litter and trash in the environment is complex; it will require better education of the public, property owners, and businesses, and improved collaboration of local government with neighborhood associations, and non-profit organizations. Implementation of this management plan involves three core strategies: undertaking periodic cleanups, implementing litter preventions programs to ensure both proper trash disposal and encourage waste reduction, and adopting any needed laws and regulations to increase awareness and accountability of litter generators. Government can also set an example in purchasing programs to focus on biodegradables and items less likely to enter litter waste streams.

Costs and Financing

The costs to implement this action plan are nominal; and the focus is to encourage individuals and businesses to take responsibility for the problem, and encourage volunteerism to solve the problem. There are some costs associated with cleanups, expendable supplies, signage, trash removal, and staff time, but some of these costs can be met through adopt a road or wetland programs with businesses and non-profit organizations.

Measuring Success

Measuring success in this action plan is difficult because the amount of litter collected is a function of collection effort. Assessments that are more complex could include evaluations of extent of littering; however, programmatic achievements might be easier to track. These could include extent of areas adopted for cleanup; length of beaches cleaned each year, and the number of cleanup events held.

Background

Loca1 economies that rely on a clean environment, can suffer when litter clutters beaches, wetlands, and open space. This debris or trash is not only an eyesore but also an inconvenience. Boaters and fishermen lose time and absorb the cost of mechanical repairs when floatable debris wraps around propellers and propeller shafts. Towns have to pay personnel to keep beaches, parks, and public lands clean.

Non-biodegradable litter threatens the health of many species of wildlife. Some plastic and rubber items, such as balloons, six pack rings, fishing lines and nets, plastic bags and utensils, are commonly found in U.S. waters, and cause the death through entanglement, suffocation, or digestive tract blockage of marine birds, mammals, and turtles. This plastic and rubber debris often accounts for two-thirds of the volume collected on Massachusetts beaches.

The sources of marine and coastal debris vary from area to area, and are sometimes difficult to pinpoint. Some enters the marine environment from commercial and recreational fishing vessels. Some comes from land sources like beach goers and fishermen. Storm drains and combined sewer overflows are often a locally important source of these items (Figure 94). Inland wetlands and open space are affected mostly by direct dumping (Figure 95). A summary of debris collected on Massachusetts beaches is shown in Figure 96.

A study of marine debris pollution in the Gulf of Maine by Hoagland and Kite-Powell (1997) concluded that public education campaigns are a key component of any strategy to reduce marine debris. The authors noted that many managers believe that elementary school pro-

Figure 94. Litter accumulating on a storm drain grate.

Photo by Tony Williams.

Figure 95. Residents may find large accumulations of litter along rivers and at the headwaters of some bays.

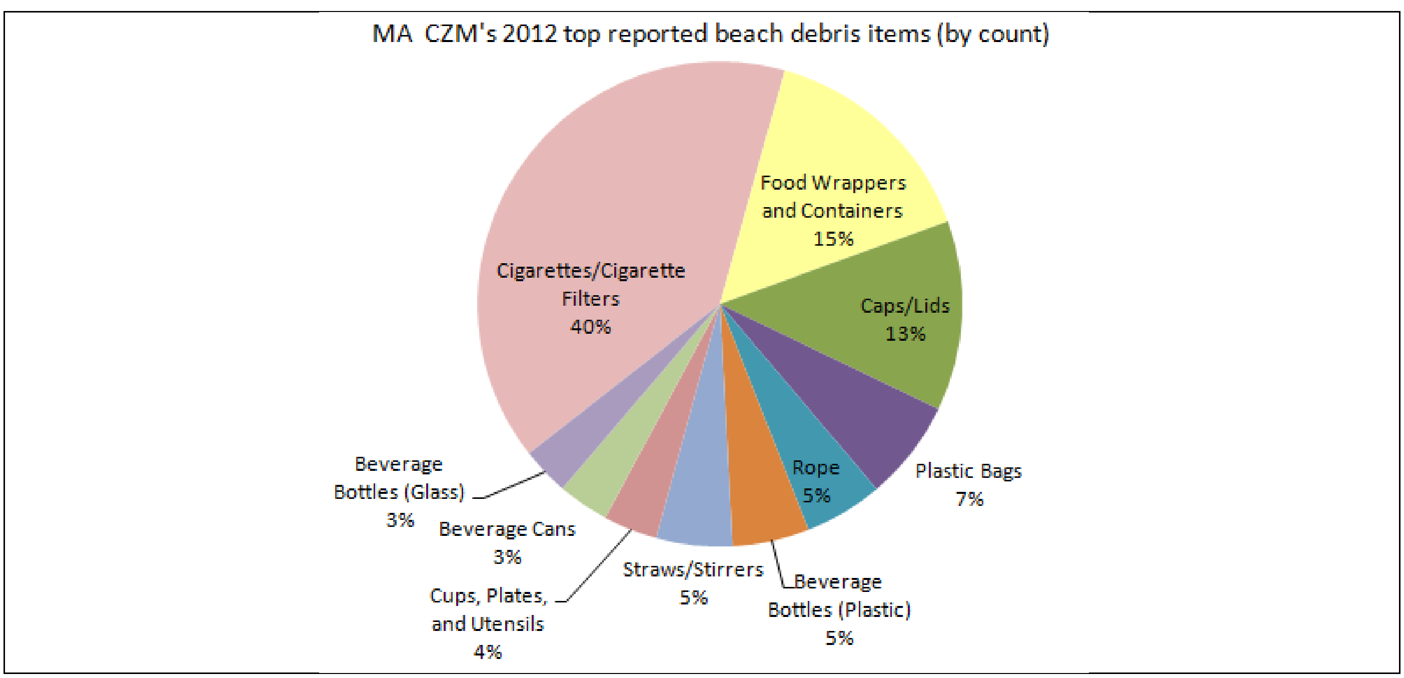

Figure 96. Top ten beach litter types collected in Massachusetts as part of Coast Sweep.

grams are among the most effective long-term strategies because it is easier to instill environmental attitudes at an early age. However, strategies targeting adults were identified as equally important. These strategies include “don’t litter” messages on product packaging, beach cleanups, educating adults about litter impacts to the environment, educational materials (brochures, flyers, pamphlets, stickers), and specific audiences like fishermen, beachgoers, and boaters. Some of these audiences can be targeted during boat registration, purchase of beach stickers, or shellfishing licenses. In one case, users signed a “pledge” not to litter and collect debris they encountered to obtain discounts at marine suppliers.

Few researchers have investigated the effectiveness of various litter reduction campaigns, especially on coastal and wetland areas. Many managers believe that some “educational” strategies, like the posting of littering fines, are more effective than general statements to discourage littering. Such signage is viewed as an important step in areas where littering is prevalent.

Individuals often dump difficult to dispose of items, such as hazardous waste and certain home goods, like television sets, on undeveloped lands and wetlands because of the cost or inconvenience of disposal. We address the financial and other barriers to proper toxic waste disposal issues in Action Plan 16 Reducing Toxic Pollution.

One idea discussed by Buzzards Bay municipalities to address these problems, but rejected, was the idea of forming special committees in every community to address the problems of beach debris, marine floatables, and litter, and dumping in wetlands and open space. These officials rejected a blanket recommendation for all Buzzards Bay communities to form these committees because in many cases, the recommendations in this action plan can be achieved through existing boards and personnel (selectmen, town manager, recycling committees). The exception to this rule is that the City of New Bedford and Town of Fairhaven should convene a workgroup to develop a comprehensive strategy to address dumping in New Bedford Harbor, a commercial-industrial seaport.

Since 1982, the Commonwealth of Massachusetts has a five-cent deposit on carbonated beverage containers. Most agree that this law has become less effective because inflation has eroded the value of deposits, and the percentage of bottles returned has declined over time, from a high of 85% in 1995 to less than 68% in 2002[160]. Some of the non-returned bottles contribute to litter. Massachusetts legislators have repeatedly introduced legislation to either increase the deposit fee collected to ten cents, expanding the law to include non-carbonated beverage containers, or to eliminating the fee altogether in favor of a tax to directly fund litter cleanup activity. All these measures have failed.

[160] This was the last year of the study posted at http://www.massbottlebill.org/ubb/files/Impacts%20of%20EBB%20on%20Municipal%20Recycling.pdf. Last accessed March, 16, 2011.

Table 46. Litter and trash regulations in the Falmouth Town Code

§ 87-6 Littering. “Leaving litter, trash, rubbish or discarded lunch containers or similar articles upon the public beaches is strictly prohibited.”
•Under non-criminal dispositions, littering has a $50 fine and can be enforced by the health agent.
§ 269-12 (7) water front marine businesses have trash removal as a requirement.
Wetland Stormwater Regulations FWR 2.00 (5): All basins/Ponds designed for stormwater runoff control shall “(d) have outflow pipes designed to minimize clogging (i.e. through the use of trash racks);”

In many urban and suburban areas, lottery tickets can be a locally important source of paper litter. The Massachusetts lottery has introduced an “instant replay” litter-recycling program where 20 used instant lottery tickets could be redeemed for a new ticket. This program has been very successful, but opportunities to redeem the tickets occur at only a few locations on a handful of dates that limits the effectiveness of the program throughout the Commonwealth.

Major Issues

There are few major issues associated with this action plan. Perhaps the most politically controversial issue related to litter generation and control is whether the bottle bill fees should be increased (currently five cents per bottle in MA), or whether non-carbonated beverages should be included in the collection fee. These decisions will need to be made by the legislature.

Another uncertainty is to what degree laws and regulations are needed to enhance accountability of those responsible for trash and litter entering the environment. A special focus should be placed on litter associated with boating activities, or plastics that enter the marine environment because these are becoming increasingly problematic in offshore waters.

Management Approaches

A special focus of litter reduction is removing large and floatable debris from the stormwater stream. Municipalities should include debris and floatable reduction strategies (e.g. maintenance and installation of litter traps and screens) in their stormwater management plans, including tasks in their MS4 permits plans.

Implementation of stormwater management plans and catch basin maintenance programs may cost municipalities hundreds of thousands of dollars, but the cost of debris removal and catch basin maintenance is typically a small fraction of overall the overall costs of stormwater management programs. Municipalities should particularly focus on discharge pipes that need to be remediated in areas of high litter accumulation. This issue is probably best addressed through municipal MS4 stormwater management committees.

Requirements for businesses to provide appropriate waste facilities, or to remove litter from parking lots before it blows on public ways is another important strategy. Many municipalities have special requirements to address this problem in businesses that serve fast food, or at convenience stores, for example.

School departments could institute programs to minimize litter disposal from students including wise buying programs to reduce sources (e.g. purchasing biodegradable items like paper cups instead of plastic foam cups). Schools could also use announcements, signage, and trash barrels at key locations to help modify student behavior.

The Massachusetts Legislature should also review the bottle bill to see if either fee changes or product applicability changes might improve litter source reduction and collection of beverage containers.

Municipalities should provide adequate waste collection barrels at public beaches, public marinas, and boat ramps, and maintain adequate pick-up, especially during heavy use periods. The extent that this service should be provided is often a concern to municipalities because there is a cost to regularly emptying barrels. Sometimes inappropriate materials are dumped in these containers. When events are held by private groups, municipalities and those sponsoring the events should ensure that proper waste disposal containers are available.

Private marinas and private beach associations need to provide adequate waste collection barrels and maintain adequate pick-up, or at least put measures in place that discourage littering. If barrels are provided, they should be emptied on a regular basis. In general, practices to reduce and manage litter should be left to property owners but towns could facilitate action with education, outreach, and adopting enforceable rules and regulations to reduce litter from chronic sources (Town of Falmouth regulations shown in Table 46).

Education about the problem and potential solutions can support all strategies. Information, flyers, fact sheets, signage, and brochures are available from many entities including the U. S. EPA's Trash Free Waters website and NOAA's Marine Debris website[161]

[161] Available respectively at water.epa.gov/type/oceb/marinedebris/index.cfm and marinedebris.noaa.gov. Last accessed October 1, 2013.

Litter Cleanup as Part of the 2011 Marion Arbor Day Celebration

As part of its annual Arbor Day celebration, the Town of Marion posted this information on its website about the annual event in 2011:

"Sponsored by the Marion Tree and Parks Committee, the DPW, the Marion Natural History Museum, the Sippican Lands Trust, Sippican Historical Society, Lockheed Martin and the Marion Garden Group, the day will be one of town-wide cleanup of the debris left in winter's wake along Marion's roadsides. Event representative Tinker Saltonstall urges residents to "please gather your family and your neighbors, rally the classes and Scout troops, and do your part to spruce up Marion for the summer months around the corner." Participants will gather at the Music Hall on Front Street to receive their safety bibs, bags, and gloves before heading to their assigned clean-up territories. Litter collected will be returned to the bandstand area of Island Wharf Park (across from the Music Hall) to create the trash mountain that stands each year as a visual testament to not only the stunning amount of litter left on town roadways by careless individuals, but also the dedicated efforts of caring individuals and organizations within the community toward preserving the health and beauty of Marion's picturesque landscape."

Financial Approaches

In general, the costs of this action plan are relatively modest, and to a large degree are achieved by more responsible behavior by individuals and businesses. Implementation of beach, upland, and wetland cleanups generally has nominal costs as these programs utilize volunteers. There are costs associated with expendable supplies, signage, and salary of a coordinator, perhaps totaling $50,000 annually for a Buzzards Bay watershed directed effort, but the costs would be less if municipal agencies or NGOs helped coordinate members of the public at no cost, as part of their normal operation budgets. A possible effective strategy could also involve "adopt a road" (or park or beach or wetland) programs for businesses with signage, as is now done on some highway systems. The net cost to business and consumers due to any changes to the bottle bill law will depend on how the law might be changed.

Monitoring Progress

Measuring success in this action plan is difficult because the amount of litter collected is not an appropriate measure for this action plan, because the volume of litter collected is a function of effort. Some measures like evaluating sites for litter or ensuring that adequate waste receptacles are available could be used, but defining success is subjective. Other actions are easier to track, such as programmatic actions: the number of communities that include a stormwater debris and floatable reduction element in their MS4 plans, the number of annual and beach cleanups and the amount of trash collected in beach and wetland cleanups, the amount of public participation in beach cleanups and the percent of Buzzards Bay adopted. The Buzzards Bay Coalition and other NGOs continue to organize annual beach cleanups to keep Buzzards Bay clean, and raise public awareness of the problem through adopt-a-shoreline and similar programs.

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Action Plan 15 Managing Coastal Watersheets, Tidelands, and the Waterfront

Problem[162]

In coastal waters, new docks, increased boating, new waterfront development, and dredging and coastal armoring to support those activities, continue to degrade water quality, destroy habitat, and affect marine plant and animal populations. Other activities, like aquaculture, are also expanding. All levels of government have some jurisdiction over activities on the water's surface (commonly called the watersheet), on the seabed (tidelands under Massachusetts law), and on the waterfront. The Massachusetts Ocean Management Plan, adopted in 2009, better regulates activities in areas greater than 1/3 mile offshore. Municipalities, with home rule powers, remain a key manager of nearshore areas not covered by the Ocean Plan (and which includes most of the harbors and embayments; see EEA, 2009). These nearshore areas are now imperfectly managed principally through local and state waterways regulations and wetlands permitting. Most municipalities have failed to undertake comprehensive planning studies of their coastal waters to protect natural resources or address cumulative impacts.

To address these needs, towns must develop local embayment management plans based on spatial planning techniques to characterize conditions and recommend action. These plans must then be implemented through laws, regulations, and policies, together with non-regulatory approaches and education.

This action plan seeks principally to address conflicting uses and management priorities for the waterfront and near coastal watersheets not addressed by the Massachusetts Ocean Management Plan, including nearshore renewable energy facilities. Issues associated with discharges from boat operation and maintenance, and adverse impacts from boat mooring systems are addressed in Action Plan 6 Managing Impacts from Boating, Marinas, and Moorings.

Goals

Goal 15.1. To manage the uses and activities in the waters and on the tidelands of Buzzards Bay in an integrated manner using sound assessments of natural resources, habitat, and water quality, to ensure sustainable recreational and commercial activities while protecting and improving ecosystem health and values.

Goal 15.2. Ensure that the effects of dredging activities are minimized on water quality, physical processes, marine productivity, and public health, and that the beneficial use of dredged sediments is maximized.

Objectives

Objective 15.1. Develop and improve upon geographic databases identifying habitat, natural resources, seabed characteristics, and contamination or impairment hotspots of lands under the ocean to establish a strong technical basis for embayment watersheet planning and management.

Objective 15.2. Promote the development and implementation of municipal embayment management plans to manage the watersheet, protect water quality, vital natural resources, and tideland habitat, and increase shoreline resilience to storms and rising sea level, while allowing sustainable uses.

Objective 15.3. Ensure that dredging methods and timing be conducted to minimize adverse impacts, and where appropriate, transfer sensitive resources out of areas to be dredged.

Objective 15.4. To maximize the beneficial uses of dredged material by creating opportunities by pre-designating or pre-permitting receiving areas (e.g. beach nourishment zones) to expedite permitting, and through increased funding.

Approaches

Towns must evaluate spatial data and characterize coastal uses to develop comprehensive embayment management plans that define watersheet and waterfront protection strategies. These plans will be fulfilled through town zoning, waterways regulations, wetland regulations, or town bylaws and city ordinances and non-regulatory approaches. Such plans may create conservation areas or activity exclusion zones, or create incentives for certain activities. While the cost to develop such plans is a hurdle, the key obstacle to implementation is developing a political consensus to pass the necessary zoning and nonzoning laws or regulations. With respect to dredging, the increased beneficial use of dredged materials could be facilitated by preselecting and pre-permitting receptor sites and through additional funding.

Costs and Financing

Based on recent town efforts, the cost of developing a resource protection based embayment plan is typically \$50-\$100,000 per embayment. Some state and federal grant programs can be used to fund these efforts, but most often municipal legislative bodies appropriate the necessary funds.

Measuring Success

This action plan is evaluated by programmatic actions by towns developing and adopting needed waterfront and watersheet management plans and policies.

[162] This action plan was not in the 1991 CCMP. There was however, a Dredging Action Plan with recommendations relating to dredging and beneficial use of dredged sediments now incorporated here.

Background

The waters of Buzzards Bay and its surrounding coast are subject to a complex mosaic of state, federal, and local laws and regulations. These laws and regulations may address activities on the surface of the water (sometimes referred to as the watersheet), underwater or on the bottom (an area legally termed the Massachusetts Tidelands), or activities on land along shore (the waterfront).

All of Buzzards Bay consists of municipal waters, which are also state waters (Figure 97)[163]. In a practical sense, both the municipalities and the state have strong interests, and regulatory authority, managing activities on and under these waters. There are no "federal waters" in Buzzards Bay, but all of Buzzards Bay is defined as Waters of the United States for the purpose of wetlands protection under the Clean Water Act.

As the population along the coast of Buzzards Bay has increased, so have the commercial and recreational uses of these coastal waters. Traditional uses such as commercial and recreational boating have increased, as have newer recreational activities such as kayaking and jet skiing. More commercial, industrial, and residential structures are being built on the waterfront. More shellfish aquaculture projects are being proposed in near coastal waters. Offshore, industrial activities such as power generation, once limited to the land, are now being proposed or considered in the form renewable wind, wave, and tide driven electrical generation turbines.

Actions to protect the natural resources of Buzzards Bay are not new. In the 19th century, seine fishing was banned to protect the recreational fisheries of the bay. Nearly a century later, in 1973, Buzzards Bay was protected through the Massachusetts Ocean Sanctuaries Act[164]. In 1987, Buzzards Bay was designated as an Estuary of National Significance in the National Estuary program as part of the Clean Water Act amendments[165]. In August of 2000, Buzzards Bay was designated by CZM and the U.S. EPA as a "No Discharge Area" under the Clean Water Act, which makes it illegal to discharge boat septic wastes to the bay. After the 2003 *Bouchard 120* oil spill highlighted the pollution risks associated with shipping and fuel transport, the state and federal government enacted[166] shipping regulations to minimize the threat of future oil spills. Similarly, concerns about the disposal of contaminated sediments from New Bedford harbor led to the legislature passing, in 2006, a bay-wide ban on the disposal of dredged material in Buzzards Bay[167].

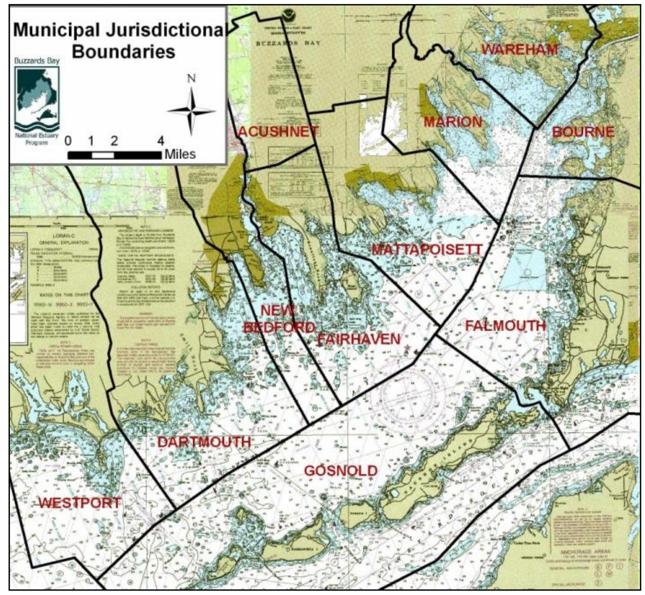

Figure 97. Buzzards Bay municipal jurisdictional boundaries of Buzzards Bay.

Ocean Management Plan and "Offshore Waters"

During the 2000s, the potential impacts from proposed offshore wind turbines raised concerns among managers and residents about their effects on the environment, water quality, and on competing uses like aquaculture, shellfishing, scenic views, and recreational boating.[168] Collectively, all these issues have increased

[163] Municipal boundaries in the Massachusetts coastal waters were established by Chapter 196 Acts of 1881. Massachusetts General Laws Ch. 42, sec. 1 establishes the boundary of state waters within the U.S. territorial sea, which extends to 12 nautical miles.

[164] The Massachusetts Legislature created five Ocean Sanctuaries. The Act (MGL c. 132A, Section 12A16F, 18, and as subsequently amended in 1984 and 2008) defined these sanctuaries as extending from MLW out to the limit of state waters. The Act prohibited activities involving building structures, energy facilities, drilling or mining (except for beach nourishment), disposal of wastes, commercial advertising, and waste incineration on vessels within these waters, and prohibits activities if they would significantly alter the ecology or appearance of the ocean, seabed or subsoil. All of Buzzards Bay lies entirely within the Cape and Islands Ocean Sanctuary. The Department of Conservation and Recreation (DCR) is the state agency that reviews projects under the Act, assisted by DEP's Chapter 91 Waterways licensing program, which refers projects within jurisdiction to DCR. Some key elements were changed with the passage of the Ocean Act of 2008.

[165] The Buzzards Bay Project was actually established in 1985 through Congressional appropriations with similar designations and a mission to develop a management plan for Buzzards Bay.

[166] The 2004 Massachusetts Oil Spill Prevention and Response Act was signed by the governor and the USCG promulgated new navigation rules.

[167] Chapter 191 of the Acts of 2006.

[168] The state, not municipalities, owns public trust lands and rights in submerged lands (MLW to three miles offshore), but exercises considerable regulatory jurisdiction over trust lands within their boundaries. The limits of this jurisdiction are set by the Home Rule Amendment, which empowers towns to enact any by-law consistent with state law. The state also assigns important roles to municipalities in their waters. For example, harbormasters permit moorings and non-fixed structures, municipalities can issue shell-

public interest in efforts to better manage activities in Buzzards Bay and other Massachusetts waters. Because of these concerns, in 2008 the Massachusetts state legislature passed the Ocean Act[169] (Figure 98). The Oceans Act required the Secretary of Energy and Environmental Affairs to develop a comprehensive ocean management plan, following a scientific and stakeholder process. Specifically the new law required that CZM develop an ocean management plan that established "goals, siting priorities and standards for ensuring effective stewardship of its ocean waters held in trust for the benefit of the public." The new law identified eleven other management concern goals including conformance to sound management practices, preserving natural, social, cultural, historic, and economic characteristics of the planning areas, and protecting biodiversity and ecosystem health sensitive areas and habitats.

CZM completed and promulgated the new ocean management plan in December 2009. Development of the plan was driven a spatial planning effort that that characterized and mapped natural resources, public and private uses, and other interests in the coastal zone. This plan was especially focused on setting standards and spatial restrictions for permitting and siting activities and facilities allowed under the Ocean Sanctuaries Act. These activities included renewable energy facilities, aquaculture, sand mining for beach nourishment, and the placement of cables and pipelines. By law, this plan must be updated every five years[170].

The ocean plan added new oversight and management within the jurisdictional waters of the plan. Despite the benefits of this plan, it did not address the near coastal waters that municipalities are most concerned about, including the semi-enclosed embayments and nearshore areas within Buzzards Bay shown in Figure 98.

Most of this action plan focuses on how municipalities in particular can more effectively address impacts to the environment from activities on the waterfront, on the watersheet, and on the tidelands. In many cases, the local approaches will employ many of the same spatial planning techniques used to develop the Ocean Plan, but with a different set of management tools available to municipal government including zoning and non-zoning bylaws and ordinances.

Docks and Piers

The management of docks and filled piers[171] is one of the foremost management issues along the waterfront for all levels of government. Development pressures are increasing along coastal waterfronts making the land-sea interface one of the most intensively used portions of the Buzzards Bay watershed. Coastal waterfront properties are highly desirable because of opportunities for recreational boating and swimming, easy access to other water resources, and scenic views. Demand for recreational boating and water access leads to a demand for more docks.

Docks are a potential source of user conflicts, since they tend to restrict access along and to the shore for shellfishermen, anglers, and the public. Long docks can impede or hinder nearshore navigation. The environmental impacts of poorly sited docks and piers, and associated motorized boating activities, can include damage to salt marsh, shellfish habitat, eelgrass beds, and water quality due to resuspended sediments. The visual and aesthetic impacts of a single small dock are arguable, but dense clustering or proliferation of docks and piers ("dock sprawl") or large dock systems may have such visual impacts (Kelty and Bliven, 2003). Measures to mitigate a single issue may end up affecting something else (e.g., siting a dock to avoid salt marsh impacts may result in an increased impact to navigation or aesthetics).

Conservation commissions typically are the leading municipal board to review the permitting of docks and other coastal structures under the Massachusetts Wetland Protection Act, or in many cases, under local wetland bylaws and regulations as well. DEP generally will overrule dock denial decisions by a conservation commission made under the state regulations, if the denial is based on non-mitigatable or cumulative impacts to shellfish or fisheries habitat[172]. Consequently, it is vital that issues relating to cumulative impacts, or impacts not adequately addressed by the state Wetland Protection Act be addressed in local zoning and non-zoning bylaws.

In many instances, the presence of eelgrass beds (Goetsch, 2011) and depth of water at the end of the dock[173] are the primary siting criteria under local bylaws and regulations. Other municipal officials may also review these structures if a zoning bylaw provides authority to do so. For example, a municipality may adopt a zoning bylaw that limits the length of docks (as is the

fish grants and aquaculture permits, and conservation commissions issue permits for activities in wetlands, including activities on the bottom of the ocean within municipal jurisdictions.

169 The Oceans Act of 2008 (Chapter 114 of the Acts of 2008) requiring the development of a comprehensive ocean management plan by December 31, 2009, amended elements of the Ocean Sanctuaries Act, and requiring certain regulatory updates.

170 The current ocean planning area generally begins about 1/3 of a mile from shore and extends seaward. Among the issues to be reviewed are the geographic scope of the ocean planning area.

171 Pier is a term sometimes used interchangeably with docks. Solid-filled piers are difficult to construct under current Massachusetts regulations and policies.

172 DEP can overrule decisions based on state regulations, but cannot overrule decisions based on municipal wetland laws and regulations.

173 For example, under the Falmouth Wetland Regulations, "the water depth at the end of the dock shall be a minimum of four (4) feet at the time of mean low water or three (3) feet greater than the draft of vessels served by the dock or pier whichever is the greatest depth."

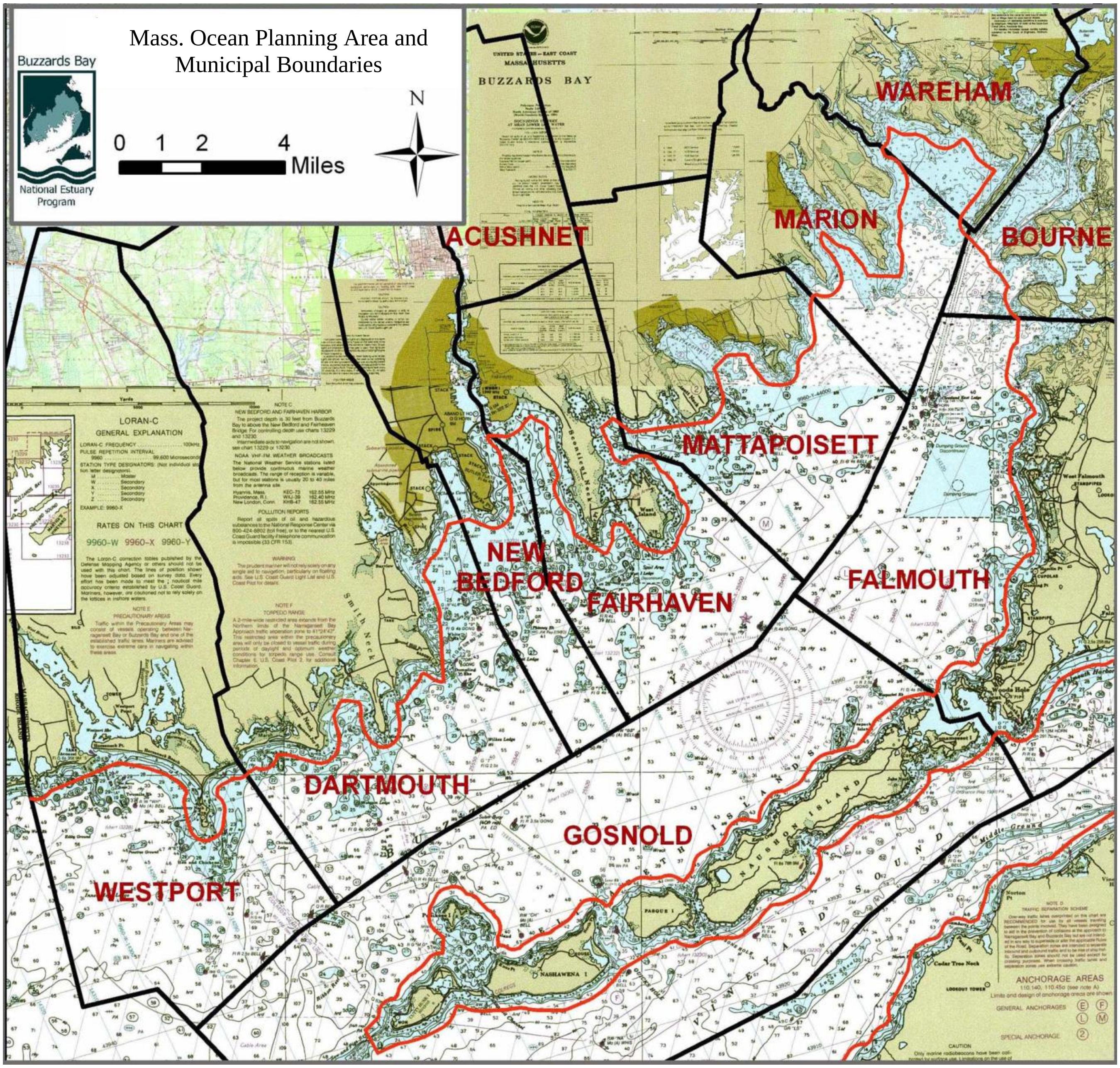

Figure 98. Mass. Ocean Planning Area (red) and municipal boundaries (black).

(Ocean planning area defined by a CZM report; area seaward of the red line.)

case in Fairhaven). A dock greater than the limit would then require ZBA approval and review by the building inspector. If building inspectors are involved in the review of dock applications under some local authority, it will be for structural and safety issues only, and not environmental or aesthetic issues.

The construction of docks and piers is often a focal point for municipal coastal management. In a sense, docks represent the tip of the iceberg of the complex issues surrounding coastal development. Like all forms of development, the challenge is how to address more effectively the cumulative impacts of the intense recreational, commercial, and residential uses of the coastal zone in a coordinated manner that protects valuable natural resources and community values.

Shellfish and herring wardens can also be provided considerable additional authority in dock placement and construction in their duties to manage and regulate shellfish and fisheries habitat. For example, in the Falmouth Wetland Regulations, docks are prohibited where "there are significant quantities of shellfish... and the area has been historically used for shellfishing or has potential for shellfishing, and the sediment provides a viable shellfish habitat."[174] Shellfish wardens typically ensure that shellfish are relayed out of the site to be disturbed by dock construction or associated dredging.

Falmouth is the only Massachusetts municipality where the board of selectmen review docks and coastal projects under a separate, older wetlands zoning bylaw (which has no performance standards). Falmouth is also the only example of a watershed town having two wetlands bylaws.

Under state law, DEP reviews the construction of docks in the Waterways Program, primarily ensuring compliance with the licensing requirements of Chapter 91 of the Massachusetts General Laws, which primarily relates to public access, navigation, and public trust issues and not environmental impacts. At the federal level, dock construction and dredging to docks requires Army Corps permits and Water Quality Certificates (issued by DEP). These permits require avoidance of certain habitat (e.g. eelgrass beds), and if habitat loss cannot be avoided, mitigation must be provided.

Indirect and Cumulative Impacts of Docks

Wetland laws and regulations typically focus on regulating individual docks and piers on a lot-by-lot basis, but generally do not address cumulative impacts. Moreover, the cumulative impacts of dock structures are not the only concern. There can be many other indirect consequences of increased boating and other recreational and commercial uses of the waterfront associated with docks. For example, new docks accompany new residential or commercial development, which in turn creates more stormwater runoff and other discharges that government must manage to protect coastal water quality.

As recreational boating and commercial shipping increase, the chances of fuel spills or accidental or intentional discharges of marine sanitation devices will also likely increase. In Buzzards Bay, there are currently 37 boat pumpout facilities to receive and transfer boat wastewater. If the total number and/or passenger capacity of boats increases, the number and capacity of boat pumpout facilities must also increase to handle the additional waste. To service more boats, marinas and repair facilities must expand and/or increase in number.

Offshore and nearshore mooring fields and anchorages for boats can affect bottom sediments, water quality and habitat through dragging anchors and mooring chains (this issue is addressed in Action Plan 6 Managing Impacts from Boating, Marinas, and Moorings). Fish and shellfish habitat will most likely decline as docks, piers, and associated boating proliferate, despite use of best practices in dock design, simply due to the overall increase in intensity of use of coastal waters. Several species of commercially important fish spend at least part of their life cycles within shallow intertidal or subtidal waters. As navigation conflicts become more complex, harbormasters must provide greater oversight.

On the positive side, coastal tourism, both on land and on the water, should benefit from more recreational uses of the ocean. The local economy may be revitalized due to an increased demand for services. Coastal real estate values may increase, leading to higher property taxes to support the increased need for municipal services. Environmental outreach and protection efforts should benefit from increased coastal tourism.

Dredging and Dredged Material Disposal

As noted above, in 2006 the Massachusetts legislature banned the disposal of dredged materials in Buzzards Bay. This law did little to alter dredging activities or mandate beneficial use of dredged materials, and other issues remain.

The harbors, channels, and embayments around Buzzards Bay require periodic maintenance and improvement dredging to compensate for natural sedimentation. In some cases, dredging is allowed for better access to permitted shoreline development (e.g. improved access of a boat to a private dock). Dredged material from these projects can have beneficial uses such as nourishing eroding beaches or capping contaminated deposits. Historically dredged material disposal has occurred at ocean dumping sites in Buzzards Bay (until 2006) and elsewhere. Some dredged materials may contain large amounts of fine-grained sediments (silts and clays), and these sediments may contain one or more contaminants of concern. Often these sediments are disposed at appropriate land sites.

During the past hundred years, numerous sites in Buzzards Bay had received dredged materials. However, during the 1970s, 80s and 90s, the only active site in Buzzards Bay that received dredged material was the disposal site at Cleveland Ledge (see Figure 99). The site primarily received dredged material from the Army Corps' maintenance of the Cape Cod Canal, but also received materials from municipal sites, particularly from Falmouth. On these projects, local, state, and federal permitting of dredging and dredged material disposal were evaluated on a project-by-project basis.

Because this permitting system did not address the cumulative impacts of disposal, and because there had never been a systemic evaluation of needs and suitability of Buzzards Bay disposal sites, in the mid 1990s, the Army Corp of Engineers (COE), the Department of Environmental Management (now called the Department of Conservation and Recreation), and the CZM began the process of evaluating the suitability of existing and potentially new Buzzards Bay Disposal Sites (BBDS). These studies were to culminate in the designation of a new site in Buzzards Bay to received clean dredged materials, as well as protocols for evaluating

[174] FWR 10.16 (1) (h) 2, although in practice, this provision appears to have been rarely invoked to prohibit the construction of a dock.

contaminant levels in sediments. This effort[175] was superseded in 2006, when the Massachusetts Legislature banned the disposal of dredged material in Buzzards Bay.

The dredged material ban legislation did encourage and allow for beneficial uses of dredged material including beach nourishment, salt marsh restoration, dune restoration, or use as capping material for underwater contamination. Despite these provisions, dredged materials from Buzzards Bay are now typically disposed of in either Rhode Island Sound or Cape Cod Bay. This is because coordinating timing between projects is difficult (for example, dredging permits and beach nourishment permits may have different timelines), material transport and land disposal costs can be high, or because it is technically difficult to collect sediment for transfer with some types of dredging equipment.

Despite these obstacles, given problems with shoreline erosion and future sea level rise, it would be preferable to use clean dredged sediments for beach nourishment projects and other beneficial uses wherever possible. The extra cost of land disposal must also be budgeted for in these projects.

A special situation remains in New Bedford Harbor, a Superfund site. There sediments have such elevated levels of PCBs and metals that the “hotspots” are unsuitable for most landfill sites, and even the lesser contaminated areas are unsuitable for ocean disposal. The issues surrounding this site are discussed in the Action Plan 16 Reducing Toxic Pollution.

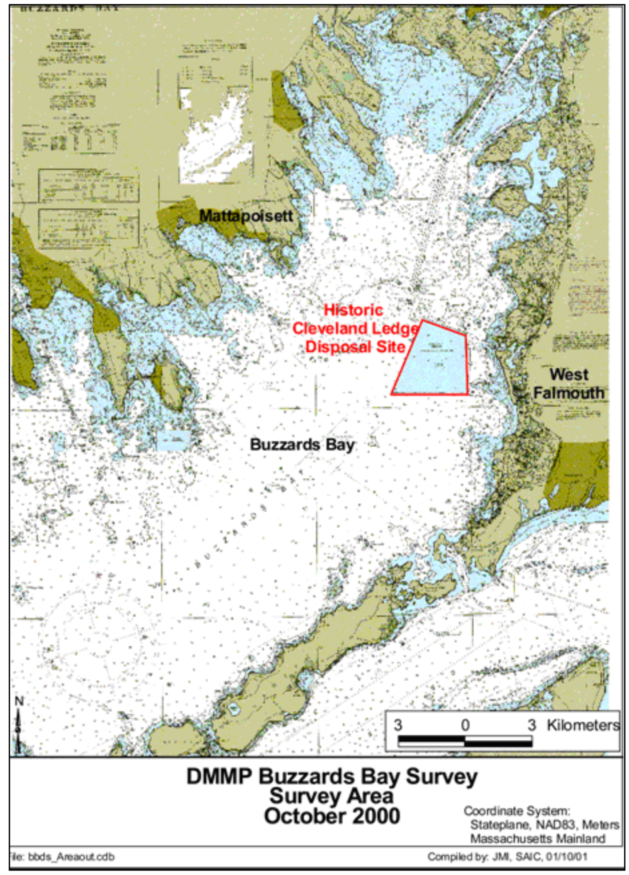

Figure 99. Location of the former Cleveland Ledge Disposal Site.

Management Framework

In the Buzzards Bay watershed, as in the rest of coastal Massachusetts, government regulates and manages coastal activities and development under a wide variety of existing local, state, federal and, in some cases, regional programs. Below is a brief overview of resources or activities and the key regulatory or management entities responsible for overseeing those activities.

General coastal development on the waterfront land

Development on waterfront lands is regulated by the local building commissioner who applies both local and state building codes, by conservation commissions for coastal wetland resource areas, and by other municipal boards and agencies depending on the issues involved (e.g., health department for wastewater issues, planning board for zoning, board of selectmen for special issues, etc.). The geographical jurisdiction often varies among local regulations.

1991 Managing Dredging and Dredged Material Disposal

Goal

Establish a comprehensive framework to manage dredging and the disposal of dredged material for Buzzards Bay.

Objectives

1. To minimize the negative impacts of dredging and disposal of contaminated and uncontaminated dredged material throughout Buzzards Bay.

2. To develop a database of potential hot spots, sediment and biota contaminant levels, and general information obtained from dredging and disposal testing.

3. To maximize the beneficial uses of dredged material by creating opportunities for disposal of dredged material, for example, nourish beaches or cover contaminated areas.

4. To review permits for dredging and dredged material disposal more uniformly and efficiently.

Recommendation and Commitment

U.S. Army Corps of Engineers (COE), with assistance from EEA, will initiate and co-chair an interagency committee of local, state, and federal authorities to develop a dredged material disposal plan for Buzzards Bay.

Note: Because of the banning of sediment disposal in Buzzards Bay in 2006, the action plan was eliminated from the 2013 Buzzards Bay CCMP Update, and relevant remaining recommendations and topics are included in this action plan.

[175] In 2002, CZM released a Draft Environmental Impact Report (DEIR) on the designation of a new Buzzards Bay disposal site just south of the old Cleveland Ledge site, within the waters of the Town of Falmouth. Because the new site might have received sediments from New Bedford that were deemed clean, public concern led to the passage in 2006 of legislation that banned the disposal of dredged materials in all of Buzzards Bay.

Structures and uses on filled tidelands are regulated pursuant to Chapter 91 and the state waterways licensing program, as are structures on flowing tidelands as explained in more detail in several sections below. Public access to the water and preserving water dependent uses are often key considerations in the review of projects on filled tidelands.

Wetlands protection

Municipal conservation commissions are the lead board that regulates most coastal activities and structures that may affect wetlands and the wildlife that depend on those wetlands. Most activities within wetland resources, or within a 100-foot buffer of those resource areas (or sometimes greater) are regulated. Conservation commissions administer the Massachusetts Wetlands Protection Act, which protects wetlands, and more broadly wildlife, shellfish and fisheries wetlands habitat. Many conservation commissions in the watershed have local wetland protection bylaws and wetland regulations that add additional levels of protection for shellfish habitat, eelgrass beds, and fisheries habitat, mostly through the siting of docks. Some commissions have also identified recreation, aesthetics, and/or commercial activities as protected interests. More details of the conservation commission authorities are found in Action Plan 7 Protecting and Restoring Wetlands, and in the Management Approaches section of this action plan. As noted below, certain larger projects may also require permits from Army Corps or DEP, and wetlands and habitat protection requirements may be incorporated in those permits.

Dock and filled pier construction

The permitting of dock construction (sometimes called piers) falls under local wetland protection bylaws, Massachusetts Wetlands Protection Act, DEP Chapter 91, Army Corps of Engineers, and MA CZM, with review by other local, state, and federal agencies (depending on the size of the project and the issues). The construction of new filled piers is difficult under existing laws and are now rarely built. Local building departments do not issue dock construction permits, unless there is a local zoning bylaw requiring such permits. Local zoning bylaws regulating dock construction exist in some Buzzards Bay towns. Regulation is generally limited to the dock structure and construction method, dock length, or water depth at the end of the dock. Most local bylaws do not address associated activities. Jurisdiction of bylaws typically extends either seaward from mean high water, the boundary of the most inland coastal resource area, or the FEMA floodplain boundary (land subject to coastal storm flowage).

The spacing and placement of docks can affect navigation and public access. DEP Chapter 91 licenses are the principal mechanism for addressing navigation and public access issues, and are especially important if no local requirements exist. Spacing between docks can be set through local zoning bylaws or ordinances, and these can be more protective that any minimum requirements for navigation or resource protection established by state and federal laws. For larger docks and piers, marinas, or coastal projects, the Army Corps of Engineers is the lead regulatory agency that also coordinates inter-agency review by local, state, and federal agencies such as EPA, NOAA National Marine Fisheries Service, U.S. Fish and Wildlife Service, MA CZM, MA Division of Marine Fisheries, DEP (for Water Quality Certification and Chapter 91), and others. For small projects, the Army Corps review may be limited and Chapter 91 instead serves as a permitting "gatekeeper," requiring that all other licenses and approvals be obtained first before issuing a Chapter 91 license. Jurisdiction is typically from mean high water line seaward for most of these programs.

Boating activities

Municipal harbormasters control and enforce regulations pertaining to boating, boating safety, moorings, and general navigation on waterways. Jurisdiction is limited to the water and waterfront activities. Waterways bylaws and regulations are typically developed by waterways committees, and approved by town meeting, but in some cases, boards of selectmen have authority to change waterways regulations. With respect to this action plan, some of the most important controls within local waterways regulations are the establishment of no-wake zones and headway speed limits, reconfiguration of mooring fields, anchorage exclusion zones, waterskiing or jet skiing exclusion zones, and conservation management zones. Management of discharges associated with boating activities is covered in Action Plan 6 Managing Impacts from Boating, Marinas, and Moorings.

Shellfishing and fishing

The local municipal shellfish warden, herring warden, or natural resources officers (these duties are sometimes combined in a single individual) are responsible for managing and protecting shellfish and fisheries resources within their municipalities. Both state and local regulations provide for shellfish and fisheries management and protection. At the state level, the MA Division of Marine Fisheries and MA Division of Fisheries and Wildlife regulate marine and freshwater fish, respectively. DMF and local shellfish wardens typically provide input to local wetland permitting hearings concerning proposed docks and piers, assessing whether the site could provide shellfish habitat. NOAA's National Marine Fisheries Service (NMFS) regulates marine fisheries at the federal level, although much of this agency's actions relate to offshore fisheries.

Stormwater management

Under the Massachusetts DEP Stormwater Policy, conservation commissions regulate stormwater discharges to freshwater wetlands, coastal wetlands, or in areas where stormwater runoff may adversely affect wetlands. Development and redevelopment may also be regulated by other local stormwater bylaws and regulations. Under the federal Clean Water Act, all communities must now manage stormwater runoff and obtain a federal NPDES Phase II MS4 permit (see Action Plan 3 Managing Stormwater Runoff and Promoting LID). Eventually, all stormwater discharges contributing to degraded water quality (closed shellfish beds) will be required to be remediated under the MS4 permits, but enforcement actions may be years in the future. Similarly, many types of "industrial" activities, including marinas must comply with the EPA multi-sector general permits for stormwater discharges under Phase II of the NPDES program.

Large complex projects

For large and/or complex projects or projects that exceed certain review thresholds, the Massachusetts Environmental Policy Act (MEPA) provides multi-agency review and gives other local, regional, state, and federal agencies the opportunity to identify which permits and approvals are needed. It is up to the project proponent to apply for and obtain the permits and approvals. Jurisdiction includes wetlands, water supply, water quality, rare species, wastewater, transportation, infrastructure, historical/cultural, air quality, hazardous materials, and other review areas.

Harbor and embayment plans

Municipalities may develop state-approved harbor plans, or they may adopt locally approved plans or policies for their embayments. In Buzzards Bay, only the City of New Bedford and Town of Fairhaven have jointly developed a CZM-approved harbor management plan for a portion of New Bedford Harbor and its waterfront. This plan does not address the construction of private and commercial docks and piers. The Town of Wareham has adopted a locally approved (by selectmen) Dock Exclusion Zone. The differences between state-approved and local-approved embayment plans are discussed in detail below.

Embayment management plans can become the foundation of many local management programs. An example of a plan that includes a good assessment of natural resources and defining uses within an embayment is the draft Green Pond Harbor Management Plan in Falmouth (Urban Harbors Institute, 2009). As outlined in the current draft and anticipated to be more fully developed in the final[176], are recommendations for mooring tackle restriction, activity use areas, dock requirements and restrictions, and identification of marine spatial planning zones.

Major Issues

Despite the apparent extensive regulatory framework highlighted above, there are some significant deficiencies and issues in existing approaches to managing docks, other coastal development along the waterfront, and watersheet activities. The lot-by-lot regulatory review of docks and other projects generally discourages assessment of cumulative impacts and precludes holistic embayment protection strategies. Exacerbating the problem, towns generally do not have systems in place to track or monitor cumulative impacts. Local shellfish and herring wardens may observe general declines in their fisheries that appear related to (and may be caused by) certain types of activities, but they may have little opportunity to act on these concerns in the project permitting process.

Similarly, current regulatory approaches do not address potential boating impacts associated with docks. Generally the permitting process regulates dock dimensions (footprint), construction, navigation, and other direct impacts on shellfish habitat and eelgrass beds, not the potential impacts of the associated boating activity which may affect water quality, shellfishing, fishing, wastewater, coastal tourism, appropriate uses, "viewsheds," coastal development, and other uses.

Applicants typically must file dock permits under a local wetlands bylaw, which may have largely qualitative performance standards. Wetlands bylaws specify protected interests such as protection of fish and shellfish habitat, and may protect aesthetic values, aquaculture, or recreational and commercial uses as well, depending on the municipality. Wetlands regulations may have vaguely defined or qualitative performance standards that allow for varying degrees of impact and/or mitigation, which requires application of subjective judgment (e.g., "Notwithstanding the above prohibition on causing impacts, the issuing authority may approve such structures if mitigation allows the project to meet performance standards"). Such wetlands bylaws and regulations that allow for varying degrees of impact and mitigation are more difficult to administer and enforce than zoning bylaws which generally have quantitative criteria and "yes-or-no" standards (e.g., "is it or is it not located within a zoning district that allows such structures", "does it meet dimensional requirements or not?", etc.). As a result, there is much litigation surrounding dock projects.

Comprehensive coastal marine resource planning by local government remains an elusive goal[177]. This is because local officials often do not fully utilize existing authorities, or because some of those authorities relative

[176] See the minutes of the Coastal Pond Management Committee for 02-04-2013, retrieved from www.falmouthmass.us/meeting.php?depkey=cpmc&number=5290. Last accessed July 30, 2013.

[177] See the MIT Sea Grant proposal by John Duff titled "The Governance Role of Local Authorities in Marine Spatial Planning: A Legal Assessment of Prospects and Problems." Project Number: 2012-R/RC-132-REG, Retrieved from seagrant.mit.edu/proj_desc.php?ID=1243. Last accessed June 28, 2013.

to state and federal control have not yet been fully defined. For example, with respect to existing authorities, most communities do not appear to have utilized the provision of the state waterways regulations (310 CMR 9.38(2)(b)) that allows municipalities to adopt a local policy, plan, or local zoning ordinance or bylaw that could control docks and piers under the state Chapter 91 waterways licensing program (discussed further below). Similarly, some municipalities have wetland or other bylaws that do not have implementing regulations or clear performance standards that address specific activities on the watersheet, waterfront, and tidelands. Even where specific authorities or regulations exist to regulate or limit certain activities, local boards and commissions often do not fully implement or enforce them. In some cases, improved training or requirements for monitoring post construction performance would help to address this issue.

Monitoring data can be especially useful in defining or refining regulations and construction performance standards. For example, environmental data on pre- and post-dock construction conditions are generally not required as part of the permitting process, despite the fact this type of data is essential for understanding the cumulative impacts of docks. The exceptions to this generalization are regulatory requirements to map eelgrass beds or sometimes shellfish abundance before a dock is constructed. However, there are rarely requirements for monitoring these same resources after construction[178], or documenting fish habitat or sediments before and after construction of docks and during the use period following dock construction. Such information could provide useful information to better evaluate the environmental impacts of docks and associated boating activities. However, because monitoring is expensive, some local boards view such requirements as too burdensome for the applicant. If monitoring is required, a credible expert should perform monitoring in an objective manner, in order to yield useful data.

Scientists must improve the process of evaluating impacts of docks, boating, and the cumulative impacts of coastal development. This will require additional funding of independent and meaningful research in Buzzards Bay and elsewhere. Docks and piers are one of the most regulated activities; yet few understand their cumulative environmental impacts or their potential impacts on community planning, community character, socioeconomic structure, infrastructure needs, and effects on essential services. Research should investigate the effects of propeller turbulence, propeller dredging, boat wakes, and dragging anchors on water quality and habitat. Planning and resource economic studies should investigate effects of docks and boating (both pro and con) on the social, economic, and demographic characteristics of local communities and identify ways to avoid or mitigate adverse impacts.

Strategies for managing impacts of docks

- limiting length to minimize footprint impacts;
- limiting the boat draught to control prop dredging;
- limiting the types of dock materials to prevent pollution by pressure-treated wood or other substances;
- specifying the degree of light transmission between deck planks to minimize impacts on salt marsh growth;
- avoiding productive shellfish areas;
- limiting dredging or fill activities to times when shellfish larval settling or fish breeding activities are not occurring;
- minimizing the piling footprint area to minimize permanent loss of habitat;
- minimizing dock width to reduce shading of salt marsh vegetation, and so on.

Both NOAA (2004) and the DEP have provided guidance on measures to minimize dock impacts on shellfish, eelgrass, and salt marsh habitat (Burdick and Short interactive CD; DEP 2003).

Currently there are few or no incentives to encourage community or common docks. Few communities in Buzzards Bay have regulations that encourage or even allow community or common docks. Although the definitions can vary, generally the concept of a community dock is that it serves a neighborhood or a number of coastal property owners, while a common dock may serve two adjacent owners. Objections to community docks include the need to have deed restrictions or covenants for a subdivision, how to restrict (or expand) the number of users, how to regulate activities (as marinas are regulated), and how to define community and common docks. In principle, community docks and common docks could potentially reduce the number of possible docks along the waterfront.

The interests specified in most local laws and regulations are often narrow. Protection of aesthetic, recreation, aquaculture, and recreational and commercial values are specified in only a few municipal wetlands bylaws in the Buzzards Bay watershed. Adding these protected values, and adopting specific standards and definitions (although sometimes difficult), may help to manage docks and other coastal structures and activities more effectively.

As noted above, defining the impacts of docks and piers on shellfish and fish habitat in a particular estuary system, or the impacts of boating activities related to the placement of those docks and piers, can be difficult without site-specific studies. Many variables affect habitat including species, life cycle, seasonality, storms, sediment movement, and water quality, to name a few. In

[178] Except in cases where eelgrass was transplanted or planted for mitigation of bed destruction.

general, managers and regulators rely on the findings of other studies to generalize about presumed actual and potential impacts.

Regulators typically have a narrow perspective in the permitting of docks and other coastal structures, and often do not consider wider community issues or other environmental impacts outside of shellfish and fish habitat impacts. Existing regulatory review processes generally do not consider community goals and community character, and instead focus on site-specific, structurally based physical impacts of coastal structures like docks and piers. As a result, while the regulated community resents the degree of permitting review they must undergo, community residents do not feel town officials hear their voices. Community-based performance standards would require visioning, planning, alternatives analysis, testing and refining of regulatory and management approaches, and a public process of input and approval. Having a comprehensive community-wide set of goals and a common vision for the coastal neighborhood could help streamline the regulatory review process and provide more meaningful management and protection than currently exists.

The review of permits for coastal projects and activities by agencies at the same level of government (i.e., between state, federal, or local agencies) can be improved through better coordination and integration of concerns between agencies and departments. The same is true in reviews of the same permit by different levels of government. Perhaps one of the best examples of an integrated formalized permitting review process is those conducted by MEPA. The MEPA process identifies which state, regional, and local agency approvals and permits are required for larger projects, and incorporates comments by the agencies and the public into the permitting conditions. Because of the thresholds for review, the MEPA process applies only to larger projects. Similarly, reviews performed by the Army Corps of Engineers for certain permits include coordinated federal agency review for federal approvals for projects that meet specified thresholds.

In reality though, projects are not reviewed in a comprehensive way. Even projects that undergo MEPA review still must receive permits from numerous jurisdictions, for different purposes, and under different regulatory standards. Because of the many agencies and different jurisdictions involved, a large and complex coastal project involving different jurisdictions may be reviewed many times by local, state, and federal agencies. For the applicant, this can make for a lengthy, complex, and sometimes-repetitive review process. This has resulted in calls for "one-stop permitting," but such efforts have largely been unsuccessful because of the complex framework of laws at each level of government. Given this reality, the best opportunity to improve the process, and at the same time increase transparency and improve public participation, is for each permitting authority to require electronic submissions of plans and permit applications, and to have these applications posted on line.

Other Issues

The proliferation of privately owned docks and piers along many sections of the Buzzards Bay coastline has resulted in presumed impacts on nearshore habitat, water quality, and in some cases, visual aesthetic values. The discharge of untreated or minimally treated sanitary wastes from commercial and recreational boats into Buzzards Bay is just one pollution source that may affect water quality, and longer term impacts of bottom paint, wood preservatives, accumulated PAHs, and chronic resuspension of sediments may contribute to long term and cumulative impacts (Barr, 1993; Crawford et al., 1998). Most of these issues need further study.

Similarly, marina and boatyard operations and activities, and their related stormwater run-off, have added to the nonpoint sources of pollution impacts in some sections of Buzzards Bay nearshore waters and habitats. Presently, few marinas currently comply with EPA's industrial stormwater (MSGP) NPDES program, and many power washing and boat-scraping activities may not comply with other state and federal discharge permits.

The damaging effects from the 2003 *Bouchard 120* oil spill demonstrated the vulnerability of Buzzards Bay natural resources to oil spills and the high costs of clean-up and recovery from such spills. Punitive actions against the barge company have resulted in new laws and funded plans and equipment that will better enable municipalities to be better prepared for the next inevitable event, but continued vigilance and adequate oversight of the shipment of hazardous cargoes is still required. Moreover, chronic small spills associated with fueling and maintenance activities, oily bilge water discharges, and discharges of 2-stroke engines remain management concerns without easy solutions. These and other issues are discussed in Action Plan 17 Preventing Oil Pollutio.

Increased interest in shellfish aquaculture may have both economic and water quality benefits, especially in ameliorating eutrophication impacts (see Action Plan 1 Managing Nitrogen Sensitive Embayments). Despite these benefits, objections are sometimes raised to aquaculture by waterfront property owners, often because of aesthetic issues. Municipalities and communities should be prepared to evaluate both nearshore conflicting uses and offshore large-scale projects (e.g., proposals for ocean wind energy and liquefied natural gas facilities) that may occur in town waters. These projects must be evaluated to determine their suitability and acceptability both in the context of local environmental regulations, and local political and economic goals. This approach requires anticipating issues and addressing them through comprehensive planning and management. Defining community goals is typically the most important first step in the process.

With respect to the Massachusetts Ocean Plan area, it is possible that conflicts may arise between state and municipal government in the management of the offshore waters. It is likely that any conflicts will be resolved through updates of the Ocean Plan or through project review during the permitting process.

Management Approaches

The permitting and management of projects on the waterfront, on the watersheet, and in tidelands is complex issue that touches upon environmental, economic, recreation, tourism, fishery, regulatory, and aesthetic issues, to name a few. It has been suggested that because of this complexity, these types of projects are prime candidates for application of integrated coastal management, or ICM, which calls for involvement by all relevant sectors (Crooks and Turner, 1999). Such an ICM approach could be applied to dock construction, aquaculture, renewable energy, and other activities in the near coastal waters outside the ocean plan jurisdictional area of Buzzards Bay. Similarly, the principals of ocean and marine spatial planning[179] used in the development of the Massachusetts Ocean Plan can be applied by municipalities to bays and harbors.

Existing regulatory approaches at the local, regional, and state level are often not fully utilized. As a supplement to existing regulatory approaches, municipalities should consider marine watersheet zoning as one tool for comprehensive management and permitting of coastal activities, including dock and pier construction, shellfish and fisheries management, coastal development, and other issues. Marine watersheet zoning can provide a comprehensive regional approach to management of docks, piers, and associated activities.

Similarly, community policies regarding Chapter 91 licensing of coastal structures, docks, and piers should be developed and sent to the DEP Waterways Program. These policies will be used by the state in their decision making process. Improved information exchange between regulatory agencies at different levels about regulations, policies, studies, findings, and impacts should further improve consistency in government decision making. Each of these themes and approaches are described more fully in the sections below.

More effective use of Chapter 91 provisions

Municipalities have considerable authority under local zoning and non-zoning ordinances and bylaws to control activities along their waterfront, on the watersheet, and on tidelands. However, few municipalities have fully utilized such authorities, and instead rely on existing regulatory programs like the Chapter 91 waterways license program administered by DEP. This program requires that construction on Massachusetts tidelands (including historic tidelands that have been filled) obtain a license. Such licenses are designed to protect the public interest in fishing, fowling, and navigation, and public access to those activities (regulations defined in 310 CMR 9.0).

In Massachusetts, some municipalities have developed state-approved harbor plans[181]. In Buzzards Bay, the only state-approved harbor plan is the joint New Bedford-Fairhaven plan for New Bedford Harbor. One of the benefits of these plans is that the municipality can modify certain discretionary standards within the Chapter 91 regulations. These harbor plans typically address designated port areas and other commercial, industrial, and non-commercial sites in a major harbor.

Where state-approved municipal harbor plans exist, municipalities can submit written recommendations (usually from the board overseeing the harbor management plan), as to whether a proposed project conforms to the harbor management plan. In such cases, DEP shall presume whether a harbor plan requirement is met or not met based on these written submissions by municipalities, as per 310 CMR 9.34(2) (a) 1. In the Chapter 91 permitting process, municipalities submit forms stating that the municipal planning board has received notification of the project and that the project does not violate local zoning ordinances and bylaws."[182]

For Buzzards Bay municipalities, management and protection of their embayment watersheet, waterfront, and tidelands areas can be summarized as:

- Employ integrated coastal management (ICM)[180] and marine spatial planning approaches to characterize land- and water-based coastal activities, water quality, natural resources and habitat. Use this information to formulate recommendations for supporting local laws, policies, and regulations.
- Implement recommended local bylaws, ordinances, regulations, and policies to implement the goals and objectives of these local plans. Use these local plans to leverage state enforcement through programs like DEP Waterways and the Chapter 91 licensing process.

179 See tools and discussion at: www.cmsp.noaa.gov/index.html.

180 Definition of integrated coastal management, at www.oceansatlas.com/unatlas/uses/uneptextsph/infoph/gsglossary.html.

181 State law allows municipalities to submit municipal harbor plans to establish "a community's objectives, standards, and policies for guiding public and private utilization of land and water within Chapter 91 jurisdiction... Harbor plans may, for example, establish siting and design criteria for projects within a harbor, or designate certain parts of a harbor as off-limits to in-water construction and mooring placement. Plans are developed under MA CZM regulations and implemented under Chapter 91 regulations."

182 DEP (DEP Waterways Program) and CZM (under federal consistency) review projects proposed within municipal harbor planning districts. The proponent triggers these reviews when they

Separate from state-approved harbor plans, municipalities can control dock and pier construction through the Chapter 91 permitting process if they adopt a formal local (non-state-approved) harbor or embayment plan or policy as per 310 CMR 9.34(2) (b)[183]. Such a plan could include spacing requirements between docks, exclusion zones, or construction standards. If a municipality adopts these local plans or policies, it is important that the town submit the written policy or plan to the DEP Waterways Program so that it is on file. Such plans or policies could cover just one bay or the entire coastal area of the municipality. In 2001, the Town of Wareham adopted such a policy[184] with maps specifying dock exclusion zones. This policy has been enforced by DEP's Waterways Program. Adoption of such a policy or plan requires public input and a public process.

Watersheet zoning and ocean zoning

Watersheet zoning is similar to land zoning in that it "involves a method for dividing a marine area into districts and within those districts regulating uses to achieve specified purposes." (Courtney and Wiggin, 2003). Local managers must delineate a specific area based on objective factual criteria, and then document the characteristics of the districts within it to provide the scientific and factual basis for regulation. Local officials then develop zoning regulations for the districts within the planning area. For example, managers may base the delineation of the area on the presence or absence of significant shellfish habitat based on shellfish surveys or other habitat indicators. Several districts may be designated within the zone based on shellfish habitat ranging from poor to moderate to excellent, and in these districts, docks and piers could be allowed with conditions, and prohibited, respectively. Areas may also be designated for aquaculture. Strategies may include creating incentives to ensure that new development and redevelopment protects water quality and sensitive natural resources, is more resilient to storm surge, and will accommodate sea level rise (see the Nantasket Beach Overlay District example below).

The advantages of marine watersheet zoning is that it can provide effective management to address cumulative impacts, provides regional and large scale management, it is efficient, comprehensive community and planning issues are considered, and zoning regulations are typically more clear-cut and of the "yes-no" variety than wetlands regulations. The disadvantages are that it requires delineation of a specific area, and the zoning bylaw is administered by the planning board or zoning board, who may be less experienced in dealing with marine and coastal environmental issues than the conservation commission. This can be remedied by having the planning or zoning board request input from the conservation commission regarding a specific project or area.

Some of these zoning-like designations need not require passage of zoning bylaws or ordinances. For example, the designation of recreational-only "family" shellfishing areas can be made through existing local authorities to manage shellfish resources. No-wake zones and waterskiing exclusion zones can be designated through local waterways regulations.

Elements of zoning or non-zoning local bylaws and regulations that can be adopted can include:

- Community or common dock to serve several lots rather than a single dock per lot (Castellan, 2003);
- Prohibiting docks within valuable shellfish or fisheries habitat;
- Promoting the use of marinas rather than multiple docks (marinas are subject to more stringent permitting than residential docks) (Castellan, 2003);
- Lot dimension requirements that must be met before a dock can be built, thus prohibiting a dock being built on a tiny lot (see Marion model bylaw);
- Use zoning standards to address aesthetic issues such as "viewshed" and community character.

Watersheet and Waterfront Zoning Examples

Marion Watersheet Zoning Model Dock and Pier Bylaw

This model watersheet bylaw, drafted by the Buzzards Bay NEP[185], but never adopted by Marion, builds upon an existing town zoning bylaw that disallows docks from very small lots based on non-conformance. The jurisdiction under the existing bylaw ends at low water. The jurisdiction of the model bylaw would add to the existing bylaw and begin at low water and extend offshore. The model bylaw specified areas where docks

submit their Chapter 91 application. CZM regulations require that a proposed harbor plan go through an extensive public process requiring a number of public hearings and a lengthy period. Because of the extensive public process, the legal standing of municipal harbor plans that are approved by CZM is very strong.

[183] This section states that "No project shall include a private recreational boating facility with fewer than ten berths on Commonwealth tidelands or Great Ponds, if the Department (i.e., DEP Waterways Program) receives written certification from the municipal official or planning board of the municipality in which the project is located that such facility does not confirm to a formal, area-wide policy or plan which establishes municipal priorities among competing uses of the waterway, unless the Department determines that such certification: is arbitrary, capricious, or an abuse of discretion; or conflicts with an overriding state, regional, or federal interest."

[184] "It is a policy of the Town of Wareham to maintain those areas designated as Recreational Shellfish Areas and Shellfish Grants, as indicated on the enclosed map, open and unobstructed for the purpose of shellfishing related activities as these activities are considered priority uses for these areas." Retrieved from www.wareham.ma.us/Public_Documents/WarehamMA_BComm/Policies/01-01%20DOCK%20PIER%20PROJECTS.doc. Last accessed October 11, 2013.

[185] Marion watersheet zoning model dock and pier bylaw. Retrieved from the Buzzards Bay NEP website at: buzzardsbay.org/dockpiermodel.htm.

would be excluded based on the presence of shellfish habitat, eelgrass beds, rare species habitat, and swimming beaches. These areas would be identified in the field, scored for relative value, and delineated on a map. Habitat and use values were scored according to a published scoring system, and those areas with highest scores (i.e., highest values) were delineated as "no pier construction zones." Existing nonconforming piers could be maintained or modified under a special permit process.

Edgartown Surface Water District, Martha's Vineyard

The Town of Edgartown adopted a surface waters district "*to encourage appropriate water dependent uses of the Town's harbors, bays, and ponds, to protect and enhance the environmental quality of those waters, to minimize potential adverse effects on marine flora and fauna and wildlife habitat, to promote the safety of navigation on said waters, and to minimize flooding and other storm-related hazards.*"

The town adopted a surface water zoning approach, that extended seaward of the mean high water line. The bylaw established permitted water-dependent uses and uses allowed by special permit (from the planning board) are specified. Few non-water-dependent uses are allowed, and uses not specified are thus prohibited (Courtney and Wiggin, 2003).

Dock Limits in Barnstable Wetland Regulations

The Town of Barnstable adopted wetland bylaw regulations that address the size and length of docks, including a provision that prohibits docks from exceeding one-half the length of the waterfront frontage of the property. The Massachusetts Appeals Court upheld this regulation provision in 2003[186].

Nantasket Beach Overlay District

In 2013, the Town of Nantasket passed a zoning bylaw create a Nantasket Beach Overlay District waterfront and near coastal lands "to stimulate mixed use redevelopment of commercial and multi-family property at scales and densities appropriate for an historic beachfront community in order to revitalize the economy and help balance the commercial and residential tax base while protecting people, property, and resources." Some of the adopted measures are meant to reduce development sprawl, protect barrier beach and dune system functions of storm and flood protection and wildlife habitat, and create "incentives for development that can withstand sea level rise and increased flooding and frequency and intensity of storms caused by climate change, and thereby; protect persons and property from the hazards that may result from unsuitable development in areas subject to flooding, extreme high tides, and rising sea level."

The specific mechanism of authority was in the creation of a special permit procedure administered by the planning board, with the ability of the town to collect fees for consultants. The district establishes prohibited uses, setback and dimensional standards, requirements for open space, and other performance and design standards. Local incentives are provided in the form of building permit rebates and variances from certain dimensional requirements and performance standards if certain conditions are met.

New Jersey Marine Conservation Zoning

In 2001, New Jersey adopted its first Marine Conservation Zone, by granting new site-specific jurisdictional authority to state land management agencies to control intertidal activities and recreational activities in order to protect natural resources and passive recreation. The key provision in the zoning regulations bans motorized vessels (e.g., jet-skis, others) within the zone, to prevent damage to wetlands and impacts on wildlife and recreational uses (Courtney and Wiggin, 2003).

Adopt a policy or plan pursuant to Chapter 91

As noted in more detail above, a community can develop and adopt a policy or plan for construction activities on tidelands that would be enforced by the DEP Waterways Program in their issuance of Chapter 91 licenses. Special area management plans can also serve this purpose if they address activities and areas subject to Chapter 91 jurisdiction (filled and flowed tidelands). One example of a special area management plan that includes dock management for the purpose of shellfish habitat protection is the Pleasant Bay ACEC Management Plan developed for the Towns of Orleans, Eastham, and Chatham. This ACEC management plan addresses dock sprawl through designation of different zones within Pleasant Bay, based on shellfish habitat value and uses. The different zones specify whether docks are allowed or not. The wetland regulations of the towns located within the Pleasant Bay ACEC are consistent with and help to implement the Management Plan.

District of Critical Planning Concern

For municipalities on Cape Cod, another kind of special area management plan is available through the Cape Cod Commission's Regional Policy Plan, called a District of Critical Planning Concern (DCPC). A municipality nominates the DCPC to protect specific interests. The Cape Cod Commission and Barnstable County Assembly of Delegates review this nomination, and if approved; they provide the municipality additional authority to designate a special area and adopt implementing zoning or wetlands bylaws. Falmouth has one DCPC on Buzzards Bay, the Black Beach/Sippewissett Marsh

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[186] Dubuque v. Conservation Commission of Barnstable No.01-P-1152. August 18, 2003. Retrieved from buzzardsbay.org/download/dubuque-et-al-case.pdf. Last accessed October 9, 2013.

DCPC, which prohibits new docks and piers and regulates building envelopes.

House Boat Prohibitions and Floating Dock Expansions

There are some special circumstances that apply to houseboats and floating docks that warrant a separate discussion. State and local wetland laws require permits for the construction of docks and piers, but a wetlands permit is not required for a vessel, barge, or floating device to tie to that dock, irrespective of its use. This situation has led to some interesting temporary and permanent structures being tied to docks including houseboats, floating restaurants, docks storage areas, floating dock attachments, and recreational platforms.

These expansions, however, may conflict with the state's Chapter 91 license for those docks and piers. In fact, Chapter 91 Waterways regulations (310 CMR 9.00) include a number of categorical restrictions on these structures and add-ons, and for others require an amendment to the Chapter 91 permit. Existing Chapter 91 licenses may also contain additional limitations on uses and activities specific to that site.

Because of concerns about the impact of these expansions on water dependent uses and the environment, the lack of past comprehensive enforcement of the Chapter 91 law, and to better assert local control, many cities and towns have adopted harbor regulations or laws addressing issues like these relating to houseboats:

- Section 5.5 (Harbor Pollution Control) of New Bedford's Code 4(d) states: "*Houseboats used as residences shall not dock in waters covered by this section unless approved by the board of health.*"
- The Town of Barnstable adopted a waterways General Bylaw regulating boats with this provision in section *40-12, Docking and mooring of houseboats restricted to licensed slips: "No person shall moor or dock a houseboat in the waters of the Town except at a pier, slip or dock for which a valid current marina license has been issued under Section 59B of Chapter 91 of the General Laws.*
- The Town of Chatham adopted a "Protective [General] Bylaw" which states: "4. *Prohibited Uses d. No person shall construct a residential dwelling unit, or use a houseboat or barge designed or used as a dwelling unit in the Conservancy District.*"

With respect to floating docks and boat impacts, when new docks are permitted, conservation commissions are increasingly establishing size limits on boats, or setting limits on boat drafts to ensure that vessels do not rest on the bottom at low tide and affect benthic habitat and species. These limitations are written into orders of conditions, which are then recorded against the property deed. In the Town of Falmouth, the board of selectmen must also issue a permit for the construction of docks and seawalls, and additional requirements may be imposed. The chief weakness of Falmouth's approach is the selectmen have not adopted support regulations or performance standards.

Financial Approaches

The cost of developing harbor management plans will be generally supported through local appropriations and town meeting, although grants may sometimes be available through CZM or the Buzzards Bay NEP. The Seaport Advisory Council can also provide funding for harbor planning efforts. Most of the strategies relating to the adoption of laws and regulations will impose a modest financial burden to municipal government.

Monitoring Progress

More than most other action plans, this action plan will be evaluated by tracking programmatic actions, especially in the formulation and adoption of waterfront and watersheet management plans and policies.

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Action Plan 16 Reducing Toxic Pollution

Problem

Toxics enter Buzzards Bay from many sources and via numerous pathways. The largest single toxic pollution management problem remains the cleanup of the U.S. EPA Superfund site in New Bedford Harbor, which at the current rate of cleanup may take another 40 years to complete. There are 4 additional Superfund sites in the Buzzards Bay watershed, and 102 hazardous waste sites altogether on the state's Chapter 21E list. All these sites may be cleaned up in a timelier manner.

Beside these known hazardous waste sites, there are many past and ongoing inputs and pathways of toxic contamination to Buzzards Bay and its watershed. A number of embayments are identified in the states 303(d) Integrated List, and will require the development of TMDLs to manage chronic inputs. Some of the environmental impacts of these contaminants are not fully understood, and will require further study. The cleanup of the existing hazardous waste sites and controlling the numerous nonpoint inputs to the environment remains one of the most complicated challenges that must be addressed in the Buzzards Bay CCMP.

This action plan focuses on reducing and eliminating toxic inputs into the bay in order to improve bay conditions and minimize the costs of cleanup and mitigation. Both point and nonpoint sources are addressed.

Several other action plans provide recommendations that are directly related to this issue, including those for reducing oil pollution, managing dredging and dredged material disposal, managing wastewater industrial discharges, and managing stormwater runoff.

Goal

Goal 16.1. Protect public health and the bay ecosystem from the effects of toxic contamination.

Objectives

Objective 16.1. To reduce the amount of toxic contamination entering Buzzards Bay and water bodies listed under the 303(d) program.

Objective 16.2. To eliminate hazardous discharges of toxic contaminants from point sources into the bay.

Objective 16.3. To reduce the discharge of toxic contaminants and contaminants of emerging concern into wastewater systems (both septic and sewer).

Objective 16.4. To reduce hazardous discharges from nonpoint sources of toxic contaminants into the bay.

Objective 16.5. To meet all state, federal, and local action levels for water and seafood.

Objective 16.6. To improve local, state, and federal regulation and control of seafood and sediment quality to protect human health and the environment.

Approaches

Implementing this action plan is complex because it involves industry, residential activity, the choice of products and compounds used, and regulated and nonregulated business activities. However, across all these activities and sectors of the economy, pollution prevention is one of the most important actions for achieving the goals of the action plan.

The second most important element is to ensure proper disposal and recycling of toxic materials. For example, fishing vessel owners often discharge oily bilge water because existing collection services are too expensive. In this regards, DEP should fund the construction of a facility to collect bilge oil along New Bedford Harbor that accepts oily bilge water for recycling and treats it at an affordable rate to boaters and the fishing fleet. Expansion of hazardous waste collection days, increased conventional recycling programs, and year round availability of facilities to dispose of waste oil, tires, leads and cadmium batteries and fluorescent tubes will offer proper disposal opportunities. The failure to have a speedy cleanup of hazardous waste sites, especially federal superfund sites, remains an important need, as these cleanups have been unacceptably slow.

Costs and Financing

The costs to implement this action plan are as varied as the sectors and pollution sources that must be managed, and the New Bedford Superfund cleanup dwarfs all others. One non-Superfund need is funding for the design, permitting, and construction, of an oily bilge water-collection and treatment facility in New Bedford, which will likely cost $500,000 to build, and tens of thousands of dollars per year to operate. The construction and operation of this facility could be funded by the Massachusetts Oil Spill Act fund.

There are many other costs associated with this action plan. Hazardous material disposal collections are expensive, and municipalities can often only afford one collection event annually, if at all. There are costs to expand conventional recycling programs as well.

Measuring Success

The success of this action plan can be evaluated by the amount of hazardous materials collected, the concentration of toxic contaminants in wastewater facility discharges, and by various programmatic and management action, measures.

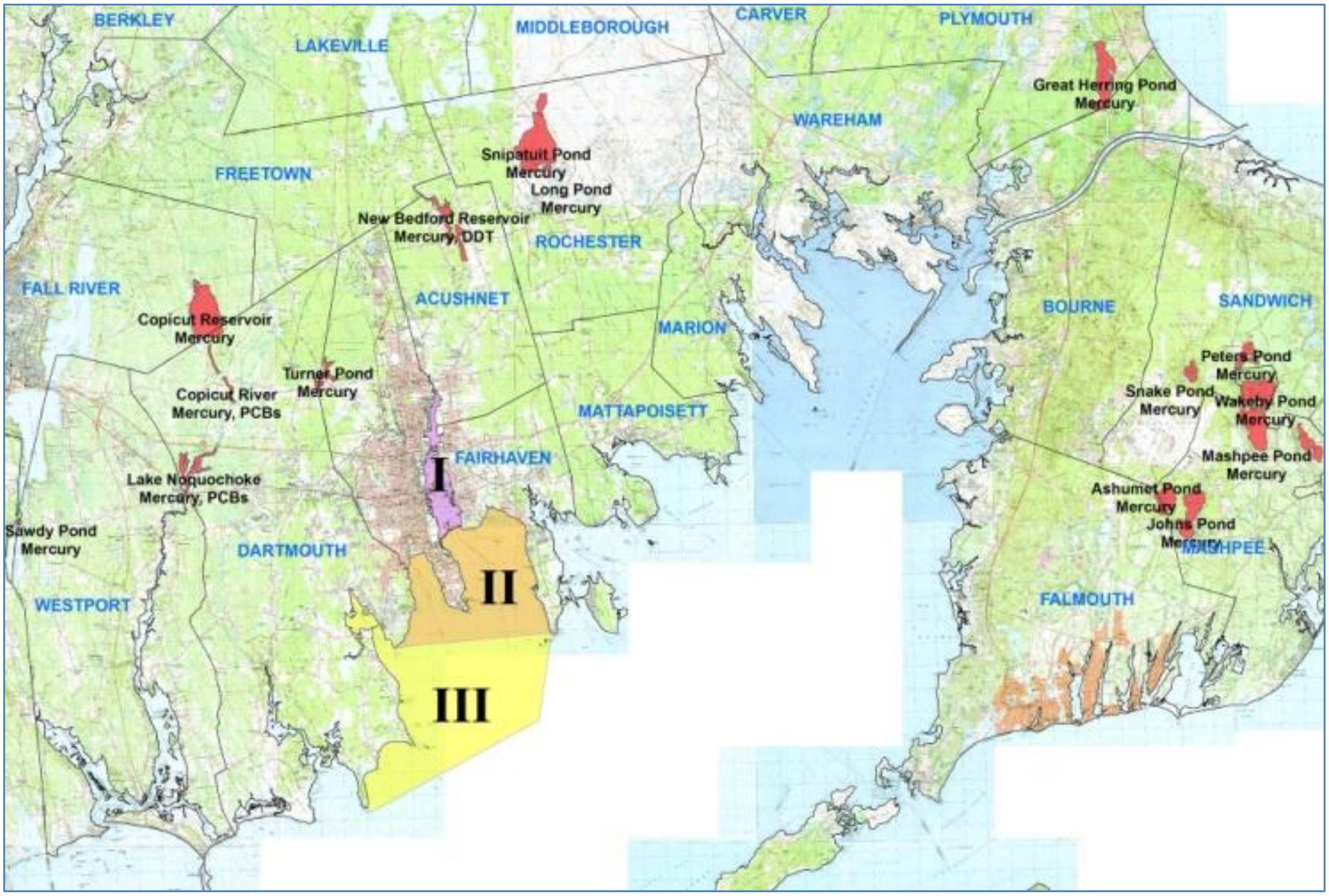

Figure 100. New Bedford area PCB fishing restrictions and fish consumption advisories for freshwater ponds in the Buzzards Bay watershed circa 2011.

The fishing bans in and around New Bedford Harbor were enacted in 1979 pursuant to 105 CMR 260 and remain in effect today.

Background

Although most of Buzzards Bay is less contaminated than many other urbanized estuaries, it has been impacted by one of the few marine Superfund sites in the country. As described in more detail in Chapter 3, this site, consisting of the wide-scale contamination of New Bedford Harbor with PCBs, has not only posed a persistent potential human health risk, but is the basis of an extensive fish, shellfish, and crustacean seafood closure around the harbor (Figure 100). These closures were enacted in 1979 pursuant to 105 CMR 260. This is the only marine fishing area in Massachusetts that is closed due to chemical contamination. This PCB contamination is also believed to contribute to an elevated, but less than action threshold, PCB concentration in seafood and birds in Buzzards Bay. In 2010, EPA recommended modifying these restrictions somewhat, but the state has not yet taken action.

Four other EPA Superfund sites are found in the Buzzards Bay watershed. These are the Atlas Tack site in Fairhaven, the Sullivans Ledge site in the north end of New Bedford, the Re-Solve Inc. site in Dartmouth (various solvents, PCBs, and other contaminants), and the Otis Air National Guard site on Cape Cod (4 plumes, mostly various hydrocarbons from fuel dumping and a landfill, are traveling towards Buzzards Bay through groundwater in Bourne and Falmouth).

While there is sediment and animal tissue testing associated with the New Bedford PCB superfund project, there is not similar testing for toxic metals and organic compounds for most other hazardous waste sites elsewhere in Buzzards Bay. The DEP (O'Brien, K., and A. Langhauser. 2003) report entitled "Buzzards Bay Watershed 2000 Water Quality Assessment Report" details specific watershed and Buzzards Bay impacts due to contaminants, as measured by sediment and water quality testing, fish consumption advisories, shellfish harvesting and shellfish bed closures, primary and secondary contact recreational uses, and aquatic life use impairments. The federal Food and Drug Administration (FDA) has also issued guidance on "action limits" for contaminants in shellfish, fish, and other food animals, based on human health risks.

Under the state's 303(d) program requiring evaluation of water quality in water bodies according to their intended human uses and ecological values, there are 12 freshwater, estuarine and marine water bodies in the Buzzards Bay watershed that are classified as Category 5 (the most severely contaminated) due to either heavy metal and/or priority organic pollutants[187]. These embayments are:

- Acushnet River outlet, Main Street culvert to Coggeshall Street Bridge (priority organics, metals, other pollutants);
- Apponagansett Bay, Dartmouth (priority organics, other);
- Clarks Cove, New Bedford, Dartmouth (priority organics, other);
- New Bedford Harbor, Coggeshall Street Bridge to Hurricane Barrier, Fairhaven/New Bedford (priority organics, metals, others);outer New Bedford Harbor, Buzzards Bay waters landward of a line drawn from Ricketson Point to Wilbur Point (priority organics, non-priority organics, metals, others);
- Cornell Pond, Dartmouth (priority organics, metals);
- Long Pond, Rochester (metals);
- Noquochoke Lake, Main Basin, Dartmouth (priority organics, metals, others);
- Noquochoke Lake, South Basin, Dartmouth (priority organics, metals, others);
- Noquochoke Lake, North Basin, Dartmouth (priority organics, metals, others);
- Snipatuit Pond, Rochester (metals); and
- Turner Pond, New Bedford/Dartmouth (metals, other).

Altogether, approximately 960 acres of fresh water and over 7.6 square miles of marine and estuarine waters are classified as Category 5 due to priority organic pollutants and/or metal contamination (see *Atlas of Stormwater Discharges in the Buzzards Bay Watershed*, Table 3, p. 9-10 for a list of Category 5 waters). Category 5 waters require that a Total Maximum Daily Load (TMDL) be developed which sets a limit on the daily input of pollutants to a water body. The 303(d) program is described further below (see Regulatory Programs), and in the atlas.

There are many potential sources of toxic compounds and chemicals within the Buzzards Bay watershed. These include both point and nonpoint sources. Point-source discharges include sewage treatment facilities, industrial discharges, combined sewer overflows, and storm sewers. Nonpoint sources include atmospheric fallout of contaminated dust particles and precipitation, contaminated groundwater, untreated stormwater runoff from developed areas of the watershed and other sources. Nonpoint sources are numerous, small, and generally unregulated inputs that discharge directly into receiving waters such as wetlands, streams and rivers, ponds and lakes, and the waters of Buzzards Bay itself. Examples of potential toxic pollution sources include, but are not limited to, the following:

- Boats, ships, and other vessels that discharge or spill oil, fuel, wastes, cleaning fluids, and other toxic substances into the waters of Buzzards Bay;
- Marinas, docks, and piers where boat washing, floor drains, refueling, and other activities could cause spills or runoff of toxic substances into Buzzards Bay;
- Contaminated sediments and shellfish from areas of Buzzards Bay that were contaminated through human activities and are awaiting completion of cleanup;
- Stormwater runoff from developed areas of the watershed where toxic substances are used, stored, transported, or fallout from the atmosphere;
- Agricultural activities involving the use of pesticides, fungicides, insecticides, herbicides;
- The use of fertilizers made from sewage sludge (these can contain high concentrations of heavy metals and organic pollutants);
- Landscaped areas, plant nurseries, and landscaping activities where pesticides, lawn care chemicals, and fertilizers are used or stored;
- Contaminated groundwater, surface water, or soils resulting from spills from underground storage tanks (USTs), industrial and commercial facilities and residences that use chemicals and fuel;
- MTBE-contaminated groundwater from service stations and refueling facilities;
- Transportation facilities where spills from fuel storage, refueling, and service activities have occurred or where runoff carries toxic substances into wetlands or water bodies;
- Wastewater treatment facilities that discharge secondary treated wastewater into wetlands or water bodies, and septic systems that discharge wastes containing toxic substances into groundwater;
- Utilities, industries, and vehicles that emit heavy metals, organic contaminants, nutrients, greenhouse gases, and other pollutants into the atmosphere, followed by fallout into Buzzards Bay and its watershed;
- Medical and research institutions that generate hazardous waste that is not properly disposed of;
- Household and institutional hazardous waste that is not properly disposed of;
- Leachate or spills of heavy metals and other contaminants from point sources such as waste management facilities and landfills;
- Explosives, lead, and other contaminants in soil and groundwater at munitions disposal sites and testing

[187] Massachusetts periodically updates the lists which are posted at: www.mass.gov/eea/agencies/massdep/water/watersheds/total-maximum-daily-loads-tmdls.html#2.

ranges (e.g., Massachusetts Military Reservation, Nomans); and

- Illegal dumpsites and discharges.

Studies suggest that toxic contaminants are contributing to the cumulative stress of aquatic and marine ecosystems. Outside of the Superfund sites, the human health and ecological impacts of the contaminants found within the Buzzards Bay watershed are still not well understood. In part, this is because existing data are not readily available and in part, because more information needs to be collected concerning sources, concentrations of contaminants generated by these sources, and the efficacy of existing state programs to mitigate or clean up contaminated materials.

Regulatory Programs

Toxic contamination is regulated through several national and state programs. Severe contamination involving highly toxic materials is regulated by the U.S. EPA Superfund Program (under CERCLIS and RCRA) and the Massachusetts DEP. The U.S. EPA regulates both shallow and deep underground injection wells under the federal Safe Drinking Water Act amendments of 1996 (underground injection control or UIC). Although there are no deep injection wells in Massachusetts, shallow injection wells used for disposal of industrial and commercial wastewater exist. The Massachusetts UIC regulations have been in place since 1982, and among the types of shallow injection wells of concern are floor drain discharges. Floor drain discharges are suspected of contaminating several water supplies in Massachusetts, and illicit floor drain discharges are not uncommon. The MA Division of Water Supply regulates and oversees injection wells, and provides guidance and assistance to owners of facilities with such discharges. The DEP Bureau of Waste Site Cleanup (BWSC) regulates underground storage tanks through its "Leaking UST Release Prevention Program" and requires operators of facilities that handle and store contaminants to prepare Spill Prevention Control Plans (SPCPs).

Point-source discharges above a certain discharge threshold require a permit from EPA's National Pollutant Discharge Elimination System (NPDES). Industrial outfalls require a NPDES permit, but most of these have been eliminated in the past 20 years, and most industrial and manufacturing flows discharge to municipal sewers rather than have their own outfall. The NPDES Phase II program now regulates nonpoint sources including stormwater runoff, and communities must develop and implement stormwater pollution prevention plans (SWPPPs) and other control measures under the Phase II program (see Action Plan 3 Managing Stormwater Runoff and Promoting LID). The U.S. Coast Guard oversees the emergency response to spills occurring on the water, and typically coordinates with local harbormasters, the DEP, and boards of health (see Action Plan 17 Preventing Oil Pollutio).

Section 305(b) of the federal Clean Water Act requires states to report to the EPA, Congress and the public on the water quality of freshwater and coastal water resources in terms of whether they support their designated uses such as aquatic life support, fish and shellfish consumption, drinking water supply, and recreation (swimming, boating). Section 303(d) of the Clean Water Act also requires states to list waters that do not meet water quality standards and schedule them for development of a TMDL. A TMDL (Total Maximum Daily Load) establishes the maximum amount of a pollutant that can be introduced into a water body and still allow attainment of water quality standards. A TMDL also allocates acceptable pollutant loads among all potential sources. The sum total of all pollutant load allocations, including point and nonpoint sources, natural background loads and a margin of safety, cannot exceed the total maximum allowable pollutant load calculated for the water body (See DEP's periodically updated Integrated List of Waters). States can submit an integrated list of waters under both Sections 305(b) and 303(d). The five categories of water quality classification are:

1) Unimpaired and not threatened for all designated uses;
2) Unimpaired for some uses and not assessed for others;
3) Insufficient information to make assessments for any uses;
4) Impaired or threatened for one or more uses but not needing a TMDL; and
5) Impaired or threatened for one or more uses and requiring a TMDL.

As mentioned above, Buzzards Bay has 13 freshwater, marine, and estuarine water bodies that are classified as Category 5 waters due to metal and/or organic pollutants.

Reducing the sources and generation of toxic pollutants represents one of the most cost-effective ways to control toxic pollution. Pollution prevention, which is defined as "source reduction and other practices that reduce or eliminate the creation of pollutants through increased efficiency in the use of raw materials, energy, water, or other resources, or protecting resources through conservation." Source reduction allows for the greatest and quickest improvements in environmental protection by avoiding the generation of waste and harmful emissions and discharges. Source reduction makes the regulatory system more efficient by reducing the need for end-of-pipe environmental control.[188] Reduction of toxic

[188] Modified from www.ecy.wa.gov/programs/hwtr/P2/whatisp2.html. See also Pollution Prevention Act of 1990 at: www.epa.gov/p2/pubs/p2policy/act1990.htm.

sources also reduces the need for mitigation of impacts due to toxic pollution.

The Buzzards Bay NEP's work on toxic pollution has been limited to two areas: 1) the indirect benefits of our stormwater remediation program, which, although focused on fecal coliform bacteria, also reduces the discharge of many toxic contaminants. 2) a toxics use reduction program for businesses in the greater New Bedford area.

In 1993, the Buzzards Bay NEP implemented the "Buzzards Bay NEP Toxics Use Reduction Program" (Buzzards Bay NEP/TURP) with four years of funding support from the EPA through the Toxics Use Reduction Act (TURA) program. A steering committee of local and state officials and representatives from volunteer monitoring groups led the effort. The program focused on providing outreach on the availability of technical resources for manufacturing and service sector businesses contributing waste streams to the New Bedford Publicly Owned Treatment Works (POTW), which treats municipal domestic and industrial wastewater. Outreach tools included a monthly newsletter ("Options") and workshops. Fifteen different workshops targeted local industries and their toxic use reduction needs. Topics included Materials Management and Chemical Reporting, Sustainable Manufacturing, Impacting Water Use, Clean Air Conference for Dry Cleaners, Metals Recovery and Abatement, Fats, Oils and Greases in the Waste Stream, Making Compliance Work for You, Pollution Prevention for Marinas and Boat Repair Facilities, Pollution Prevention Day, Solvent Degreasers, Wastewater Treatment in New Bedford, and BOD Discharge into the Waste Stream for Fish Processors.

The Buzzards Bay NEP Toxics Use Reduction Program has helped to reduce toxic pollution in significant ways:

- Businesses in the New Bedford area became aware of state regulations and technical assistance programs, including grant opportunities and awards.
- A pretreatment program for industrial wastewater at the New Bedford POTW and elimination of dry weather discharges was successful, resulting in dramatic reductions of toxic discharges to Buzzards Bay.
- The Buzzards Bay NEP TURP program helped a textile dye facility (Brittany Dye in New Bedford) to obtain a U.S. Department of Energy NICE[3] grant for $425,000 that enabled the business to modernize their textile production process, reduce toxic discharges, increase energy efficiency, and increase production.
- Containment of the PCB hot spot in New Bedford Harbor has helped to reduce dispersal of toxics into Buzzards Bay.
- Companies significantly reduced their toxic waste streams and several were recognized through the Governor's Award for Toxic Use Reduction.
- The program created a repository of useful information from EPA and state environmental agencies.
- The successes in New Bedford have raised awareness of the value of reducing toxics use and the environmental benefits of pollution prevention and waste reduction.

In 1997, the Buzzards Bay NEP ended its Toxic Use Reduction program due to cutbacks in federal funds. Nevertheless, there is a need to continue the Toxic Use Reduction program.

This action plan addresses control, management and reduction of toxic pollutants from a variety of point and nonpoint sources, including Superfund sites (excluding stormwater management, see Action Plan 3 Managing Stormwater Runoff and Promoting LID).

Many kinds of contaminants can harm ecosystems and/or humans. Scientists often divide contaminants into two major classes: 1) metals and other inorganic elements and compounds that lack carbon atoms, and 2) organic compounds characterized by having at least one carbon atom in their structure. Organic contaminants include hydrocarbons, petroleum products, organic solvents, pesticides, PCBs, dioxin, and many other substances that can harm living organisms, humans, and ecosystems through direct toxic effects on physiological functions. Since the 1940s, humans have released over 70,000 synthetic chemicals into the environment. Although there are many beneficial uses for these chemicals, their effects may include cancer, genetic changes, and birth defects in human and marine organisms. The EPA has designated certain contaminants as "Priority Pollutants" due to their toxicity to humans and ecosystems. These chemicals have multiple routes of entry into the aquatic and marine environment, which complicates identification of the relative contribution of toxicants from specific sources.

A second toxic contaminant category includes naturally formed biological toxins, such as the toxins formed by red tide-causing dinoflagellates, certain blue-green algae, and other harmful algae. For toxic substances, toxicity varies depending on the nature of the toxin or poison and how it affects physiology, the concentration (dose), the exposure mechanism, the species-specific sensitivity, and the speed at which the toxic effects become manifested.

A third contaminant category includes various substances that are not necessarily toxic at low concentrations but which may cause toxic impacts on aquatic ecosystems at higher concentrations or if they are suddenly introduced into an ecosystem. Examples in this category include road salt, de-icing agents, and additives to drinking water or wastewater (e.g., copper sulfate, alum, hydroxides, chlorine, others).

Yet a fourth contaminant category includes so-called "emerging pollutants"; that is, substances suspected of causing biological and/or ecological impacts but needing further research to confirm the extent of effects in nature (e.g., endocrine disrupting compounds or estrogens, found in many pharmaceuticals, personal care products, organic chemicals and wastewater; surfactants; and others).

Methyl-tertiary-butyl-ether (MTBE): MTBE was a gasoline additive that was required in order to increase fuel efficiency and cut down on internal combustion emissions to the atmosphere. However, the use of MTBE resulted in widespread MTBE contamination of groundwater throughout the nation due to its high mobility in groundwater. This unanticipated effect caused it to be withdrawn from use, but MTBE-contaminated groundwater plumes may exist in the Buzzards Bay watershed since they are common outside the watershed. Typically, such groundwater plumes are associated with refueling stations or activities where MTBE-fuel was formerly sold or utilized. The operation, maintenance, and sale of such facilities is subject to state standards, including the Massachusetts Contingency Plan (MCP) regulations, known as 21E, which require site investigations in the event of a spill or change of ownership.

Regulation of Toxic Contaminants

Broad changes in state policies and stricter state enforcement of discharges of toxic materials have resulted in a tremendous reduction in the use and discharge of toxic materials. In 1989, the Massachusetts legislature enacted the Massachusetts Toxics Use Reduction Act (TURA) to help the industrial and commercial sectors to reduce their use of toxic substances in order to reduce toxic contamination. TURA required Massachusetts companies and industries that use large quantities of toxic chemicals to inventory their toxics and to develop a plan to reduce toxics use and storage. Such companies were also required to evaluate their efforts and update their toxics use reduction plans every other year. TURA set the following goals for users of toxic substances:

- Reduce the generation of toxic waste by 50 percent statewide (this was accomplished in 1998);
- Establish toxics use reduction (TUR) as the preferred means for achieving compliance with federal and state environmental, public health, and work safety laws and regulations;
- Provide and maintain competitive advantages for Massachusetts businesses, both large and small, while advancing innovation in cleaner production techniques;
- Enhance and strengthen environmental law enforcement across the state; and
- Promote coordination and cooperation among all state agencies that administer toxics-related programs.

Toxic compounds regulated under TURA include those compounds listed in Section 313 of the Emergency Planning and Community Right to Know Act (EPCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or "Superfund"), excluding compounds that have been delisted by the Administrative Council on Toxics Use Reduction. There are more than 300 listed compounds (see "Massachusetts Toxics Use Reduction Act, Reportable Chemical List, at www.mass.gov/eea/docs/dep/toxics/laws/turadc.doc.

Other Pollution Prevention Approaches

Other pollution prevention approaches that help to reduce the waste stream of toxics include recycling of reusable solid waste and providing proper disposal facilities for household hazardous waste and used motor oil. Most communities in the Buzzards Bay watershed appear to provide recycling services (both curbside and/or central drop-off facility), which may vary from community to community in the type of recyclables collected. Not all communities provide central facilities for the drop-off of household hazardous wastes and used motor oil; hazardous waste drop-off facilities are located in Acushnet, Bourne, Dartmouth, Fairhaven, Falmouth, Massachusetts Military Reservation, New Bedford, and Rochester. A number of commercial auto service businesses also provide drop-off facilities for used oil, such as AutoZone (East Wareham, Fairhaven), Napa Auto Parts (Wareham, Falmouth), and others.

Major Issues

Some specific toxic contamination issues in Buzzards Bay are being addressed or reviewed by regulatory agencies. These include remediation of the Superfund site in the Upper Acushnet River and attention to sewage treatment problems in New Bedford. The latter includes development and implementation of a plan to better control combined sewer overflows, and aggressive pursuit of a pretreatment program. Ongoing review of NPDES permits allows for incorporation of best available technology or best management practices to reduce wastes in discharges. This technology-based approach must be balanced with water quality-based controls. Sometimes effluent limitations by themselves will not be stringent enough to meet water quality standards. In these cases, pollutant-specific standards will be necessary to achieve or maintain the beneficial uses of the bay.

Once toxic chemicals get into the marine environment, they are difficult to remove. EPA has already spent $250 million dollars on the New Bedford Harbor Superfund site cleanup, and under the current level of funding from the EPA Superfund, roughly, $15 million per year is spent. The cleanup strategy, which includes dredging with off-site disposal, and burying of less contaminated materials in the harbor in what are known as confined disposal facilities (CDFs), could take 30-45 years[189] to

[189] See www2.epa.gov/new-bedford-harbor. Last accessed October 11, 2013.

complete at a cost of $750 million[190] to 1.2 billion dollars[191].

Preventing contaminants from reaching the marine environment is cheaper and more protective. In 1989, Massachusetts passed a Toxics Use Reduction Act that required a 50% reduction of hazardous wastes in discharges by the year 1997 and provided for a funding mechanism to do so. This goal was met and even exceeded. While much of these reductions occurred because industries adapted and implemented water savings and toxics reduction programs, in places like New Bedford, some of these reductions were due to plant closings because of increasing water costs or economic downturns in manufacturing. A pilot project in the Taunton and Fall River areas was successful in reducing metal discharges from jewelry manufacturers. Other areas of the country have implemented toxic audit programs to assist small businesses and industries in reducing both the use and generation of toxic materials.

Toxic contaminants associate with particles and accumulate in the sediments, where they remain for long periods. Human activity or natural processes may bury, or resuspend these sediments. Marine organisms may eat sediments or contaminants may be absorbed directly across cell membranes with contact with water or sediments.

In 1993, Massachusetts adopted the Massachusetts Contingency Plan (MCP) and supporting regulations (310 CMR 40) to create a regulatory framework for cleaning up existing and future hazardous waste sites in Massachusetts. The purposes of the Massachusetts Contingency Plan are to "provide for the protection of health, safety, public welfare, and the environment by establishing requirements and procedures" for the cleanup and evaluation of hazardous waste sites.

It outlines the schedule and procedures to be followed at disposal sites to undertake necessary and appropriate response actions to provide protection of health, safety, public welfare and the environment. Massachusetts has adopted criteria for sediment contamination under the Massachusetts Contingency Plan. The development of chemical-specific cleanup standards for use under the Massachusetts Contingency Plan (MCP) represents an important piece of the effort to streamline the site assessment and remediation program. The MCP Numerical Standards provide a simple means to determine whether remediation is necessary at a site and when no further remedial response action is necessary.

There are a number of critical unknowns in defining risk to humans from eating contaminated seafood. Based on the conclusions from the Symposium on Chemically Contaminated Aquatic Food Resources and Human Cancer Risk held by the National Institute of Environmental Health Sciences, some basic approaches are available that are more appropriate than our past approaches. The recommendations include, but are not limited to, locating sources of carcinogens in water, suspended and deposited particles; identifying biochemical markers in seafood as indicators of organisms of concern; and pursuing specific research studies that link environmental neoplasms (cancerous tissues) to specific causes. Many of these recommendations require resources at a national level. Nonetheless, some of the actions will be of direct benefit to Buzzards Bay communities and are included in this section.

TURA facilities should continue to be monitored. Regarding statistics on compliance, DEP states[192], "Most TURA enforcement actions are taken out of DEP's Boston Office for failure to file a complete annual Toxics Use Report and/or bi-annual plans update. Below are numbers for the two most recent complete years (state fiscal years 2004 and 2005) for TURA reporting compliance:

For Fiscal Year 2004, 675 reports were reviewed, and 44 enforcement actions were undertaken, including: 35 lower level enforcement actions (i.e., notice of noncompliance); and nine higher level enforcement actions (i.e., administrative consent order with penalty) with $11,250 in penalties assessed.

For Fiscal Year 2005, 647 reports were reviewed, and 46 enforcement actions were undertaken, including: 37 lower level enforcement actions (i.e., notice of noncompliance); and 9 higher level enforcement actions (i.e., administrative consent order with penalty) with $27,250 in penalties assessed."

These statistics indicate that enforcement must continue to be done in order to ensure that companies subject to TURA comply with state and federal regulations.

In addition, TURA only applies to certain types of businesses that use more than threshold amounts of listed toxic chemicals (i.e., companies that manufacture or process 25,000 pounds per year or more of a listed chemical, and companies that use 10,000 pounds per year or more of a listed chemical) and have 10 or more employees. Other businesses or facilities that use less than the threshold amounts of toxic chemicals, particularly small businesses that have fewer than 10 employees, are not subject to TURA, and such types of businesses may be a significant but unknown source of toxics.

Despite the achievements of the Buzzards Bay NEP Toxics Use Reduction Program, federal funding cuts in

[190] 2009 state press release at: www.mass.gov/governor/pressoffice/pressreleases/2009/announcement-of-federal-stimulus-funding-for.html. Last accessed October 11 2013.

[191] 2010 cost estimate report at: www.epa.gov/region1/superfund/sites/newbedford/466839.pdf.

[192] DEP. 2006. Statistics on TURA compliance. DEP, One Winter Street, Boston, MA 02108, June 2006 and Personal communication John Fischer, Branch Chief, Waste and Toxics Planning, DEP.

1997 ended the program. There are many toxics issues that need to be addressed, including:

- Developing comprehensive standards for allowable concentrations of contaminants, including whole fuel mixtures of compounds, in fish and shellfish and in particular developing action levels for mixtures of toxic compounds (i.e., petroleum, fuel, oil, etc.);
- Eliminating boat waste oil;
- Reducing and eliminating hazardous leachate from landfills;
- Improving seafood-testing and regulation at the local, state, and federal levels to address a comprehensive array of toxic compounds;
- Meeting all local, state, and federal action levels for water and seafood;
- Expanding the existing state program for testing fresh water fish to all of the municipalities within the Buzzards Bay watershed in order to develop a regional "Fish Closure Map,"
- Improving enforcement of TURA requirements for inventorying and reporting;
- Inventorying non-TURA toxics sources for the purpose of managing these sources if necessary, and providing outreach and training to the stakeholders involved;
- Expanding the Buzzards Bay Toxics Use Reduction Act (TURA) program to other communities in the Buzzards Bay watershed;
- Ensuring that all communities have comprehensive, user-friendly programs for pickup, recycling, and proper disposal of household hazardous waste;
- Ensuring that all communities have drop-off facilities for residential hazardous wastes;
- Finalizing, adopting, and implementing sediment quality criteria to facilitate cleanup and/or mitigation and to prevent further degradation of sediment quality;
- Inventorying potential groundwater contamination from 21Es and other contaminated sites for evaluating whether remediation activities are helping to protect Buzzards Bay or whether remediation efforts need to be expanded;
- Comparing toxics releases from sources within the watershed and outside the watershed, to determine whether "interwatershed" or interstate actions are needed to address toxic pollution (For example: are activities conducted outside the Buzzards Bay watershed contributing to environmental decline within the watershed? Are emissions from outside the watershed resulting in atmospheric deposition of nutrients and pollutants in the watershed and in the bay?).

A special concern that was identified in the wastewater facility action plan, that is also relevant to this action plan, is new and emerging pollutants of concern, and the risk they may pose to Buzzards Bay and to humans through contamination of groundwater from septic systems. Examples include estrogen compounds (a.k.a. endocrine-disrupting compounds), surfactants, optical brighteners, drinking water disinfection by-products (e.g., trihalomethanes, other chlorination products), and other wastewater components. These compounds can affect development in both fish and humans. The presence of these contaminants in wastewater will likely become a significant management issue in the coming decades, as the scientific understanding of the impacts of the contaminants on the environment is better understood. EPA and DEP should continue to assemble information and data to better characterize and identify the risks.

In the 1990s, a Buzzards Bay Toxics Action Committee existed to develop strategies to reduce the discharge of toxic materials in the Buzzards Bay watershed. This group could be reconvened to organize this effort and provide outreach to businesses and the public concerning ways to reduce release of toxic materials in the environment, and to promote cost effective toxic material recycling and reclamation. This group could address areas that need more focus such as the hazards of eating contaminated seafood, including the potential hazards related to lack of comprehensive seafood testing for all contaminants of concern.

Management Approaches

Implementing this action plan is complex because it involves industry, residential activity, the choice of products and compounds used, and regulated and non-regulated business activities. However, across all these activities and sectors of the economy, pollution prevention is one of the most important methods for achieving the goals of the action plan.

The second most important element is to ensure proper disposal and recycling of toxic materials. For example, fishing vessel owners often discharge oily bilge water because existing collection services are too expensive. In this regard, DEP should fund the construction of a facility to collect bilge oil in New Bedford Harbor that accepts oily bilge water for recycling, and treats it at an affordable rate to boaters and the fishing fleet.

The failure to have a speedy cleanup of hazardous waste sites, especially federal superfund sites, remains an important need, as these cleanups have been unacceptably slow.

The increased incidence of pesticides in drinking water is a serious concern that needs to be addressed. The ultimate goal of pesticide management efforts should be to develop and implement strategies to minimize the use and potential off-site impacts of pesticides (including insecticides, herbicides, and fungicides) and fertilizers. The use of Integrated Pest Management (IPM) and alternative organic approaches should be encouraged for landscape maintenance for residential homeowners, golf courses, agriculture, landscapers, and institutional facilities. IPM outreach should focus on the cost benefits of using less fertilizer and pesticide and using appropriate chemicals in sensitive areas. The NRCS has an ongoing technical assistance program to train and help farmers to utilize IPM methods that minimize use of such chemicals.

One special concern in the Buzzards Bay watershed with its large acreage of cranberry bogs is the need to implement BMPs on flow-through cranberry bogs (that is, bogs where pesticide runoff cannot be adequately managed) to better separate and contain pesticide applications from the adjacent natural receiving waters. BMPs include berming and construction of stream bypasses.

NRCS and state environmental regulators should direct more efforts to educate other pesticide users because the use of pesticides and fertilizers is not limited to farmers. Examples include golf courses; landscaped areas of institutions, parks, schools and other public and private facilities; plant nurseries, etc.

MA EEA should coordinate with the Massachusetts Department of Public Health (DPH) to review the current seafood-testing program and develop recommendations for future actions. Other agencies that should participate in this effort include MA EEA, MA DPH, FDA, EPA, and the seafood industry.

The Buzzards Bay NEP can work with Buzzards Bay watershed communities to promote the implementation of industrial water use and toxics reduction programs. These efforts can be encouraged through directed technical assistance to water utilities, boards of health, planning boards, and by promoting a model water savings toxics reduction program. These efforts could also compliment Action Plan 10 Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies.

Watershed and environmental non-profits should help towns implement their outreach campaigns to homeowners to identify common household toxic and hazardous materials and provide guidance on proper disposal and safer alternatives. These efforts might include outreach materials, public service announcements, and website information.

Where requested by municipalities, the Buzzards Bay NEP could develop a detailed GIS database inventory and maps of active 21E, Superfund sites, other regulated sites with contaminated groundwater and surface water, and facilities with underground storage tanks (USTs). Much of this data can be assembled from databases in various agencies like MassGIS, DEP, and EPA. This inventory could be placed on line, which could assist local fire and emergency officials needing information after catastrophic events like hurricanes.

DEP should review opportunities to enforce existing regulations and develop new ones that would more effectively discourage the discharge of oily bilge water from ships and other vessels into the environment. Some consideration should be given to providing sufficient staff to undertake and enforce these requirements in the most polluted harbors of the Commonwealth. Implementation and enforcement may require legislation, but more importantly, DEP must work with municipalities to provide bilge oil collection facilities in each port.

DEP and EPA should require that marinas and other industrial facilities that handle or store hazardous wastes comply with Phase II Stormwater NPDES permits and regulations. Requirements include adopting control measures for nonpoint source pollution, spill prevention plans, and emergency response plans that incorporate spill response and spill control. There should be outreach targeting waterfront facilities that handle and/or store hazardous wastes, especially those without MSGP for stormwater.

Existing sediment quality criteria are varied and not consistently applied. There are currently no sediment quality criteria at the state or national level, despite abundant data concerning existing sediment quality and potential impacts of contaminants in sediments. The lack of criteria makes it impossible to evaluate and improve contaminated sediments outside of Superfund areas. Adoption of final sediment quality criteria, reflecting decades of research by NOAA, EPA, USGS, and others, and incorporating toxicity values and biological impacts of contaminated sediments would be important steps to meet the goals of this action plan.

DEP should establish sediment quality criteria with respect to toxic materials for beach nourishment projects, dredging, and dam removal projects in Buzzards Bay. This is important to prevent the spread of contamination through these projects. A draft policy was developed by CZM more than a decade ago, but was not implemented. There is sufficient guidance and science now to identify suitable sediment quality criteria, based on NOAA, EPA, USGS and other states' and other nations' draft and interim sediment quality guidance. These efforts also relate to seafood quality criteria for toxics.

In the face of limited staff resources and funding, DEP could evaluate and prioritize risks from point sources of pollution (e.g., waste handling facilities, discharges, landfills, etc.) to determine if measures are needed to manage these sources to protect water supplies, or to direct limited resources for enforcement and technical assistance.

NRCS and EPA should expand education and outreach programs to minimize the use of pesticides and fertilizers to reduce offsite impacts. Numerous entities are or can be involved with these efforts including UMass Extension, NRCS, lawn care products vendors and manufacturers, golf course managers, qualified consultants in IPM, BBAC (for municipal users), gardening clubs and associations, etc. For resource management areas, an implementation strategy might involve forming a steering committee composed of representatives from these sectors. An outreach strategy could be used to target and educate all pesticide users. Examples of outreach programs that encourage minimizing pesticides and fertilizers include Greenscapes (Massachusetts Bays Program), Falmouth Friendly Lawns, and programs developed by the Massachusetts Audubon Society and others.

All municipalities in the Buzzards Bay watershed should establish and implement a program of toxic-waste reduction for all industries and facilities that discharge directly into receiving waters (NPDES permits) or sewage treatment facilities, regardless of whether or not they meet TURA threshold criteria for regulation. Typically, public works and wastewater facility staff are involved in these projects, but other departments, like boards of health could be involved.

All municipalities in the Buzzards Bay watershed should ensure that facilities exist for the pickup and recycling of boat waste oil. Generally, private marinas provide this service, and municipalities should take steps to discourage any illicit disposal at public facilities. This problem is also mitigated when municipalities should have a program for collection and proper disposal of household hazardous waste on a continual basis. Most towns now have periodic toxic waste pickup days but funding for program expansion has not appeared. Many municipal waste transfer stations have permanent waste oil and fluorescent light collection facilities provided with no fee, and all municipalities should consider implementing such programs.

All watershed municipalities should adopt recycling programs that will reduce the amount of all recyclables sent to landfills and incinerators. Recycling programs help reduce the volume of materials sent to landfills and toxic materials recycling reduces the risks of toxic contamination of the environment.

DEP and EPA, with technical guidance from USGS regarding groundwater pathways, should periodically inspect all facilities that are required to prepare and implement Spill Prevention Control Plans, Spill Response Plans, Stormwater Pollution Prevention Plans, or NPDES Multi-sector General Permits in order to validate implementation of these various plans. Having up-to-date inventory of these facilities in GIS databases would help the agencies with these efforts. Local municipalities (boards of health, building inspectors) are trained to recognize facilities requiring such plans, and local regulations may also require spill prevention and response plans.

The Buzzards Bay NEP could work with state and federal agencies to better characterize and develop inventories of toxic contamination throughout the Buzzards Bay watershed to assist these agencies. As noted in the issues section, there is a need for water quality monitoring of streams, rivers, ponds and lakes and groundwater in the Buzzards Bay watershed for a wide range of toxic contaminants and those of emerging concern.

EPA, DEP, and the Buzzards Bay NEP should continue to assemble information and data to better characterize and identify the risks from new and emerging pollutants to determine if there is a need for managing them in Buzzards Bay based on risk of harm to ecosystems and/or humans. In the coming years, scientists and other experts must evaluate these issues and provide recommendations, including measures for incorporating and addressing new information.

A Buzzards Bay Toxics Action Committee could be reconvened to organize this effort and provide outreach to the public concerning the hazards of eating contaminated seafood, including the potential hazards related to lack of comprehensive seafood testing for all contaminants of concern.

Financial Approaches

The costs associated with implementing this action plan are as varied as the sectors and pollution sources that must be managed. One particularly expensive need is funding for the design, permitting, and construction, of an oily bilge water-collection and treatment facility in New Bedford, which will likely cost $500,000 to build, and tens of thousands of dollars per year to operate. The construction and operation of this facility could be funded by the Massachusetts Oil Spill Act fund, which collects fees on barge oil deliveries to fund spill response and oil spill prevention activities. With coordination between DEP and the New Bedford Harbor Development Commission and the City of New Bedford, this facility could be built within five years. Construction of this facility has long been recognized as an important need by the fishing vessel operators in New Bedford Harbor.

There are many other costs associated with this action plan. Hazardous material disposal collections are expensive, and municipalities can often only afford one collection event annually, if at all. There are costs to expand conventional recycling programs as well.

Monitoring Progress

The success of this action plan can be evaluated by the amount of hazardous materials collected, the concentration of toxic contaminants in wastewater facility discharges, and by various programmatic and management measures. These programmatic measures include whether public works have pretreatment programs to reduce contaminates from businesses and industries connected to their wastewater facilities, whether the acreage of flow through cranberry bogs is declining, whether the New Bedford Bilge Oil Collection Facility is built, whether sediment criteria for toxics are adopted, and whether there are more hazardous waste collection events.

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Action Plan 17 Preventing Oil Pollution

Problem

This action plan addresses catastrophic and chronic discharges of oil to Buzzards Bay and its surrounding watershed[193]. These discharges of petroleum products have caused environmental degradation of water quality and habitat. To minimize future catastrophic spills and their impacts, improved navigation protocols need to be implemented, and environmental responses must be made effective through training and planning. The cumulative inputs of small chronic discharges of hydrocarbons from boat engines, stormwater, fishing fleets, and other sources often do not receive the same level of attention as accidental spills, but these inputs are also important.

The 2003 Buzzards Bay oil spill resulted in the passage of the 2004 Massachusetts Oil Spill Prevention and Response Act (MOSPRA) and companion legislation. The Act, required among other things, pilots, tug escorts, and oil delivery fees to fund oil spill response planning and training. Certain legal disputes between the federal government and Commonwealth are unresolved.

Goals

Goal 17.1. Reduce the amount of petroleum hydrocarbons released to Buzzards Bay.

Goal 17.2. Prevent the occurrence of oil spills in Buzzards Bay, both large and small.

Goal 17.3. Minimize the environmental effects from oil inputs to Buzzards Bay.

Objectives

Objective 17.1. To promote a regional strategy for preventing oil spills and hydrocarbon discharges.

Objective 17.2. To promote a coordinated and effective regional strategy for responding to large oil spills.

Objective 17.3. To implement a source-reduction plan for chronic inputs of hydrocarbons into Buzzards Bay.

Objective 17.4. To provide adequate facilities for the collection of waste oil from cars and boats.

Objective 17.5. To take enforcement actions against the illegal discharge of oil.

Approaches

Reducing future hydrocarbon discharges and impacts to Buzzards Bay will require decreasing the likelihood of catastrophic spills, improving the cleanup effectiveness and response time when spills do occur, better monitoring impacts after spills, and reducing chronic hydrocarbon release, like those associated with stormwater discharges and vessel operation in Buzzards Bay.

The presence of escort tugs for all oil barges and improved navigation aids and tracking will minimize future oil spills. To reduce future impacts of oil spills that do occur, increased local availability of response equipment, installation of boom anchorages, improved training and coordination among municipalities, and periodic re-evaluation of response plans are continuing needs. Completion by NOAA of a water circulation oil spill trajectory model for Buzzards Bay will greatly improve predictions of the location of oil landings after a major spill. Installation of Physical Oceanographic Real-Time System (PORTS®), employed elsewhere around the country, will also assist with navigation, and spill model predictions. The state also needs to develop an oil spill damage assessment-monitoring plan, in collaboration with local universities and research centers, to establish a protocol to collect essential data quickly for the environmental damage assessments after a spill.

With respect to chronic discharges of oil, better treatment of permitted discharges, including stormwater, can further reduce hydrocarbon release. (Stormwater related hydrocarbon discharges are addressed further in Action Plan 3 Managing Stormwater Runoff and Promoting LID.) Strategies to reduce illicit discharges in New Bedford Harbor and Buzzards Bay may include remote camera monitoring of harbor activities and oil sheens, better enforcement, and services or a facility to collect oily bilge water from commercial vessels in the harbor. The increased use of 4-stroke engines will minimize hydrocarbon discharges from recreational boats. Municipalities can set an example by buying 4-stroke engines for harbormaster vessels. Local recycling programs and education remain important strategies.

Costs and Financing

Estimated costs for these approaches are NRDA monitoring plan development, ~$80,000; NOAA circulation model, ~$100,000; PORTS®, $1 million installation, $200,000 annual operating costs; program to minimize illicit discharges to New Bedford Harbor, ~$200,000 in capital and $200,000 annual operating costs. Some costs might be eligible for MOSPRA funding, others through state and federal grants or appropriations.

Measuring Success

The effectiveness of measures to reduce large spills may take years to evaluate. Numbers of reported sheens and oil recovered from bilge water can be used to track measures to reduce small spills. Adoption of regulations with hydrocarbon BMP requirements can be enumerated. Reductions of nonpoint sources of hydrocarbons can only be evaluated programmatically.

[193] The stormwater management and toxics reduction action plans compliment the goals and objectives of this action plan.

Background

Accidental Spills

Most past accidental discharges relate to the fact that Buzzards Bay is a major transit route for tanker and barge traffic transporting heating and industrial oil and gasoline into Boston and northern New England markets Ssee Hampson (2000) and other citations in the references section that describe the locations and impacts of Buzzards Bay spills. The Army Corps of Engineers reported that during 2005, 1189 cargo vessels passed through the Cape Cod Canal. Among those vessels were tankers and tank barges that transported 8,534 short tons or roughly 2.1 billion gallons[194] of petroleum products, equaling 78% of the total commodity tonnage passing through the canal (Figure 101). During that same year, vessels transported 235 tons or 75 million gallons of petroleum products in and out of the port of New Bedford. In past decades, oil commodity transport through Buzzards Bay was as much as 50% greater than these totals.

From this level of activity, it is therefore not surprising that Buzzards Bay has been the site of several large oil spills (Table 48). The largest of these spills was the 1969 *Florida* spill off West Falmouth, spilling 189,000 gallons[195] of No. 2 fuel oil. Most recently, in April 2003, the Bouchard No. 120 tank barge ran aground near the entrance of Buzzards Bay, spilling an estimated 98,000 gallons of No. 6 fuel oil (summarized to the right). This latter spill prompted important changes in state laws and federal navigation regulations.

Oil spills impact mobile and stationary organisms, sensitive species, and vulnerable life stages, including eggs, larvae, and juveniles. If a spill occurs in a small, confined embayment so that oil is unable to escape, damage is heavier than with offshore spills. However, winds and currents can push oil into any harbor or embayment, exacerbating environmental impacts. Bathing beaches and nearshore shellfish areas are often among the most vulnerable areas.

Immediately after a spill, certain species may exhibit high mortality. For organisms that survive, short-term stress and impaired metabolism may affect the ability of populations to reproduce and maintain themselves. Scientists have observed long-term impacts on populations and ecosystems where toxic hydrocarbons persist. For example, thirty-eight years after the 1969 West Falmouth oil spill, (Peacock et al., 2007) observed oil residues and

[194] This is an approximate estimate based on a weighted average of the volumes reported of various constituents like gasoline (350 gallons per ton), residential fuel oil (307 gallons per ton) and other heavier constituents.

[195] The volume of the Florida No. 2 fuel oil spill was repeatedly misreported in a number of publications during the 1960s and 1970s because of conversion errors. The final volume reported to Congress in a 1975 report was 4,500 barrels. see buzzardsbay.org/pastspills.htm.

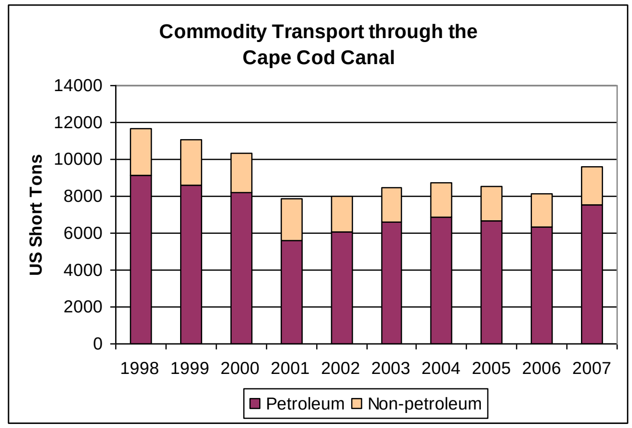

Figure 101. Commodity transport through the Cape Cod Canal.

Source: Prepared by the Buzzards Bay NEP from data posted by the Waterborne Commerce Statistics Center at www.iwr.usace.army.mil/About/TechnicalCenters/WCSCWaterborneCommerceStatisticsCenter.aspx.

Overview of the *Bouchard 120* oil spill

On Sunday, April 27, 2003, the tank barge Bouchard No. 120 struck rocks south of Westport, MA, when it passed on the wrong side of a navigational marker at the entrance of Buzzards Bay. The resulting 12-foot gash on the bottom of the hull released an estimated 98,000 gallons of Number 6 fuel oil in Buzzards Bay. The vessel was on route to deliver oil at the Mirant electricity generation facility located on the Cape Cod Canal.

A large fraction of the released oil washed ashore on the beach at Barneys Joy in Dartmouth the next day, but because of shifting winds and rough seas in the days following the spill, oil continued to wash ashore for more than two weeks eventually landing on more than 90 miles of shoreline. The spill impacted a variety of natural resources, including wildlife (mostly birds, with 500 found dead, including Roseate Terns, a U.S. endangered species), salt marshes, rocky shorelines, recreational beaches, and shellfish beds, which were closed for many months after the spill to protect human health.

The U.S. Coast Guard, which oversaw the emergency response phase of the cleanup, terminated this phase of the cleanup in September 2003. Non-emergency cleanup activities continued after that date under the Massachusetts hazardous waste spill laws, through a required Massachusetts Contingency Plan. Most areas were cleaned pursuant to the Massachusetts law by 2004, but cleanup activities continued at a small number of difficult sites through the fall of 2007.

Separate from the state and federal clean-up activities (estimated to have cost more than $40 million dollars) and from the $7 million dollars in fines levied by the federal government in 2004 (as part of a criminal liability settlement), the Natural Resource Damage Assessment (NRDA) has been ongoing, and has involved state and federal scientists reviewing all the data associated with the spill to determine the full extent of environmental impacts and damages. Based on the findings of the NRDA to date, in 2010 a partial $6 million dollar settlement was agreed to, and additional environmental restoration actions or compensation may be required by the responsible party, the Bouchard Transport Company, for damages to certain endangered species. The NRDA process is expected to be complete by 2014.

identified impacts from previously oiled salt marsh sediments.

The type of oil released greatly influences ecosystem response and human impacts. The *Bouchard 120* spill of No. 6 fuel oil killed hundreds of birds, and affected more than 93 miles of coastline, but had little impact on fish and invertebrates in the water or in subtidal areas. In contrast, the No 2 oil spilled in Falmouth in 1969 released many highly toxic compounds in the water, and killed many fish and invertebrates, but this oil affected fewer birds (Figure 102).

Chronic small spills and discharges

Although not as conspicuous in the mind of residents and politicians, the cumulative discharge of hydrocarbons from chronic spills and discharges, may exceed, on average, most catastrophic spills in Buzzards Bay[196]. These discharges are associated with smaller land spills and water-based spills as well as chronic discharges associated with stormwater, CSOs, industrial discharges, boat fueling facilities, improper waste oil disposal, and oil and fuel contamination of boat bilge compartments may be appreciable. While industrial pretreatment programs, together with more stringent limits in NPDES permits, have reduced contributions, cumulative discharges from other sources remain sizable.

Successes since the 1991 Buzzards Bay CCMP

Various entities implemented many of the oil spill recommendations in the 1991 Buzzards Bay CCMP during the 1990s (next page). The grounding of two large vessels in Buzzards Bay in 1990 to some degree prompted the 1991 Buzzards Bay CCMP oil spill action plan and initiated actions to plan for and minimize future spills. The first of these was the grounding of the 617-foot luxury ocean liner the Bermuda Star on June 10 at Cleveland Ledge, releasing 6000 gallons of No. 6 fuel oil. The second near disaster occurred on June 18, when the Bouchard tank barge No. 145, carrying 5.3 million gallons of No. 2 oil, grounded in the same area.

These events, together with the 1993 grounding of the Queen Elizabeth II, led the Buzzards Bay Coalition to advocate for changes in federal and state navigation requirements and the Buzzards Bay Action Committee to establish mutual aid agreements. The BBAC also began holding meetings and training sessions to improve the coordination of oil spill response among Buzzards Bay municipalities. At the same time, the Buzzards Bay NEP, through its municipal grant program, began to fund the purchase of oil spill containment equipment and training classes.

Table 47. 1991 Oil Spill Action Plan accomplishments up to the 2003 *Bouchard* oil spill

1990-1994: The Buzzards Bay Coalition makes calls for new regulations, pilotage requirements, and better navigation aids for Buzzards Bay.

1991: Buzzards Bay NEP begins awarding funds for oil spill containment equipment; BBAC forms a workgroup of oil spill first responders.

1993: BBAC fulfills a key Buzzards Bay CCMP recommendation of increased coordination of first responders by the signing of a Buzzards Bay mutual aid agreement among Buzzards Bay communities. Oil spill coordinators beginning holding oil spill response training.

1993: Coalition supports federal shipping rule change to require pilots on foreign vessels.

1994: BBAC organizes hazmat training sessions for all oil spill responders. The Coalition pushes for pilot requirements for transport through the Cape Cod Canal by foreign vessels which are exempt from the requirement.

1994: The Massachusetts legislature amends Section 28 of Chapter 103 of the Massachusetts General Laws, as called for by the Buzzards Bay Coalition and Buzzards Bay municipalities, to require pilots on foreign vessels, to require pilots 10 miles in advance of the Cleveland Ledge (the site of many accidents), require pilots aboard vessels (prohibiting onshore pilotage), and raising fines from $50 to $10,000.

1995: Coalition and shipping industry fight against the proposed closure of the Buzzards Bay light tower by the U.S. Coast Guard. The Coast Guard agrees to instead replace it with a new tower, Congressman Studds helps allocate $1.2 million dollars for its upgrade.

1996: DEP develops policies on the use of oil spill dispersants, effectively prohibiting their use in Buzzards Bay.

1994-1996: Coalition pushes for pilot requirement for transport through the Cape Cod Canal by foreign vessels, which are exempt from the requirement.

1997: BBAC proposes new legislation relating to fueling of vessels, but legislation does not advance.

1998: Buzzards Bay NEP hires Massachusetts Maritime Academy to help train local first responders.

2001: The BBAC updates its 1998 Buzzards Bay Municipal Oil Spill Response Manual identifying protocols, contacts, and access points for Buzzards Bay first responders.

By 2003, Buzzards Bay NEP grants for oil spill containment equipment and training approach $100,000. Municipalities use most of this equipment in the April 2003 oil spill. In 2004, the Buzzards Bay NEP suspends funding grants in this category when DEP agrees to pay for this training, and provide oil spill containment equipment and trailers for each Buzzards Bay coastal community out of fees collected in the 2004 Massachusetts Oil Spill Act.

[196] Based on an assessment of oil pollution in the 1991 Buzzards Bay Comprehensive Conservation and Management Plan, between 1969 and 1989, more than 1600 tons of petroleum entered Buzzards Bay from oil spills. During the same 20-year period, it was estimated that more than 2,000 tons of hydrocarbons were discharged into Buzzards Bay from other sources including sewage effluent, stormwater runoff, and industrial effluent. Since 1989, both chronic discharges and catastrophic discharges have declined dramatically, and there has not been a new evaluation of these sources.

Table 48. Past oil spills in Buzzards Bay.

Date	Vessel Name	Vessel Type	Location	Type	Volume Spilled (gallons)	Comments
14-Nov-63	***Dynafuel***	Tank Barge	Collision occurred between Mishaum Point Dartmouth and Cuttyhunk. The empty barge sank off New Bedford while under tow.	No. 2 Fuel Oil	unknown; probably residual oil from sunk-en tank barge	A 1970s scientific report notes oil came ashore near Nyes Neck, North Falmouth, during the winter of 1963. This may have been the result of collision of the Norwegian freighter *Fernview* with the with the empty tank barge *Dynafuel*. The vessels were locked together and caught fire. The empty barge sank in 40 feet of water.
16-Sep-69	***Florida***	Tank Barge	Fassets Point, West Falmouth	No. 2 Fuel Oil	189,000	Final estimate was 4,500 barrels spilled.
9-Oct-74	***Bouchard 65***	Tank Barge	Cleveland Ledge (near canal entrance)	No. 2 Fuel Oil	7,500-36,500	Hampson and Moul (1978) list the spill as indeterminate volume, but this may not reflect actual USCG reports. A 1975 article suggests 7,500 gallons, Town of Bourne Annual Reports imply 40,000 gallons or less. In 2001, Cape Cod Times suggest 25,000 gallons. In the NOAA report "Polluting Incident Compendium Part iii – Historic Spills: 1969 - 1993, it is noted that In 1974, Massachusetts had 110 spills recorded spill, the largest of which was 21,000 gallons. Another USCG document lists 36,500 barrels, but the units likely should have stated gallons.
28-Jan-77	***Bouchard 65***	Tank Barge	Cleveland Ledge	No. 2 Fuel Oil	81,144	Barge grounded, oil spilled on ice covered bay, some burned. Final estimate was 81,144 gallons (1,932 barrels) spilled, although initial press reports suggested 500,000 gallons spilled. The grounding ruptured four of the seven tanks.
2-Aug-77	unknown	unknown	Canal	No. 6 Fuel Oil	550	As reported in the 1977 Annual Report of the Town of Bourne (pg. 91) where 6 oil spills are listed as having occurred during 1977 in Town of Bourne waters. Four of those spills appear to be minor, with spill volumes listed as unknown.
1-Apr-78	***Rhode Island***	Tank Barge	Cape Cod Canal near Bourne Bridge	No. 2 Fuel Oil	6,000	Barge was carrying 77,300 gallons. Volume reported as 6,000 liters by Farrington et al.(1982).
24-Jan-85	***Barge Corpus Christi***	Tank Barge	South of Cleveland Ledge	No. 2 Fuel Oil	50-100	3x4 hole, anchored at Buoy 11.
30-Oct-85	***M/V Sun Bird***	Cargo Ship	Wilkes Ledge, off Mishaum, Dartmouth	No. 4 Fuel Oil	2,500	A 310-foot cargo ship out of Japan hit a shoal, causing a 2x20-foot long gash that ruptured a central fuel tank.
17-Sep-86	***T/B ST-85***	Tank Barge	Cleveland Ledge	Gasoline	119,740	Tank barge under tow by the tug *Seastar*, grounded. Two port tanks were damaged, including a gash 60 feet long. Initial gasoline losses were estimated at 23,000 gallons, subsequent summaries list the spill as 119,740 gallons.
10-Jun-90	***Bermuda Star***	Cruise Ship	Cleveland Ledge	No. 6 Fuel Oil	7,500	Cruise ship went aground, impacts to Naushon. Incident news has erroneous entry for a Burma Starr on June 11 with 110,000 gallons of number (actually the vessel fuel oil capacity).
18-Jun-90	***Bouchard 145***	Tank Barge	Cleveland Ledge	Diesel oil or heating oil	100-200	Navigational error, veered off course in fog. The 475-foot barge was loaded with 5 million gallons.
7-Aug-92	***Queen Eliza-beth II***	Cruise Ship	Sow and Pigs Reef, Cut-tyhunk	No. 6? Fuel Oil	50	Empty fuel tank that was ruptured, spill from residual oil.
27-Apr-03	***Bouchard No. 120***	Tank Barge	Entrance to Buzzards Bay	No. 6 Fuel Oil	98,000	Vessel travelling 6 knots 1/4 mile outside of lane marker.
9-Nov-08	***Southern Cross***	Tugboat	Dartmouth waters, south Buzzards Bay	Diesel	110	Tugboat grounding and partial sinking.
20-Mar-13	***Justice***	Tugboat	Stony Point, Wareham	Hydraulic Oil	330	The 93-foot tugboat lost its lower starboard drive unit, and the unit leaked 300 gallons of the 625 gallons of hydraulic oil contained within it.

This table does not include small less well-documented spills prior to 1990. Spills prior to 1982 are generally poorly documented, and it was not until after 1990 that natural resource damage assessment studies were undertaken. The summary also does not include land-based spills reaching the bay. For example, on February 7, 1975, five thousand gallons of home heating oil spilled into Sippican Harbor Marion (Boston Globe, Feb. 8, 1975, pg. 20). An entry for a fuel oil spill in southern Buzzards Bay during the 1940s was deleted from this table. This entry may have been confused with the sinking of the coal barge Joseph J. Hock sinking off Penikese on Jan 22, 1947, after striking and breaking tow at Hen and Chicks. Additional information relating to this table is available at buzzardsbay.org/pastspills.htm.

Original 1991 Action Plan: Preventing Oil Pollution

Goals

1. Reduce the amount of petroleum hydrocarbons entering Buzzards Bay.
2. Minimize the occurrence of oil spills in Buzzards Bay, both large and small.
3. Minimize the environmental effects from oil inputs to Buzzards Bay.

Objectives

1. To promote a regional strategy for preventing and managing oil spills.
2. To implement a source-reduction plan for chronic inputs of PAHs to Buzzards Bay.
3. To provide adequate facilities for the collection of waste oil from cars and boats.
4. To take enforcement actions against the illegal discharge of oil.

CCMP Commitments

The Coastal Zone Management Office (CZM)

1. CZM will provide technical assistance to Buzzards Bay communities developing contingency plans in each municipality.
2. CZM will encourage the satisfactory completion of oil spill contingency plans by each municipality.

The Buzzards Bay Action Committee (BBAC)

1. BBAC will ensure that each municipality appoints an oil spill coordinator responsible for overseeing maintenance and deployment of equipment and for directing response activities.
2. BBAC will develop a mutual aid protocol that will govern the purchase and use of oil spill equipment by the towns.
3. BBAC will work with MassDEP to develop model regulations that will: a) require all boatyards and marinas to maintain oil containment and cleanup equipment on site; and b) manage the appropriate fueling of vessels.

The U.S. Coast Guard

1. The Coast Guard will conduct training sessions on the use of oil spill equipment and other contingency plan activities for all Buzzards Bay towns once a year.
2. The Coast Guard will review and approve each municipality's contingency plan and utilize those plans in the event of a spill.
3. The Coast Guard will advise municipalities on the appropriate spill equipment that should be maintained.

Buzzards Bay Municipalities

1. Falmouth, Bourne, Wareham, Marion, Mattapoisett, Fairhaven, New Bedford, Dartmouth, and Westport have appointed oil spill coordinators, some of whom are developing local contingency plans.
2. Marion (through its Marine Resources Commission) is working with the boatyards and marinas to ensure they maintain adequate oil response equipment.
3. The Buzzards Bay Coalition will continue to work with state legislators to re-file a bill in December 1991 that addresses oil spill prevention including: pilot accountability language, better pilot testing and training including recertification on a regular basis, and pilotage requirements in the upper portions of Buzzards Bay and the Cape Cod Canal. An early version of the bill was filed in December 1990 but was not voted upon.

Other Recommended CCMP Actions

1. To reduce the impact of future spills, DEP should coordinate annual regional oil spill response drills for Buzzards Bay communities on land, to ensure preparedness and proper interface between themselves and local personnel.
2. All other communities should require all boatyards and marinas to have specified response equipment on site.
3. All levels of government should adopt a policy to minimize or reduce oil entering the bay.
4. Municipalities should require performance standards for catch basins that remove oil and grease and implement a maintenance program.
5. Enforcement Task Force of the Executive Office of Environmental Affairs should enforce proper storage and disposal of oil.
6. Buzzards Bay communities should adopt regulations managing fueling of vessels; regulations should include a provision requiring booms and absorbent material available at all fuel loading facilities.
7. The state should develop a policy and criteria for the use of dispersants in Buzzards Bay during oil spills.
8. DEP should adopt a policy for treating stormwater by requiring oil and gas traps, absorbent pads, and regular catch-basin maintenance.
9. The Coast Guard should install a more effective navigational system at the western entrance of the Cape Cod Canal.

Photo credits, left: Joe Costa; right: George Hampson

Figure 102. Impacts of heavy versus light fuel oil spills.

Left: Heavy viscous oils, like the No. 6 fuel oil that spilled from the Bouchard Tank Barge 120 into Buzzards Bay in 2003, primarily killed birds, plants, and animals by physical contact. Photo shows dead cormorant. In contrast to the Bouchard spill, the No. 2 home heating oil that spilled in 1974 from the Bouchard Tank Barge 65 in Buzzards Bay was far more devastating to aquatic species (right photo fish and invertebrates like worms, crustaceans, and mollusks) because of toxic soluble compounds in the oil.

After the January 1996 grounding of the barge North Cape off Moonstone Beach and its disastrous effects on Rhode Island waters, concerns about oils spills and the need for local oil spill preparedness continued to prompt action by all three Buzzards Bay groups. Table 47 summarizes these activities.

Collectively, these actions likely helped minimize the frequency of catastrophic accidents in Buzzards Bay, and helped ensure a high degree of success in local first responders minimizing impacts to the 2003 *Bouchard 120* oil spill. But despite these successes, the 2003 *Bouchard* spill illustrated that such accidents can and will continue to happen because of human error or negligence, and that many navigational and response issues remain.

State and local government and industry have reduced chronic discharges of petroleum products as well. In the 1990s, the City of New Bedford implemented an industrial pretreatment program to reduce inflows of oils, PAHs, and other toxic compounds to its wastewater treatment system and combined sewer overflow infrastructure. The effectiveness of these programs has been documented by the dramatic declines in toxic contaminant levels in the City's effluent discharges including petroleum products. The fact that DEP has reclassified the sludge from the wastewater facility from Class 3 to Class 1, enabling its use for fertilizer and soil amendments in public areas, illustrates the success of these programs.

Another area identified as a problem in the 1991 Buzzards Bay CCMP has met with less success. Commercial fishing vessels, which operate mostly out of New Bedford but also Westport, usually have their engine oil changed (10-120 gallons per boat) after practically every trip. It was believed that the inconvenience and the expense (at the time about 30 cents per gallon, today one dollar or more) of safely disposing of waste oil or contaminated bilge water, was believed to have resulted in a number of boat operators blatantly dumping oil into the bay or offshore waters. Although this is illegal, it is difficult to document violations and hence take enforcement actions against the appropriate fishing boats. The Coast Guard and DEP believe that contaminated bilge water is the principal cause of the frequent sheens that appear in New Bedford Harbor. Convenience and expense in disposing of waste oil may also be a problem for the general boating public but oil changes in small launched boats are much less common.

To address this problem, the City of New Bedford adopted some policy changes in the early 1990s prohibiting the storage of waste oil in barrels on docks, and to require locks on dumpsters, as well as promoting oil reclamation education through the fishing coop. These actions helped, and the fishing coop's actions helped increase the volume of waste oil collected in the harbor. Nevertheless, some waste oil, particularly the oil accumulating in bilge compartments, might still be dumped at sea.

In the 1990s, the Buzzards Bay NEP renewed calls to the City to provide adequate facilities and provide further incentives for the collection of waste oil and contaminated bilge water. In 1998 the Buzzards Bay NEP, in partnership with the City of New Bedford, and with enthusiastic support from the fishing industry, wrote grant proposals and obtained funding from DEP's 319 grant, CZM's CPR program, and from the Massachusetts Environmental Trust to build a bilge oil reclamation facility for New Bedford Harbor. Initially regulators delayed the project because of prohibitions against siting a reclamation facility for bilge oil away from the harbor, and because of issues related to the transport of the oil, which is classified as a hazardous material. The City, agreeing to find a new site on the waterfront, overcame this issue. However, by the time the City of New Bedford acquired the site, it had second thoughts about the long-term costs of operating the facility and canceled the project, despite the ongoing need for such a facility in the harbor.

In 2013, the Buzzards Bay Coalition revisited the issue of chronic sheens in the harbor[197]. They concluded that a multi-pronged approach involving remote camera monitoring of harbor activities and oil sheens, better enforcement, and subsidized services to collect oily bilge water from commercial vessels in the harbor might be the most cost effective approach in reducing chronic harbor hydrocarbon discharges.

This action plan primarily addresses oil spills and oil from stormwater discharges. We address industrial and municipal discharges of oil and other toxics in the toxics reduction and managing sewage treatment facilities action plans.

Oil Spill Response and Framework

Today, the Oil Pollution Act (OPA) of 1990 largely defines how the federal government responds to oil spills. This law, prompted in part by the Exxon Valdez oil spill in Alaska, both streamlined and strengthened the federal government's ability to prevent and respond to catastrophic oil spills. It also levied a tax on oil to establish a trust fund to provide funds to enable emergency response teams to hire immediately personnel needed to respond to these disasters, including when the responsible party is incapable or unwilling to do so. The law also required the use of double hull oil transport vessels by 2015 for transporting oil, and imposed requirements relating to vessel manning, training, alcohol, and drug screening, standards for foreign tankers, vessel traffic and communications systems, and oil spill contingency plans for oil spill haulers and storage facilities.

One of the most important aspects of OPA is that it established and defined the response and responsibilities of government and the party responsible for the spill, and addressed a number of issues including liability and compensation. The Act also requires that the Coast Guard -- the federal agency that is the lead for ocean spills -- maintain a computer file of available spill containment and cleanup equipment, and create Area Contingency Plans.

In related legislation, under the U.S. Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) in effect since 1986, those who spill hazardous substances, including oil, must pay cleanup costs. The federal government and the states, in their roles as trustees, can claim damages for injuries to natural resources.

Massachusetts' companion spill cleanup legislation is found in the Massachusetts Oil and Hazardous Material Release Prevention and Response Act (MGL 21E), and supporting regulations (310 CMR 40). This law essentially picks up cleanup issues where the federal laws and regulations jurisdiction ends. Whenever there is a spill of oil or hazardous material in Massachusetts, the "Massachusetts Contingency Plan" regulations define the cleanup process and establish cleanup "endpoints." The Massachusetts Department of Environmental Protection

> Town of Harwich Fueling Regulations
>
> 3.04: FUELING AREA REGULATIONS
>
> All boats must fuel at a legally operated fuel dock or at a place where fueling has been authorized by the fire chief. The only exception to this rule is the fueling of commercial vessels having offloading permits, who shall only take fuel from tank trucks (diesel only) with a permit to fuel at designated areas. Any other fueling operations will be unlawful and violators will be subject to arrest.
>
> SMOKING IS ABSOLUTELY PROHIBITED IN A FUELING AREA.
>
> TO ALL SERVICE STATIONS 527 CMR 5 AND 8.
>
> 1. No smoking will be enforced while gasoline is being pumped. This applies to occupants of the boats as well as those outside. Signs must be posted in accordance with State requirements.
>
> 2. All motors shall be shut off while refueling.
>
> 3. All portable containers must be approved by the State Fire Marshall's Office. At present U.L. Standard 30 and F.M. Standard 6051 and 6502 meet the requirements.
>
> 4. No portable container shall have more than 7 gallon capacity and the total gallons must not exceed 21 gallons, unless a permit has been issued for transportation of Class A liquids.
>
> 5. Class A products may only be transported in an open vehicle or in a compartment of a closed vehicle separated from the passengers.
>
> 6. Attendants will have complete control when dispensing flammable liquids.
>
> 7. All extinguishers and fire suppression systems will have annual inspection.
>
> 8. In the case of a leak or spill the Fire Department will be notified. No leaks are to be washed away. Speedy dry will be used to pick up any spills.
>
> 9. Self-service operations are not allowed on the water.
>
> 10. No hold open devices may be used on self-service nozzles. Flow must be maintained by hand contact on the part of the person filling the vessel.
>
> Any person who knowingly violates any rule or regulation made by the board of fire prevention shall, except as otherwise provided, be punished by a fine of not less than one hundred dollars nor more than one thousand dollars (GL 148 S10 C.).

[197] Presentation at the Massachusetts Oil Spill Prevention and Response Act (MOSPRA) Advisory Committee meeting October 23, 2013.

(DEP) enforces the cleanup process defined in the Massachusetts Contingency Plan (MCP). An important provision of the Massachusetts Statute (Chapter 21E and regulations in the MCP) require the responsible party to hire an environmental specialist called a Licensed Site Professional (LSP) to direct assessment and cleanup activities in response to a release to the environment.

Once a spill has occurred, the principal factor in minimizing environmental damage is speed of response. Oil spreads rapidly, dispersing through the water column, making clean-up efforts more difficult, and eventually contaminates sediments. Cleanup effectiveness diminishes over time as weather disperses the oil. Most often, emergency responders recover not more than 10-20% of the spilled oil. In the case of the World Prodigy spill in Narragansett Bay, which was generally considered a successful operation, only 10% of the spilled product was recovered. In this spill, most of the lighter hydrocarbons evaporated, but substantial amounts entered coastal sediments, beaches, flats and marshes. With such low recovery rates typical in most spills, emphasis should be on prevention and speedy response. It is vital that the logistics be in place so that when an incident occurs, it is clear who to call, where equipment is located, and which cleanup methods are appropriate.

Response to the problem of oil spills generally falls into three categories: prevention, early response, and mitigation. As long as oil is used as an energy source spills will not be eliminated. Therefore, policy makers should pursue a dual effort of reducing the occurrence of spills and preparing to limit their damage. Mandating safety procedures and safety features on equipment used for storage, transport, and handling of oil may reduce the number of spills.

Separate from the emergency response and cleanup actions of an oil spill, state and federal agencies conduct an after-the-fact evaluation of spill impacts on the environment referred to as the Natural Resources Damage Assessment (NRDA). The Oil Pollution Act of 1990 established the NRDA process. The objective of this process is to restore coastal and marine resources injured by releases of oil, and to obtain compensation for the lost use and enjoyment of these resources by the public. The law requires the assessment of both environmental and indirect economic impacts.

After an oil spill, the state and federal government establish a board of trustees to oversee the NRDA process (state and federal agencies, any Indian tribes, etc.). These trustees guide scientists, economists, restoration experts, and attorneys on the collection of data during the emergency phase of the spill and after, until the damage assessment is finalized. The trustees use this data for the damage assessment, and to help protect resources during the cleanup or remediation activities. Collectively the trustees utilize this data to determine the full extent and magnitude of environmental injuries and lost services, and to define the type and scope of restoration best suited to address these injuries and lost services. These trustees also oversee and approve implementation of restoration activities. The responsible parties can undertake proposed restoration projects, or they can "cash out" and provide funds to the trustees to implement those agreed upon restoration efforts.

After the 1996 North Cape oil spill in Rhode Island, officials in that state discovered that important information about the impacts of the oil spill was not collected in a meaningful way for use in the NRDA process. This is a common problem with catastrophic spills because government officials are initially focusing on containing the extent and impact of the spill during the emergency response phase of a spill, and they are less focused on systematically documenting the physical extent of oil landings or inventorying invertebrate and vertebrate species mortality in a systematic and scientifically meaningful way. Key information, like hydrocarbon concentrations in the water column, is not collected because state managers, who might not have worked on a catastrophic spill, do not realize that this information is invaluable in the months or years of the subsequent NRDA process. In the absence of such data, scientists must instead use computer models to estimate mortality of aquatic species such as fish and crustaceans, including their planktonic juvenile forms.

Because of this issue, the Rhode Island Department of Environmental Management brought together scientists to identify and develop recommendations to address this problem. In 1996, after the North Cape oil spill in Rhode Island, the Rhode Island state legislature created the Oil Spill Prevention Administration and Response Fund[198]. One of the uses of these funds was to prepare documents outlining what each state agency must do in the event of a spill to ensure that the state collect the right scientific information for the damage assessment. One documented objective was to "collect and document needed ephemeral data during the first few days after the spill, that might be overlooked or lost otherwise."[199]

The *Bouchard 120* spill had some similar problems. In the absence of actual measured hydrocarbon concentrations in the water column, the Aquatic Resources Technical Workgroup had to rely on computer models of toxicity. These models were inadequate to evaluate toxicity of oil in shallow nearshore areas however. Similarly, the shoreline technical workgroup had to estimate the extent of the area of stranded oil (footprint) on beaches

[198] The fund now receives 5 cents per barrel fee on petroleum products received at marine terminals in Rhode Island. The purpose of fund in part is to help the state promptly respond to contain and remediate oil spills, as well as to take prevention measures.

[199] ASA 2003. Protocols for oil spill modeling. Prepared for RIOST RI Oil Spill Science Team. Retrieved from www.dem.ri.gov/topics/erp/app2_4_1.pdf.

Timeline of legal actions on the MA act

- August 4, 2004: Governor signs legislature's MA Oil Spill Prevention Act into law (Chapter 251, Acts of 2004). The Act establishes a trust fund, financed by a 2-cent/barrel fee (later raised to 5 cents) on petroleum products delivered to marine terminals in the state.
- January 18, 2005: the United States (later joined by international shipping companies) files a lawsuit against Massachusetts claiming that the United States has the exclusive authority to regulate oil tanker shipping.
- July 24, 2006: Federal District Court rules that certain elements of Massachusetts Oil Spill Prevention and Response Act are invalid. MA Attorney General and the Buzzards Bay Coalition appealed this decision.
- June 21, 2007: First Circuit Court reverses the District Court's decision and remands it back to the District Court with guidance.
- On August 30, 2007: USCG passes final rule requiring pilots and escorts on single hull barges only.
- October 29, 2007: United States requests a preliminary and permanent injunction in federal district court
- November 16, 2007: Attorney General's Office and Buzzards Bay Coalition vigorously opposed the United States' request.
- On January 2008, Massachusetts files a countersuit asserting the 2007 Coast Guard rule is invalid.
- On June 6, 2008, the District Court recommends a preliminary injunction in favor of the U.S.
- In August 2008, the Massachusetts legislature passes work-around legislation (Chapter 268 of the Acts of 2008), using an increase in oil delivery fees to fund the state paying for escorts and pilots for both single and double hulled vessels. The law is further modified by Chapter 101 of the Acts of 2009. Vessels carrying 6,000 or more barrels of oil within Buzzards Bay may require the services of a state pilot to be paid for by the OSA Trust Fund.
- On March 31, 2010, the US District Court for Massachusetts issued a judgment to enjoin Massachusetts from enforcing the personnel and operating requirements for tank vessels and the tug escort provisions enacted by the OSA of 2004. They also find that the USCG violated NEPA, but finds the error harmless.
- On July 11, 2011, after years of motions, arguments, and appeals, the U.S. Court of Appeals for the First Circuit found that the US Coast Guard violated the National Environmental Policy Act (NEPA) when it issued navigational rules for Buzzards Bay that were weaker than the original MA Oil Spill Prevention Act of 2004. The court lifted the US District Court injunction, which meant that tug escorts were again required on double-hulled barges. This also relieved the state's obligation to fund escorts and pilots. Additional information at: savebuzzardsbay.org/page.aspx?pid=3143.

because the initial assessment teams focused on identifying oiled areas to deploy cleanup crews not calculate the area of stranded oil on sandy beaches.

Aftermath of the 2003 oil spill

In the aftermath of the Bouchard No. 120 oil spill, the Governor of Massachusetts appointed an oil spill commission that eventually recommended important changes in state law. Most importantly, in 2004 the Commonwealth of Massachusetts passed the Massachusetts Oil Spill Prevention and Response Act (Chapter 251 of the Acts of 2004, "MOSPRA") that, among other things, imposed a delivery fee of 2 cents per barrel (later raised to 5 cents) on oil delivered to Massachusetts ports (later raised to 5 cents) in order to establish a $10 million oil Massachusetts Oil Spill Prevention and Response Efforts fund. The fund would subsequently be used to provide oil spill response equipment and training to municipalities, fund the development of geographic response plans and other studies. The law also required pilots and tug escorts for tankers and tank barges in Buzzards Bay (and for several years this expense was covered for certain vessels by the state MOSPRA fund. The requirements under the law are defined in 314 CMR 19.00 Regulations: Oil Spill Prevention and Response.

In January 2005, the U.S. Department of Justice brought suit in U.S. District Court claiming that the following provisions of the Massachusetts Oil Spill Act are preempted by Federal law: state pilotage requirements, personnel and manning requirements, tank vessel design requirements, drug and alcohol testing provisions, tugboat escort provisions, mandatory vessel routing requirements, and the certificate of financial assurance requirement. The oil delivery fee was unaffected by the ruling. That year the U.S. Coast Guard also proposed changes to navigation requirements, but these were not to be finalized until November 2007. Meanwhile the merits of the 2004 state law were still the subject of litigation.

In 2006, the District Court held that the challenged provisions of the Oil Spill Act were preempted and unconstitutional under the Supremacy Clause of the U.S. Constitution. The District Court permanently enjoined Massachusetts from enforcing those seven provisions.

Massachusetts and the Buzzards Bay Coalition partially appealed the District Court decision. In June 2007, the U.S. Court of Appeals for the First Circuit found that the District Court erred in concluding that the federal law preempted the Oil Spill Act, and erred in entering a permanent injunction. The First Circuit Court remanded the matter to the District Court to hear additional evidence. On August 20, 2007, the First Circuit Court issued a mandate lifting the permanent injunction, pending further District Court proceedings, as the injunction relates to three appealed provisions: personnel and manning requirements; tug escort provisions; and the certificate of financial assurance requirement. The personnel and manning requirements, tug escort provisions and certificate of financial assurance requirements remained in force.

Later in 2007, the USCG issued a final rule for Buzzards Bay requiring escorts and pilots for single hull barges only. Based on that new rule, the District Court enjoined the state law.

In the summer of 2008, in an effort to ensure that every barge had the benefit of an escort tug in Buzzards Bay, the Massachusetts legislature passed a law (signed by the Governor on August 11, 2008) that had the state providing escort services for double hull vessels at state expense (federal rules only required escorts for single hull vessels.), funding the service with an increase of oil delivery fees from 2 cents to 5 cents a barrel. In 2008, the Commonwealth also sued the USCG, claiming that the USCG violated the National Environmental Policy Act when it issued its final rule. Ultimately in 2011, the First Circuit court agreed with the Commonwealth and the Buzzards Bay Coalition, inavlidating the USCG rule, and reinstating the state law, thus requiring escorts for both single and double hull barges.

Another outcome from the 2003 spill is that in 2007 the USCG implemented a Vessel Movement Reporting System (VMRS) requirement for Buzzards Bay. The VMRS provides for improved communication and positional awareness for all mariners. The system is helping shipping use the Recommended Vessel Routes (so-called "green lanes") by commercial vessels, especially tug/barge combinations. Captains not using the Recommended Vessel Route[200] are required to notify the VMRS control center ("Buzzards Bay Control").

Major Issues

With respect to catastrophic spill prevention, the 2003 Buzzards Bay spill had many consequences, the most important of which was the passage of the 2004 Massachusetts Oil Spill Act, and its 2008 amendments. The Act required among other things, pilotage and tug escorts for oil shipments in Buzzards Bay, and a fee imposed on oil shipments to Massachusetts to fund a trust fund to pay for equipment, training, and tug escort service. Since passage of the Oil Spill Act, the federal government and Commonwealth of Massachusetts have been at odds over whether the state has the authority to require navigation rules in state waters. This matter needs to be resolved. The most contentious issue is that the federal rules only require an escort tug and federally licensed pilot for single hull barges carrying 5,000 or more barrels of oil or other hazardous material[201]. The differences in the law should be resolved by making changes in federal shipping regulations to match those adopted by the Commonwealth.

In Massachusetts, the response to marine and inland oil spills is regulated and overseen by the Department of Environmental Protection (DEP). The U.S. Coast Guard has authority over the cleanup response for spills in marine waters, and has oil spill response capability through the National Strike Force, but the primary response is by private contractors. In fact, both the Coast Guard and DEP have standing contracts with private firms to contain and cleanup spills. If responders cannot contain the spill with locally available equipment, DEP contacts the National Strike Force. The strike team for the east coast is located in Fort Dix, New Jersey. In a practical sense these private contractors cannot be deployed as quickly as locally trained municipal first responders, which are generally fire department personnel and harbormasters. For this reason, the continued training and outfitting of these municipal first responders must remain a priority.

Actions taken by town personnel in the initial hours and days of an oil spill can greatly minimize local impacts. One lesson learned from the response to the *Bouchard 120* oil spill was the inability to integrate quickly local first responders into cleanup activities, and the municipalities were in fact taking actions independently for several days. This problem occurred in part because local government did not have adequate access to the unified command structure. Decisions about the response and cleanup of oil spills are made through consensus of three parties: the U.S. Coast Guard, Massachusetts DEP, and an agent for NIMS. ICS guidelines for incident command allow for input to the unified command structure, through a liaison officer and better use of this mechanism could have minimized conflicts between the federal government and the municipalities.

Another issue that developed from the 2003 oil spill was that the Coast Guard did not immediately use the expertise or incorporate information or resources from municipal first responders. In 1998, the BBAC had developed a general response plan and equipment inventory, and they updated this plan in 2001. Although the BBAC provided this oil spill response manual to the U.S. Coast Guard, and it was available on-line, it was not used initially by the *Bouchard 120* Incident Command. The federal officials were also not coordinating with municipal first responders until two days after the spill.

After the 2003 oil spill, the Coast Guard recognized the need to better integrate local needs and expertise into area contingency plans. DEP also provided funding to the Buzzards Bay Coalition to work with area oil spill coordinators to develop a geographic oil spill response plan (GRP) for Buzzards Bay that includes specific boom deployment strategies and tie off locations in the event of various oil spill scenarios. The Buzzards Bay Coalition hired a contractor to complete a Buzzards Bay GRP in 2005. With funding from DEP, the Coalition has since met with oil spill responders and local officials to

[200] At the west entrance to Buzzards Bay, the VMRS zone is bounded by a line extending from Sakonnet Point, Rhode Island, to the Buzzards Bay Entrance Light, and then to the southwestern tip of Cuttyhunk Island. At the east entrance to Buzzards Bay, the VMRS boundary is the same as the boundary for the Cape Cod Canal, which is 1.6 statute miles seaward of the Canal Breakwater Light. Tugs/barges should take appropriate action early to ensure they are escorted, with a federal pilot aboard the primary tug, before entering the VMRS zone.

[201] This includes liquids like ethanol.

update the GRP. Another contractor updated GRP in 2007.

In 2005, DEP established a Massachusetts Oil Spill Act Advisory Committee to help target uses of funds collected under the state Oil Spill Act. Currently, coastal communities have received oil spill response trailers, but many inland municipalities also want similar equipment to deal with land-based and inland spills. DEP has not decided upon the frequency and levels of funding needed for training of local officials.

The need for a either a bilge oil facility or a subsidized bilge water collection service to serve commercial vessels in New Bedford Harbor remains. In recent years, the Buzzards Bay NEP and others have been discussing reviving the project with the City of New Bedford. However, in a 2013 reassessment, the Buzzards Bay Coalition has proposed a comprehensive approach involving both a subsidized oil bilge water collection service (utilizing hazardous waste disposal companies rather than building a bilge water collection facility on the harbor), coupled with monitoring the waterfront and surface waters, and better enforcement and education. The committee overseeing the use of Massachusetts Oil Spill Prevention and Response Act Oil Spill Act funds is considering the various strategies.

There is still a need to improve fueling regulations at marinas. Either the state or municipalities can accomplish this task (see Town of Harwich Fueling Regulations inset).

Unified Command and Hazmat Responders may utilize a General NOAA Oil Modeling Environment (GNOME) computer model to quickly predict landing sites for spilled oil, but such a model was not available to predict the movement of oil in Buzzards Bay during the 2003 Bouchard 120 oil spill. Models of this type are only as accurate as the input of variables such as real time tidal, wave, and wind conditions.

The GNOME model is more predictive than the Physical Oceanographic Real-Time System (PORTS) that is in place in some ports. The PORTS system provides real-time oceanographic data about wave, wind, and current conditions with the primary purpose of improving navigation safety, but is also helpful when a spill occurs. NOAA and the Coast Guard have implemented the PORTS and GNOME model for neighboring Narragansett Bay (an NEP also), but PORTS has not been installed in Buzzards Bay.

Management Approaches

To reduce future hydrocarbon discharges and impacts to Buzzards Bay will require reducing the likelihood of catastrophic spills, improving the cleanup effectiveness and response time when spills do occur, and reducing chronic hydrocarbon release, like those associated with stormwater discharges and vessel operation in Buzzards Bay. Many specific recommendations that meet these goals are contained in the Oil Spill Act Interim Plan[202].

Future oil spills will be minimized with the presence of escort tugs (which also have some spill response equipment), and improved navigation aids and tracking. To reduce future impacts of oil spills that do occur, increased local availability of response equipment, improved training and coordination among municipalities, and continued improvements and evaluation of strategies contained in response strategies are all needed measures. Completion by NOAA of a water circulation model for Buzzards Bay will greatly improve predictions of the location of oil landings after a major spill. Installation of a navigation buoy system like that in Narragansett Bay will also assist with navigation and spill response. The state also needs to develop an monitoring plan for oil spill damage assessment in collaboration with local universities and research centers to establish a protocol to speedily collect data essential for the environmental damage assessments after a spill.

With respect to chronic discharges of oil, the most important action to reduce illicit discharges in New Bedford Harbor and Buzzards Bay is to provide either subsidized services or a facility, coupled with improved education, monitoring, and enforcement. Increased use of 4-stroke engines will minimize hydrocarbon discharges from recreational boats throughout Buzzards Bay, and municipalities can set an example by using 4-stroke engines for harbormaster vessels. Reduction in stormwater related hydrocarbon discharges is addressed in the municipal stormwater plans as described in Action Plan 3 Managing Stormwater Runoff and Promoting LID, and other strategies to reduce hydrocarbon release to the environment are discussed in Action Plan 16 Reducing Toxic Pollution.

In 2004, the Buzzards Bay Coalition collaborated with the Coast Guard and twelve other local, state, federal, and private organizations to create the Buzzards Bay Geographic Response Plan for Oil Spill Mitigation. The plan was subsequently updated in 2007 and 2009. This plan is posted online[203],· and should remain so, to facilitate its distribution during an oil spill emergency. Because many of the strategies laid out in the plan were conceptual, as part of local training efforts, the towns, DEP, and the USCG should test and evaluate specific deployment strategies included in the plan to evaluate them and improve upon them. This approach was also recommended in the Oil Spill Act Interim Plan. Funding for these trainings could be included in a future update of

[202] DEP. 2007. Interim plan for implementing the Massachusetts Oil Spill Prevention and Response Act. October 23, 2007. 17pp. Retrieved from www.mass.gov/eea/docs/dep/cleanup/laws/iosaip.pdf.

[203] Original Retrieved from www.savebuzzardsbay.org/document.doc?id=13. Updated version at: grp.nukaresearch.com/BBgroup.htm.

the geographic response plan, and funded by Oil Spill Act funds. A contractor could update the existing plan and GIS files, hold meetings to develop consensus, with the final product being completion of a revised GRP. The cost of revising an existing plan and existing GIS files may be nominal.

The U.S. Coast Guard should continue to update the area oil spill contingency plan every five years to ensure that current state and municipal priorities are included in the plan, as well as key elements of the Geographic Response Plan for Buzzards Bay. The U.S. Coast Guard should update the navigation rules in Buzzards Bay to match requirements under the oil spill act adopted by Massachusetts, including requiring pilotage and escorts for oil tankers and tank barges through all of Buzzards Bay.

It would be highly advantageous to managers in Buzzards Bay if NOAA developed the previously mentioned GNOME oil spill trajectory model for Buzzards Bay. NOAA would need to provide funding in a budget authorization, and such a task might cost $100,000 for a contractor to do the work for NOAA. When developed, it should be made available on line. This is a one-time effort but the model could be evaluated after 5 years. After the 2003 oil spill, Massachusetts Maritime Academy established an oil spill simulator, but it does not have the predictive capability of the GNOME model.

Similarly, NOAA and the USCG could implement a PORTS technology real time buoy tidal condition system to compliment the VMRS system and GNOME model. This too would need to be budgeted, and this is a considerable expenditure, totaling at least $1 million for buoy system plus $200,000 in annual maintenance and operation costs. This real time online network of data collection buoys would likely take several years to implement.

CZM and DEP will work with Buzzards Bay municipalities to ensure that local priorities and needs are included in the USCG area contingency plan.

DEP should continue to fund the testing of deployment strategies included in the geographic response plan for Buzzards Bay as directed by the statewide oil spill act strategic plan. This might require expenditures for contractual services, and these costs could be paid by Oil Spill Act funds. DEP should continue to work with the USCG and Buzzards Bay municipalities to coordinate and fund regional oil spill response drills for Buzzards Bay communities to improve preparedness, and better utilize oil spill response equipment and the geographic response plans to enhance coordination of local, state, and federal response agencies. DEP should continue to use oil spill fund fees to ensure adequate equipment to both coastal and inland communities in the Buzzards Bay watershed to provide first response to land and ocean based spills. This is a policy and management decision. The costs are estimated to be $50,000 for annual training contractual services. Inland communities may require tens of thousands of dollars for similar cleanup equipment to help minimize spills to waterways from road tanker accidents. Potential funding could come from the MA Oil Spill Act Funds as well.

DEP should initiate an inspection of the oil spill response trailers provided to Buzzards Bay municipalities to ensure the adequate condition and maintenance of the equipment and replacement of expendable supplies. This could be achieved through Oil Spill Act Funds if needed. Equipment inspection could be included as part of local training efforts.

EEA, with assistance from DEP, should establish a Oil Spill Damage Assessment Response Panel to develop protocols for the collection of data in the hours and days after a spill that will be used in later damage assessment evaluations. This effort could use as a model similar work undertaken in Rhode Island around 2000. The estimated costs for such an action might total $50,000, and would be a one-time cost to hire a scientific contractual analyst to organize the panel, hold meetings, and develop a consensus for damage assessment protocols. The potential funding source is the MA Oil Spill Act Funds.

The New Bedford Harbor Development Commission, the USCG, and Mass DEP should collaborate to reduce chronic discharges of hydrocarbons in New Bedford Harbor. With respect to discharges associated with bilges, a bilge oil facility could be built, or simply subsidized oil collection services could be provided. The cost of a facility might include $500,000 one time capital cost to build the facility then $75,000 annually for a part time operator and disposal fees. Alternatively, a collection vehicle could be purchased for $100,000, and the oily bilge water disposed by hazardous waste disposal vendor (up to $200,000 per year)[204].

In the 1990s, the BBAC updated an oil spill mutual aid agreement among Buzzards Bay municipalities, and facilitated training (with equipment and funding from the Buzzards Bay NEP) which helped prepare them for the 2003 *Bouchard 120* oil spill. Since that time, with Massachusetts Oil Spill Prevention and Response Act funding, municipalities have received considerable additional training and oil spill containment equipment. If there is a desire among municipalities, the BBAC could work with MA DEP to review and update the communication and coordination protocols among Buzzards Bay municipality's protocols in response to catastrophic spills. If the BBAC remains involved with this effort, the BBAC could annually update its first responder contact list and equipment inventory for Buzzards Bay communities and provide this information to the USCG and DEP to make sure their information is up-to-date. This work would be undertaken by the BBAC Executive Director communicating with local oil responder leads. The municipal con-

[204] Buzzards Bay Coalition presentation to the Massachusetts Oil Spill Prevention and Response Act (MOSPRA) Advisory Committee, October 23, 2013.

tacts should be listed online. If desired, municipalities of the Buzzards Bay watershed could enact new mutual aid agreements.

Financial Approaches

The most expensive state costs were those associated with maintaining pilotage and escort costs associated with the Massachusetts Oil Spill Prevention and Response Act when the Coast Guard interpretation of federal rules were in place in the mid-2000s. Currently, however, with the 2004 state rules in effect, industry is paying for pilots and escorts on both single and double hull barges, so the state is not expending funds for these oil spill prevention measures. If the current rules should again change (such as a proposed 2013 rule change to not require escort tugs on double hulled tankers), the state has indicated it would use Act funds to ensure every oil barge and tanker has a pilot and escort.

The greatest single local cost under this action plan would be the cost of strategies to reduce chronic oil discharges in New Bedford Harbor. A combined strategy of subsidized services, monitoring, and enforcement might total $200,000 in capital costs and $200,000 annual operating costs.) Other costs identified in this action plan include developing a monitoring plan to implement immediately after a spill to collect necessary data for the natural resource damage assessment (~$80,000); development of a water circulation model by NOAA to better predict landing sites and impacts (~$100,000); and development of a Physical Oceanography Real Time System (PORTS®) to provide better data for hydrologic models and to provide better sea conditions to navigators ($1 million installation $200,000 annual operating costs). Some costs might be eligible for MOSPRA funding, others through state and federal grants or appropriations.

Monitoring Progress

Spills of oil greater than 1,000 gallons are uncommon in Buzzards Bay, and the effectiveness of measures to reduce these rare events could only be evaluated perhaps after a decade or more. Quantities of oil recovered from bilge water, or the number of oil sheens reported in a harbor annually would be easier measures to track. Adoption of regulations that require hydrocarbon BMP requirements relating to materials storage and stormwater treatment can be enumerated. It is likely that reductions of nonpoint sources of hydrocarbons can only be evaluated programmatically because of the cost of analyses and intermittent nature of discharges.

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Action Plan 18 Planning for a Shifting Shoreline and Coastal Storms

Problem[205]

For millennia, the Buzzards Bay coastline has been subject to the rise in sea level and storms that have continued to erode and shift materials that change the shape, elevation, and position of the shoreline. These processes shift the locations of barrier beaches and alter wetland areas, resulting in the loss of habitat for certain species, and cause the migration of other habitats like salt marshes. Structures built in these hazard-prone areas can not only impede natural processes, but when they are destroyed in storms, they become hazards to public health and the environment. They can also become a financial burden to government. The frequency and intensity of these processes will likely increase in the coming decades due to climate change. Some state and federal programs are creating moral hazards by promoting development in high-risk areas.

The Massachusetts Coastal Zone Management updated its program plan with goals to prevent, eliminate, or significantly reduce threats leading to loss of life, destruction of property, and degradation of environmental resources that result from improper development. They also sought to limit public expenditures in coastal high hazard areas, allow natural physical coastal processes to continue unabated, to the extent feasible, and prioritize public expenditures for acquisition and relocation of structures out of hazardous coastal areas. Unfortunately, current state, federal, and local laws, regulations, and policies are far from achieving these goals.

Goals

Goal 18.1. Protect public health and safety from problems associated with coastal hazards including rising sea level, shifting shorelines, and damage from storms and storm surge.

Goal 18.2. Reduce the public financial burden caused by the destruction of or damage to coastal property.

Goal 18.3. Plan for shifting shorelines and the inland migration of buffering wetlands and shifting sand formations, and the species that utilize these habitats.

Objectives

Objective 18.1. To incorporate sea level rise, increased frequency and intensity of coastal flooding, and shoreline change phenomena into all relevant planning and management programs.

Objective 18.2. To develop a comprehensive strategy for handling existing structures in areas that will be affected by future shoreline changes and other coastal hazards.

Objective 18.3. To adopt regulatory and non-regulatory measures for guiding growth and development in areas that will be influenced by coastal flooding and new shorelines.

Objective 18.4. To encourage continued restructuring of the national flood insurance program to discourage development in flood prone areas.

Objective 18.5. To adopt emergency response plans to reflect additional needs and constraints caused by reduced access and increased flooding potential of developed coastlines.

Approaches

This action plan requires changes in regulations, policies, and actions by all levels of government. Public spending for infrastructure in high risk areas should be avoided, and government should not create incentives for private construction in high-risk zones. The latter problem will require changes in the flood insurance program, and the kinds of actions required by the federal government in the aftermath of disaster relief aid. Municipalities will need to conduct evaluations of new risks caused by rising sea levels. They should adopt hazard mitigation plans, and participate in the FEMA community rating systems. RPAs and CZM should assist in these efforts. They also need to lead by example by not building new public structures in high-risk areas.

Costs and Financing

Much of the expenses associated with this action plan relate to conducting risk assessments, planning, and adopting or amending laws and regulations. These efforts might cost hundreds of thousands of dollars per community and require dedication of staff time. Those measures requiring regulatory or policy changes have nominal costs.

Measuring Success

Because of the rarity of catastrophic storms, and slowness of sea level rise, tracking programmatic actions, like completion of hazard mitigation plans, adoption of changes in the state building code, or adoption of local bylaws, ordinances, and regulations that support climate adaptation, will be the primary measures for tracking success.

[205] This action plan was revised and re-written from the original 1991 CCMP. The first four objectives were in the 1991 CCMP, but have had some minor changes in text. [Goals 1 and 2 were in the 1991 CCMP, but have had some changes in text, including concepts relating to coastal hazards. Goal 3 was changed from planning for loss to planning for inland migration of wetlands.]

Background

Development Pressures and Adaptation

With the tremendous increase of development on the coast and storm damage prone areas in recent decades, human activities to control natural coastal processes have included the filling of tidelands, and the "hardening" of shorelines through the construction of groins, revetments, bulkheads, and other structures. Through direct and indirect effects, there have been wetland losses and impairments, such as restrictions to tidal flow. Hardened shorelines also prevent natural shoreline processes, like coastal sand transport, which in turn may exacerbate coastal erosion rates. These structures also prevent the natural inland migration of salt marshes.

The increasing propensity of private construction in vulnerable coastal areas, particularly residential development, followed by improved public infrastructure of roads, utilities, and bridges, has caused concerns about the economic and ecological costs of this growth. The economic losses due to storm-related damage to the coastal zone have increased, not because of increased storm frequency or intensity, but because of increased development along the coast.[206] In dense urban centers along the coast, the economic value of public and private property and infrastructure is so great that public and private action will result in the continued protection and elevation of existing filled tidelands as has occurred for the past several centuries[207]. In less densely developed coastal areas, particularly residential areas, there is a debate about whether the public (taxpayer) should bear the costs of protecting and rebuilding private property in these vulnerable areas, and whether government should limit new development in these areas.

Since the creation of a federally subsidized National Flood Insurance Program (NFIP) in 1968, there has been an ongoing debate about moral hazards[208] created by the program, and how the program may be encouraging development in high-risk areas. In fact, in the 1991 Buzzards Bay CCMP, an objective of this action plan was "to restructure the flood and hazard insurance programs in threatened areas so that the financial burden on the general public is decreased." The U.S. Congress finally addressed this issue in part with the passage of the Biggert-Waters Flood Insurance Reform Act of 2012. The legislation required the Federal Emergency Management Agency (FEMA) to make a number of changes to the way the NFIP is run. A key provision of the legislation is to require NFIP policy rates to reflect true flood risks and costs. The planned changes, which will be implemented over several years, will raise insurance premium rates appreciably for new construction in the flood plain, and raise the rates for many previously built structures.

Global Climate Change and Sea Level Rise

During the past 750,000 years, the earth has repeatedly cycled between ice ages lasting 70,000 to 100,000 years, and brief warm periods lasting between 10,000 to 30,000 years. We are currently living in one of these warm interglacial periods. Since the peak of the last ice age 21,000 years ago, when Buzzards Bay was covered with a mile thick sheet of ice, sea level has risen roughly 400 feet. During the last interglacial period (130,000 years ago), the earth's climate was warmer than today, Greenland's entire ice sheet melted, and sea level was roughly 15-20 feet higher than today.

Sea level rose rapidly during the rapid retreat of the ice sheet across North America beginning 19,000 years ago, averaging 4 feet per century for thousands of years. About 6,000 years ago, the rate of sea level rise slowed dramatically. During the past 4,000 years, sea level rise in southern New England likely was only 6 inches per century (Engelhart et al., 2011). During the past 3,300 years, relative sea level near Boston was only 3 inches per century (Donelly, 2006). However, the rate of sea level rise is again increasing. Woods Hole tidal records have documented a 10-inch rise during the past century. Due to emissions of greenhouse gases from human activity, the rate of sea level rise may increase by 1.5 feet or more by the 2100. Increased ocean temperatures may also cause coastal storms to become more severe and more frequent. Changes in global temperature will also alter weather and precipitation patterns in both subtle and not so subtle ways.

This action plan is not about climate change or greenhouse gas emissions. Anthropogenic inputs of greenhouse gases will add to an existing trend of rising sea level, and other climate change patterns. However important it is to address and mitigate these human impacts to world climate, this is an international and global scale problem that is beyond the scope of this watershed management plan. Moreover, as noted in the 2007 IPCC report for managers, "anthropogenic warming and sea level rise would continue for centuries due to the timescales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilized." Thus, for the indefinite future, whether or not greenhouse gas emissions are controlled, coastal managers and planners need to promote long-term policies to address the expected continued rise of sea level rise over the next centuries, and society must plan and adapt for future storm damage impacts to minimize the financial and ecological impacts of coastal development.

[206] Pielke et al., 2008. Normalized Hurricane Damage in the United States: 1900-2005. sciencepolicy.colorado.edu/admin/publication_files/resource-2476-2008.02.pdf.

[207] Despite a 2.5 foot rise in sea level, between 1700 and 1950, the cities of Boston and New York increased appreciably both in size and elevation as millions of cubic yards of fill were placed on uplands, tidelands, and wetlands.

[208] In economic theory, a moral hazard is a situation where a party may take risks because the full costs that could incur will not be felt by the party taking the risk. The term was defined by the insurance industry more than a century ago. It is also characterized as when an individual, who is insulated from a risk, behaves differently than if they were fully exposed to that risk.

These changes will likely alter future patterns of development along flood-prone coastal areas.

The focus of this management plan is to implement strategies to reduce the severity of impacts of future storms and sea level rise on the coast and on existing and future coastal development. Management agencies call this approach adaptation. Mitigation measures are required to address global climate changes, but these measures are best addressed at the national and international levels of governments, not in this action plan.

Geologic Cycles and Greenhouse Gases

Shorelines have shifted significantly over geologic time. In the 19,000 years since the Laurentian ice sheet began retreating across North America, shorelines everywhere began withdrawing inland as sea level rose in response to melting glaciers and expansion of warming seawater. As recently as 9,000 years ago, Buzzards Bay was a dry-land valley, and the southeastern Massachusetts land mass extended seaward 100 miles encompassing the Elizabeth Islands, Martha's Vineyard, Nantucket, and portions of Georges Bank (Shaw, 2006). As recently as 5,000 years ago, sea level was likely at least 25 feet lower than today[209] (Donnelly, 1998; Engelhart et al., 2011). At this time, the northern boundary of Buzzards Bay was likely defined by a shoreline that ran from Sippican Neck in Marion, to Scraggy Neck in Bourne. All during these millennia, the sandy shores along southern New England continually shifted inland due to erosion in response to major hurricanes and winter storms and rising sea levels.

The rate of sea level rise then lessened dramatically after 5,000 years before present, although with some variability likely related to global temperature shifts. For example, Engelhart et al. (2011) estimated that sea level rise during the past 4,000 years was around 5 inches per century in southern New England. During the past 3,300 years, Donnelly (2006) found the rate to be only 3 inches per century in a Revere, MA marsh[210]. Rates are higher today, and in Woods Hole sea level rise has been 10 inches during the past century (Figure 103). Furthermore, scientists project that the rate of sea level rise and shoreline change will increase appreciably in the next few centuries because of elevated concentrations of greenhouse gases from human activity. The resulting warming is expected to increase the rate of sea level by both raising ocean water temperature (thermal expansion), and by melting glaciers and ice caps in Antarctica and Greenland.

Since colonial times, the two principal ways of measuring coastal changes has been through shoreline mapping and more recently, through the collection of tidal elevation data. A casual examination of old nautical charts shows that some tidal rocky areas, headlands, and tiny islands in Buzzards Bay have disappeared. A more thorough analysis of charts and aerial photographs by Massachusetts Coastal Zone Management has shown that the horizontal migration of shorelines in a few parts of Buzzards Bay has averaged more than 10 feet a century. However, in most of Buzzards Bay, shorelines have been relatively static during the past few hundred years due to the protected natured of most of Buzzards Bay shores, and in a few areas, because of the presence of bedrock.

Tidal data collected around the world documents that during the past century global sea level has been rising at an average rate of approximately 0.3 feet (3.6 inches) per century, consistent with the past few millennia. Actual rates depend on whether a portion of a continent is subsiding or lifting. In Buzzards Bay, like most of the Atlantic seaboard, relative sea level has been rising at a slightly higher rate, approximately 10 inches (0.85 ft) per century during the same period, due to the slow subsidence of the earth's crust along the east coast (Figure 103). Recent models have suggested that sea level rise during the 21st century could range anywhere from 4 inches to 2.5 feet, with a median consensus estimate of 1.5 feet (IPCC, 2007; see also Munk, 2002; Titus, 2000, Titus and Richman, 2000). An additional 0.5-foot increase could result from additional glacial melting predicted by some models.

Atmospheric monitoring and analysis of glacier ice cores show unequivocally that greenhouse gases have increased dramatically in the atmosphere during the past 100 years. There is wide consensus that these increases will further elevate worldwide ocean and atmospheric mean temperatures in the coming decades and centuries. A warmer planet will further raise sea level by expanding ocean water and melting glaciers and polar ice sheets. These changes will not only result in increased coastal inundation, but a warmer climate could result in

[209] Donnelly (1998) concluded (based on radiocarbon dating of buried salt marsh sediments) that 5,000 years ago, sea level was about 39 feet lower in southern New England (=9.4 inches per century increase for the entire period), and 13 feet lower around Boston (=3.1 inches per century average). In 2006, Donnelly revised his Boston estimate (a Revere marsh) to 8.5 feet in 3,300 years, which is still about 3.1 inches per century. Engelhart et al. (2011) estimated an average rate a bit over 5 inches per century during the last 4,000 years in the area New York. When sea level was 39 feet lower, Buzzards Bay would have been defined by a shoreline between Mattapoisett Neck and West Falmouth.

[210] Sea level rise in southern New England may be slightly faster than around Boston. Variability in rates is caused by differing rates of land subsidence and proximity to effects of the Atlantic Gyre (Engelhart et al., 2009). Boston may have also experienced an increase in tidal range. In addition, sea level rise may have varied appreciably during this period as well, as Donelly et al. (2004) also found that during the cold period known as the Little Ice Age, sea level rise in southern New England might have been slowest during the period.

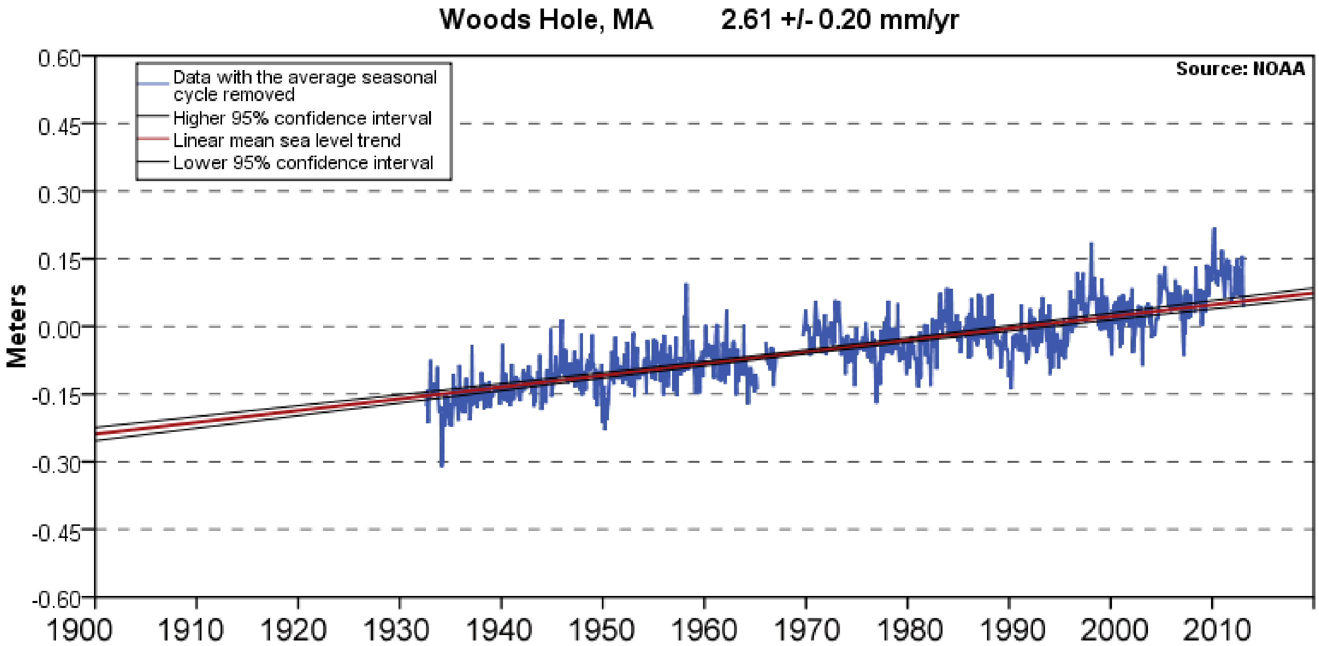

Figure 103. Mean sea level trend at NOAA tidal station 8447930 Woods Hole, Massachusetts.

The mean sea level trend is 2.61 millimeters/year (0.86 feet/century) with a standard error of 0.20 mm/yr based on monthly mean sea level data from 1932 to 2012. Figure generated at tidesandcurrents.noaa.gov/sltrends on 19 April 2013. IPCC (2007) consensus estimate predicts a 1.4-foot increase during the 21st century. An additional 1-foot increase could occur during the same period because of glacial melting.

more severe storms, which in turn accelerates ongoing changes to the coastline.

The greenhouse gases of greatest concern are carbon dioxide, largely derived from the combustion of fossil fuels, and methane, which are increasing because of increased farm animal production, increased areas of rice production, and deforestation of tropical forests. While methane is in much lower concentrations in the atmosphere than carbon dioxide, it has 16 times the heat trapping effect of carbon dioxide, so its release into the atmosphere is also of concern.

Climate change is receiving significant scientific and public attention in national and international forums, and scientific models to predict future conditions have improved. Some previous predictions of sea level rise during the 21st century were unrealistically high (IPCC 2001), and consensus estimates now predict a 60% increase over the current rate. To most individuals, the rise in sea level will seem gradual and imperceptible during their lifetime. Furthermore, even if governments immediately curtailed greenhouse gases, climate change patterns and sea level rise will continue for centuries (IPCC, 2007).

While these facts may generate complacency in some (and alarm in others), policy makers, regulators, and lawmakers must recognize that irrespective of potential future conditions, coastal storms and erosion will continue to shape the shores of Buzzards Bay and affect residents. These individuals must establish a course of action to plan for both the effects of coastal storms, and the effects of sea level rise, and to regulate coastal development in a way to minimize costs to property owners, municipalities, and the environment.

For the 1991 Buzzards Bay CCMP, the Buzzards Bay NEP funded two studies about the potential impacts of rising sea levels (Giese and Aubrey, 1987; Giese, 1989). These studies evaluated the potential loss of upland areas due to sea level rise in the 11 communities directly abutting the bay. Loss of "upland" included both potential shoreline loss and conversion of dry land to wetlands from rising groundwater. The study evaluated three rates of sea level rise: 0.45, 1.3, and 2.1 feet per century (the middle rate is close to the current 2007 IPCC consensus best estimate).

Results showed that under this scenario, several municipalities bordering Buzzards Bay would experience significant losses in area of their coastal uplands by rising waters. Effects from these losses would include increased occurrences of floods at higher elevations, loss and erosion of wetland resource areas, elevated groundwater levels, and potential saltwater intrusion into groundwater near shore. Although some changes, like elevation of groundwater levels will appear as a gradual and continuous change, most sea level rise shoreline change effects would be manifested as dramatic shoreline changes caused by major coastal storms, followed by gradual redistribution and migration of coastal sediments during more quiescent periods.

Managers must also address the inland migration of wetlands, particularly salt marshes, which is an im-

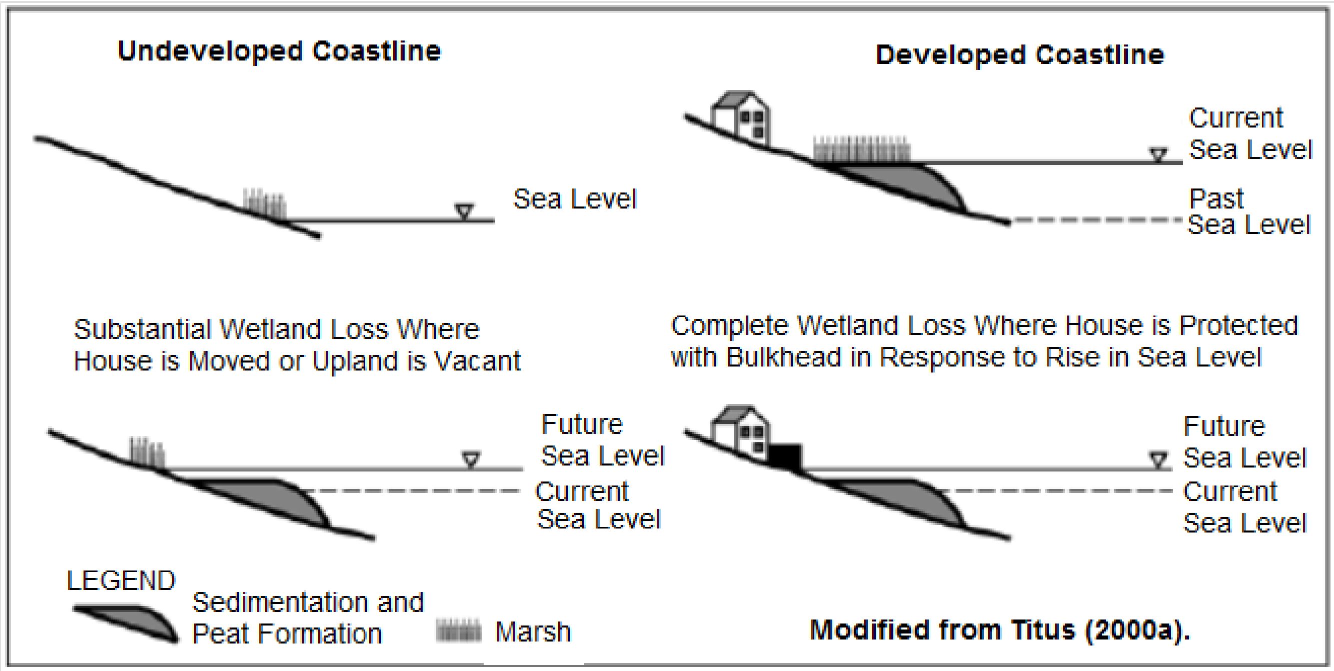

Figure 104. Salt marshes having been migrating inland for thousands of years as illustrated by the figure on the left. Construction of bulkheads and other structure prevent this inland migration, resulting in loss of salt marsh (right).

portant collateral environmental impact of sea level rise. Sediment cores of coastal bays and estuaries show a natural inland migration of nearshore freshwater cedar swamps converting to salt water systems, first as salt marshes, then salt ponds. Barrier beaches migrate inland. Some areas of coast lose sediment, and sediments may build up elsewhere. Construction of bulkheads, sea walls, and revetments interrupt this inland migration and consequently the frontward eroding edges of salt marshes are often not replaced on their backside (Figure 104). Preserving the ability of salt marshes to migrate, and the restoration of tidally restricted salt marshes altered in the past, remain priority actions for the Buzzards Bay NEP.

Figure 105 clearly illustrates this phenomenon in the aerial photograph of Great Sippewissett marsh. This photograph shows the extent of the existing salt marsh, as well as old salt marsh peat offshore showing the extent of salt marsh centuries ago when the barrier beach was more than 100 feet shoreward. This salt marsh peat is now habitat for juvenile lobsters and other invertebrates. The photograph also shows a railroad track and bed constructed in the 19th century. This railroad track isolated areas to the east from tidal exchange. While some culverts were installed under the railroad, to permit tidal exchange, over the years many culverts collapsed or filled in. The net result of this construction was the conversion of salt marsh to freshwater wetlands at many sites, and prevention of the natural inland migration of the salt marsh in response to sea level rise.

Storm Damage and Storm Frequency

Hurricane frequency appears somewhat cyclic over roughly a 30-year period (Figure 106). Because most coastal development in the U.S. occurred during the relatively quiescent period between 1970 and 2000, if a hurricane equivalent to the Hurricane of 1938 (estimated to be a Category 3 hurricane with a tidal surge of 14 feet in portions of Buzzards Bay) were to strike Buzzards Bay today, property damage would be far more extensive.

Figure 105. Aerial photograph of Sippewissett Marsh showing salt marsh peat offshore, remnants from a period, hundreds of years ago, of lower sea level and a more westward barrier beach.

Table 49. National Flood Insurance losses in the Buzzards Bay watershed since 1978 and policy values.

Data from FEMA as of 02/28/2009. From www.fema.gov/policy-claim-statistics-flood-insurance/policy-claim-statistics-flood-insurance/policy-claim-13 as of January 31,2009.

Loss Statistics Massachusetts Since 1978 as of 02/28/2009						NFIP Policy Statistics for Massachusetts as of January 31, 2009.				
Community Name	**Total Losses**	**Paid Losses**	**Unpaid Losses**	**Total Payments**	**Dollars per Paid Claim**	**Policies In-force**	**Total Insurance Coverage**	**Annual Premiums Paid**	**Hazard Mitigation Plan**	**CRS partic. (2013)**
ACUSHNET	1	1	0	$14,622	$14,622	11	$2,863,800	$7,992	no	no
BOURNE	459	377	82	$5,435,069	$14,417	1143	$240,108,100	$1,677,292	yes	no
CARVER	9	6	3	$24,692	$4,115	5	$1,400,000	$1,711	no	no
DARTMOUTH	122	76	46	$778,988	$10,250	516	$113,612,000	$539,568	2013 draft	no
FAIRHAVEN	395	314	81	$3,273,025	$10,424	725	$140,240,500	$908,250	no	no
FALMOUTH	619	472	147	$9,091,549	$19,262	2092	$502,122,200	$2,783,527	no	no
GOSNOLD	1	1	0	$2,215	$2,215	7	$2,055,700	$7,895	county	no
MARION	174	131	43	$2,877,321	$21,964	408	$103,432,000	$615,097	no	no
MATTAPOISETT	468	380	88	$6,754,052	$17,774	692	$156,627,700	$968,386	no	no
MIDDLEBOROUGH	16	11	5	$81,802	$7,437	28	$6,582,300	$31,349	yes	no
NEW BEDFORD	51	27	24	$635,184	$23,525	224	$65,282,400	$325,253	yes	no
PLYMOUTH	348	254	94	$4,127,976	$16,252	445	$100,790,800	$429,518	yes	yes
ROCHESTER	0	0	0	$0	$0	1	$350,000	$388	no	no
WAREHAM	835	721	114	$11,500,072	$15,950	1803	$323,510,900	$2,051,640	no	no
WESTPORT	107	78	29	$1,112,631	$14,265	293	$71,013,400	$316,012	no	no

This is because in the 1930s, most of the population lived in cities like New Bedford (which actually had a higher population than today), with a smaller portion of the population in the 100-year flood zone. Surrounding communities were more rural, and the structures built closest to shore were often summer cottages, built to be expendable in the face of coastal storms. With improved roads and infrastructure, and with government subsidized flood insurance programs that de facto promoted residential growth near shore, development within the flood zone of Buzzards Bay increased dramatically. Even in the face of relatively minor storms, Buzzards Bay communities have seen tens of millions of dollars in claims under the National Flood Insurance program since 1978 (Table 49).

The effects of another direct hit of a category 3 hurricane in Buzzards Bay will be immediate and dramatic compared to the gradual effects of sea level rise.

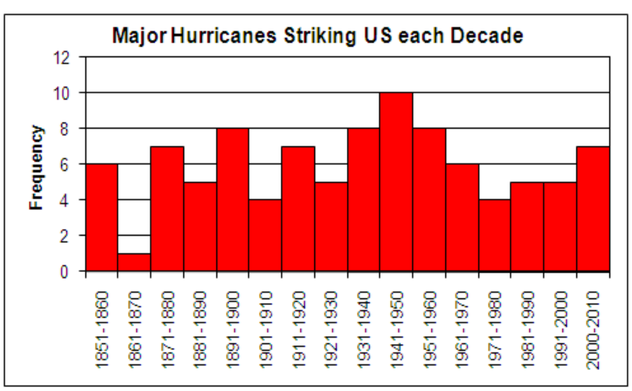

Figure 106. Frequency of major hurricanes (greater or equal to category 3) striking U.S. during the past 150 years.

The frequency of severe hurricanes striking seems to be cyclic, but future trends are less certain. Data from Blake et at. 2005, modified to include 2005 (severe year) and 2006 (hurricane free year) and 2007 and 2008 data. See also: www.nhc.noaa.gov/pastdec.shtml.

Management Opportunities

From a planning point of view, shoreline dynamics occur broadly within three hydrologic regions: flood-prone areas, surface-water areas, and groundwater areas. Issues to be considered include loss of uplands, increased flooding impacts, loss of wetlands, accelerated shoreline changes, saltwater intrusion, and elevated groundwater levels. For currently developed areas, two basic management strategies are available: retreat from the rising water or attempt to protect threatened areas, with varying combinations of both. For undeveloped areas, avoidance is another possibility. However, political, legal, and economic considerations will probably override the scientific issue. Although we know that changes are occurring now, and cannot be reversed, the issues of property rights and equity will probably dominate how the problem is managed. The challenge is to incorporate existing scientific information, even with its uncertainties, into a rational and equitable management scheme.

An example of this can be found in the 1991 Buzzards Bay CCMP. The Buzzards Bay NEP recommended that rising nearshore groundwater levels could be addressed through DEP regulations requiring a five-foot separation to groundwater for septic system leaching fields (instead of the current 4-foot separation required). DEP addressed this issue indirectly by tackling another issue simultaneously. In their 1996 regulations, they required a five-foot separation in very fast perking soils (as might be found near coastal beaches). The strategy was imperfect, for while this regulatory change addressed groundwater separation in most coastal areas, it did not capture all near shore areas, and this recommendation has been revised in this updated action plan.

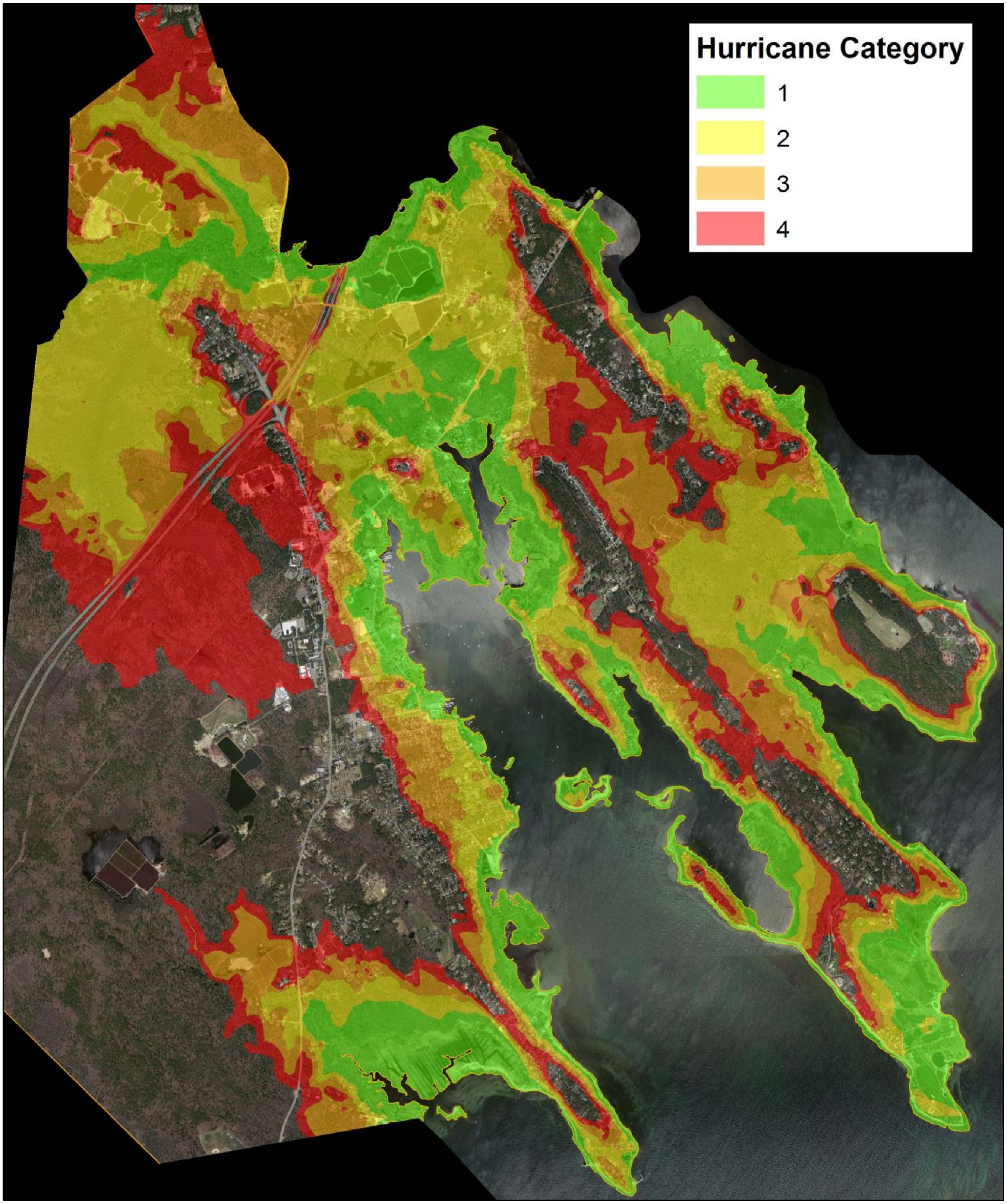

Figure 107. 2013 updated SLOSH flooding model map of Marion, MA produced by the U.S. Army Corps of Engineers.

Shows the current “sea, lake, and overland surges from hurricanes” model for coastal flooding developed by the U.S. Army Corps of Engineers for the Town of Marion. The model shows the worst-case flooding scenario for Category 1-4 hurricanes striking Buzzards Bay. Marion is one of several Buzzards Bay communities with extensive areas within the flood zone. The Buzzards Bay NEP has estimated the assessed value of structures within the FEMA floodplain (nearly the Category 2 storm boundary here) to be 93.5 million dollars.

For three decades, the Massachusetts Coastal Zone Management Office (CZM) has tried to tackle broader sea level rise and coastal erosion issues across Massachusetts. Besides the various guidance documents, policies, and regulations that were developed by CZM staff, the agency, with funding from NOAA, began conducting a GIS analysis of historic maps and aerial photographs.

This effort culminated in two important shoreline change reports that identified the most erosion prone coastal areas of Massachusetts (Thieler et al., 2001; O'Connell et al., 2002). The reports helped towns and regulatory agencies formulate policies and regulations that account for the threats to infrastructure and the environment posed in these dynamic areas. In 2002, CZM updated its program policies to address sea level rise issues in their review of projects. For example, in the 2011 Massachusetts CZM Policy Guide, it is noted that "relative sea level rise should be factored into the design life, elevation, and location of buildings and other structures within the coastal floodplain," and "non-structural alternative approaches to coastal hazards reduction are preferred over structural alternatives."[211]

Massachusetts joined the National Flood Insurance Program (NFIP) in 1978, the first year of the program. Today, more than 95% of Massachusetts' 351 communities participate in the NFIP program. In 1986, Massachusetts also was one of the first states to receive FEMA approval for its State Hazard Mitigation Plan. In 2007, the State Hazard Mitigation Team comprised of staff from the Massachusetts Emergency Management Agency and Department of Conservation and Recreation, together with other state and federal agencies, prepared the most recent State Hazard Mitigation Plan. This document, organized differently than past plans, addressed a number of additional laws and requirements, and for the first time attempted to include priorities contained in local plans.

The 2007 state plan recognized the importance of local government in defining patterns of development and redevelopment, and placed an increased emphasis on the creation of local mitigation plans, with the state providing funding to regional planning agencies to achieve those goals. At the time of the writing of this report, only 25% of the communities in Massachusetts had a local hazard mitigation plan.

While the state was updating its 2007 State Hazard Mitigation Plan, a parallel effort was underway to evaluate coastal hazards. This effort began in February 2006, when the governor created the Massachusetts Coastal Hazards Commission. The charge to the commission was to review existing coastal hazards practices and policies, identify data and information gaps, and draft recommendations for administrative, regulatory, and statutory changes. In May 2007, the commission released its final report. The report contained 29 specific recommendations, most of which were directed to state and federal agencies, and most of these recommendations revolved around improving databases, resources, and local and regional plans to better respond to disasters.

Both these reports touched on the importance of local hazard mitigation planning and better understanding the role of local government and the fact that the development and approval of the local plans creates increased opportunities of funding and technical assistance to local government. One of the more important of these opportunities is the eligibility for hazard mitigation grants. Equally important is that municipalities become eligible to participate in the Community Rating System (CRS). The CRS program provides two key local benefits. The first of these is that it reduces flood insurance policy rates for homeowners in the flood zone. Second, it results in a higher rate of municipal reimbursements in the event of natural disasters. The key disadvantages from the town's point of view are that the town must first dedicate resources to help develop the local hazard mitigation plan. Second, the town must dedicate staff to comply with annual reporting requirements and activities to meet annual CRS certification.

While municipalities may participate in the CRS to reduce threats to human life and property, and for additional political or financial benefits that participation convey, from an environmental policy perspective, many activities that achieve high CRS scores will also reduce environmental impacts from new development, or reduce environmental impacts resulting from natural disasters[212] (see Table 50). For this reason, local participation in the CRS is a high priority in this action plan.

In 2008, in an effort to better increase public awareness and local government action to plan for sea level rise and future storm and coastal erosion impacts, CZM launched the StormSmart Coasts initiative. The effort consisted of a mix of outreach materials, an information exchange StormSmart Coasts website, and workshops directed toward planners and local government officials. As such, it became a logical extension of the state's efforts to place more emphasis on local government actions to manage development. The website was established to provide an accessible collection of ideas, strategies, and case studies to help communities improve efforts to manage coastal floodplains and support local efforts to improve the management of coastal floodplains in Massachusetts.

In 2013, the Buzzards Bay NEP created a similar subdomain website climate.buzzardsbay.org to present storm smart planning and climate ready assessments for

[211] Available at www.mass.gov/eea/agencies/czm/about-czm/czm-policy-guide/, last accessed October 22, 2013.

[212] According to FEMA CRS guidance documents, participation will help "reduce the risk of erosion damage, and protect natural and beneficial floodplain functions." FEMA 2006. CRS Coordinators manual. 130 pp.

Buzzards Bay. This website consolidate information, data, and assessments undertaken by the Buzzards Bay NEP and others, about the potential impacts to Buzzards Bay and its watershed from storms, shifting shorelines, rising sea level, and changes in climate and precipitation. This information, along with potential adaptation strategies, is meant to inform and guide government officials, researchers, local managers, and the public.

The Buzzards Bay National Estuary Program has established this website to consolidate information, data, and assessments undertaken by the Buzzards Bay NEP and others, about the potential impacts to Buzzards Bay and its watershed from storms, shifting shorelines, rising sea level, and changes in climate and precipitation. We are providing this information, along with potential adaptation strategies, to inform and guide government officials, researchers, local managers, and the public.

Major Issues

Even though the magnitude and timing of future storms and shoreline changes is not known, the fact that shorelines erode and migrate is incontrovertible. More importantly, hurricanes are certain to cause more economic damage in the future, not because storms will be more intense, but because there is so much additional development, infrastructure, and residences built in coastal storm damage prone areas than in past decades. Pielke et al. (2008) found that between 1900 and 2005, increases in economic damage caused by hurricanes were the result of patterns of development, and not increased storm frequency or intensity.

It is often argued that the National Flood Insurance Program creates moral hazards[213] by undercharging for actual risks and even funding those who failed to pay for government flood insurance (Kriesel and Landry, 2004). As noted earlier, the U.S. Congress finally addressed this issue with the passage of the Biggert-Waters Flood Insurance Reform Act of 2012. A key element of the legislation is to require the NFIP to charge flood insurance policy rates that reflect true flood risks and program costs. These higher costs will discourage new development in flood prone areas. These changes (to be phased in over several years) will affect existing property owners, and will eliminate grandfathering of insurance rates after a property is sold. Concerns have been raised about financial impacts to existing homeowners. These concerns have prompted attempts to pass new legislation to curtail or delay elements of the act and possibly undermine the climate adaptation benefits of the law[214].

Table 50. Selected Community Rating System activities that may benefit the environment.

Listed by CRS program category number; from FEMA, 2006.
410 (Additional Flood Data) Develop new flood elevations, floodway delineations, wave heights, or other regulatory flood hazard data for an area that was not mapped in detail by the flood insurance study; or have the flood insurance study's hydrology or allowable floodway surcharge based on a higher state or local standard.
420 (Open Space Preservation) Encourages communities to keep hazardous areas open and undeveloped;
420 (Open Space Preservation) Extra credit is provided for open space areas that are preserved in their natural state, have been restored to a condition approximating their pre-development natural state, or have been designated as worthy of preservation for their natural benefits, such as being designated in a Habitat Conservation Plan.
430 (Higher Regulatory Standards) Require freeboard; require soil tests or engineered foundations; require compensatory storage; zone the floodplain for minimum lot sizes of 1 acre or larger; regulate to protect sand dunes; or have regulations tailored to protect critical facilities or areas subject to special flood hazards (e.g., alluvial fans, ice jams, or subsidence).
430 (Higher Regulatory Standards) Regulations that protect natural areas during development or that protect water quality are credited.
450 (Stormwater Management) Regulate new development throughout the watershed to ensure that post-development runoff is no worse than predevelopment runoff.
450 (Stormwater Management) erosion and sediment control and water quality requirements for projects that affect stormwater runoff are credited.
520 (Acquisition and Relocation) Acquire and/or relocate flood prone buildings so that they are out of the floodplain.
540 (Drainage System Maintenance) Conduct periodic inspections of all channels and retention basins and perform maintenance as needed.

In 2011, Massachusetts Coastal Zone Management updated its program plan with these goals: "(1) prevent, eliminate, or significantly reduce threats to public safety, property, and environmental resources resulting from hazards such as erosion, flooding, and storm damage; (2) allow natural physical coastal processes to continue while allowing appropriately sited coastal development and economic growth and promote the use of nonstructural alternatives for shore protection where appropriate and to the extent feasible; (3) limit, prohibit, or condition public expenditures in coastal high hazard areas to ensure that increased exposure to coastal hazards is not encouraged; and (4) prioritize public expenditures for acquisition and relocation of structures out of hazardous coastal areas." Collectively, state, federal, and local policies, laws, and regulations, as currently implemented, are not yet adequate to meet these goals.

Despite the harsh reality of increased development in storm prone areas, most regulations at all levels of government currently assume a static sea level, static shorelines, static nearshore groundwater elevations, or inade-

[213] In legislation proposed by Congress in 2010, the authors wrote, "The Congress finds that.... phasing out flood insurance premium subsidies currently extended to vacation homes, second homes, and commercial properties would result in significant average annual savings to the national flood insurance program.... In addition, we are concerned by provisions that delay the phase out of subsidies and the phase in of risk-based rates. There is an inherent moral hazard when any premium rates are subsidized, and we believe these reforms are urgently needed. Charging less than full-risk rates by the NFIP maintains a system of financial incentives backed by the federal government for individuals to live and build in high-risk flood zones."

[214] There are many benefits of the law for climate adaptation beyond restructuring flood insurance policy rate changes. A good summary is provided by the Georgetown Climate Center (Grannis, 2012).

quate estimates of coastal inundation. Therefore, flood prone areas could expand along the coast as sea level rises

Management Approaches

This action plan requires changes in regulations, policies, and activities at all levels of government, especially public spending for infrastructure in high risk areas, and public spending and program polices that promote development in high risk areas by creating moral hazards. The latter problem will require changes in, and rethinking of flood insurance programs and the kinds of actions required by the federal government should require in the aftermath of disaster relief aid.

With respect to regulations, DEP should amend its wetlands regulations for the resource area "Land Subject to Coastal Storm Flowage" (100-year floodplain) to include performance standards to create a seawall exclusion area 1 vertical foot above the upper salt marsh boundaries. This would allow for salt marsh migration for at least the next 50 years. Such regulatory change could be accomplished in less than a year if desired.

CZM should prepare and post online a Coastal Hazards Characterization Atlas for Buzzards Bay to assist area planning boards, conservation commissions, and other relevant local boards to create plans and regulations to better plan development in coastal areas prone to storm damage and shifting shorelines. They completed such an atlas in 2005 for Massachusetts South Shore communities. Municipalities need such reports to help justify changes in zoning and general bylaws, and to develop and update local land use plans.

Similarly, CZM and USGS could develop a Risk and Vulnerability Assessment Map for each coastal municipality using a standardize methodology and recent LiDAR data. This map series should include scenarios of sea level rise and storm surge. Most of the LiDAR data needed for such an effort was acquired by the federal government for 2011[215]. Much of the GIS work could be conducted in house. The Buzzards Bay NEP is currently undertaking such inundation maps for 1-, 2-, and 4-foot sea level rise scenarios for both the expansion of the flood zone and high tide line for Buzzards Bay.

The Federal Emergency Management Agency should update and maintain Flood Insurance Rate Maps for Buzzards Bay to ensure they are based on the best available LiDAR data. For example, FIRMS for Bristol County in 2009 did not appear to incorporate correctly the latest FIRM data[216].

MassGIS, with support from CZM, should continue to expand its online GIS portals (such as Oliver) to make available and distribute coastal hazards information.

EEA should also evaluate the distribution of coastal hazards and emergency management information relating to coastal municipalities to ensure that the public is kept informed with up-to-date and accurate hazard information, and understand the actions that government may ask of the public. FEMA already publishes information on the number of claims filed and paid in each municipality, but maps of claim locations or recurring damage to public structures would help justify local measures to manage growth in hazard prone areas.

EEA should revise and promote policies, regulations, and take actions to promote sand nourishment as the preferred alternative for eroding and shifting shorelines. Some of these policies can be implemented through the MEPA permitting process, much like the way policies on greenhouse gas emission have been implemented[217]. Most federal and local dredging projects still have the largest fraction of dredged materials disposed at sea. This action would also compliment CZM's policies on the beneficial use of dredge materials.

EEA should help fund a standardized benefit-cost analysis model that fully compares the capital, societal, and natural resource benefits and costs of proposed shoreline protection projects and appropriate alternatives. The hidden extra costs of government (and therefore to taxpayers) to provide services to development in hazard-prone areas is not fully appreciated and needs to be explained.

After catastrophic storms, the Department of Fish and Game and the Department of Conservation and Recreation should acquire storm damaged and storm prone properties from willing sellers in fee or through conservation restrictions and easements. This is accomplished by revising current criteria in agency policy (or state regulations) to promote coastal land acquisition, and utilizing federal incentive grant programs. FEMA has a program in place, but state agencies and municipalities must apply. Municipalities should acquire storm prone properties through Community Preservation Act funding. The estimated costs of these acquisitions will total many tens of millions. Besides federal and state grants, local CPA funds could fund purchases. These lands can be acquired by not only purchase in fee approaches, but by conservation restrictions. This approach will take many years, and depends on willing buyers. Adding to the challenge is the fact that these hazard prone properties tend to be very expensive waterfront properties, so there

[215] There is a gap between the 2011 Northeast LiDAR data set and the 2006 LiDAR data acquired by FEMA in the western half of the Buzzards Bay watershed. This data gap can only be filled with the acquisition of new LiDAR data.

[216] See the Buzzards Bay NEP report Discrepancies between recently updated FEMA FIRM base flood elevation boundaries and LiDAR data in Buzzards Bay. Buzzards Bay National Estuary Program and Massachusetts Office of Coastal Zone Management Technical Report SLR13-8 Draft May 3, 2013.

[217] More information is retrieved from the Massachusetts Greenhouse Gas Emissions Reporting Program website.

may be low local interest and capacity to pursue such purchases.

The Massachusetts Emergency Management Agency, the Department of Conservation and Recreation, and the Office of Coastal Zone Management, along with other appropriate planning agencies, should continue to encourage coastal communities to develop, update, and implement coastal hazard mitigation plans. Few Massachusetts communities, and none in Buzzards Bay, have these in place. EEA can provide technical assistance, and possibly the legislature could help by funding.

Municipal planning boards can adopt and implement strict development/redevelopment standards within FEMA A and V flood hazard zones and other areas subject to coastal flooding, erosion, and relative sea level rise. For example, the Marion subdivision regulations prevent new subdivisions in the flood zone. Broader zoning measures will require town meeting approval. Possible supporting legislation may be needed at town meeting.

Through municipal zoning and local wetland bylaws, Buzzards Bay municipalities should establish coastal

1991 Shoreline Action Plan and Outcomes

Goals

1. Protect public health and safety from problems associated with higher waters and shifting shorelines.

2. Reduce the public financial burden caused by the destruction of or damage to coastal property.

3. Plan for the loss of buffering wetlands and shifting sand formations.

Objectives

1. To incorporate sea-level rise and shoreline change phenomena into all relevant planning and management programs

2. To develop a comprehensive strategy for handling existing structures in areas predicted to be affected by future shoreline changes.

3. To adopt regulatory and non-regulatory measures for guiding growth and development in areas that will be influenced by new shorelines.

4. To restructure the flood and hazard insurance programs in threatened areas so that the financial burden on the general public is decreased. [The U.S. Congress finally addressed this issue in part with the passage of the Biggert-Waters Flood Insurance Reform Act of 2012.]

Recommendations and Outcomes

1. DEP will amend its wetlands regulations and adopt performance standards for the resource area “Land Subject to Coastal Storm Flowage” (100 year floodplain).

Outcome: Deemed partially complete through adoption of the Rivers Protection Act and some other changes in 2008.

2. CZM will provide technical assistance to Buzzards Bay area planning boards, conservation commissions and other relevant local committees, commissions and boards in mapping coastal areas that are, or will be, affected by erosion and/or sea level rise

Outcome: Deemed complete through completion of shoreline change maps, Geise study, and other publications and outreach materials. Still ongoing, with communication facilitated through a new Storm Smart Climate Ready Buzzards Bay website.

3. CZM will provide technical assistance to Buzzards Bay communities in developing by-laws, regulations, guidelines, and policies for building in flood zones mapped by the Federal Emergency Management Agency.

Outcome: Deemed complete through adoption of post Hurricane Bob policies, completion of shoreline change maps, Geise study, and other publications and outreach materials.

4. Buzzards Bay communities should pass bylaws increasing the required setback for septic systems from groundwater, water bodies, and vegetated wetlands for areas subject to sea-level rise, erosion, or flooding.

Outcome: Local regulations largely not adopted, but state Title 5 regulations and River Protection Act helped partially chieve this recommendation.

5. Buzzards Bay communities should establish coastal construction setbacks and regulate construction activities more stringently for areas predicted to be subject to sea-level rise, erosion, or flooding.

Outcome: Some communities (like Falmouth) adopted firmer no build set backs from some wetlands, but most towns did not adopt setbacks. Some Title 5 changes helped partially meet this recommendation.

6. Buzzards Bay communities should establish higher flood elevations that exceed the minimum elevations mapped by the Federal Emergency Management Agency.

Outcome: Recommendation cannot be implemented by town; and rejected as written. However, in 2008, the Commonwealth of Massachusetts changed the state building code, requiring freeboard for V-zone properties and required other “storm smart” measures.

construction setbacks and regulate construction activities more stringently for areas predicted to be subject to sea level rise, erosion, or flooding. In particular, these regulations should prohibit the construction of seawalls, revetments, and groins to allow wetland and natural sediment migration processes. Priorities should be set focusing first on the velocity zone and faster eroding coasts.

Municipalities are not allowed to create local building codes. These policies and requirements must be set at the state level. The state Board of Building Regulations and Standards has the ability to update the State Building Code requirements for coastal construction to include requirements for freeboard (the vertical distance between a water level and the top of something that contains or restrains it), and other measures. Such a requirement was implemented in 2008 for properties in the V-Zone (2 feet is now required). Freeboard could also be required for the first floor of properties in the A-Zone. The state also implemented a program to enable local flex code standards. The board should also encourage collaboration between building inspectors and conservation commissions.

Municipalities should prepare and distribute outreach materials encouraging the voluntary adoption of freeboard for new and major reconstruction. Property owners may incorporate freeboard if they recognize the savings in insurance costs. All municipalities should adopt and keep up-to-date their hazard mitigation plan, and participate in the Community Rating System. The CRS not only benefits communities by focusing their planning efforts, and minimizing public storm-related expenses, but also can result in low insurance premiums for residents. CZM, in cooperation with U.S. Army Corps of Engineers, should help implement a program of regional sand management through adoption of state policies, regulations, and activities that promote beach nourishment as the preferred alternative for coastal hazard protection and require beneficial uses of dredged materials, with limited waiver ability from the requirement. Municipalities should consider beneficial uses of dredge materials, even beyond their political boundaries.

CZM and DEP should develop a guidance document or revise the Wetland Protection Act regulations to incorporate best management practices or performance standards for land subject to coastal storm flowage (LSCSF). The state's WPA regulations have long lacked clear performance standards for LSCSF.

CZM should conduct a regional sand management study that identifies (1) critically eroding public beaches where access is open to the public, (2) areas most vulnerable to coastal hazards, and (3) potential regional beach nourishment methodology and costs. CZM will need to update and finalize the existing draft document entitled Assessing Potential Environmental Impacts of Offshore Sand and Gravel Mining for the Purposes of Beach Nourishment to include contemporary state of knowledge regarding the potential short- and long-term physical and biological impacts associated with offshore sediment removal.

There are both confusion and confounding technical issues surrounding the real world elevations of the mean high water mark and the high tide line (the latter defined by the annual high tide or "king tide")[218]. Often these elevations are not correctly identified in engineering plans submitted to state and local permitting agencies. These issues can be partly resolved through the presentation of data, maps, and information disseminated on the Buzzards Bay NEP website.

Financial Approaches

Many of the expenses associated with this action plan relate to conducting risk assessments and planning. These efforts might cost hundreds of thousands of dollars per community and require dedication of staff time. The actual costs for changing, implementing, and conforming to any regulations are probably negligible. Specific projects like the CZM Coastal Hazards Characterization Atlas for Buzzards Bay might cost $10,000 or more to produce. The costs of updating CZM and Mass GIS portals would be minimal because both systems are already well established and the agencies can use existing website management staff.

Potential funding sources for planning and assessment include NOAA Coastal Zone Enhancement (Section 309) Grants, and various FEMA grant programs.

Monitoring Progress

Because of the rarity of catastrophic storms, many of the benefits of this action plan might not be assessed for decades. Therefore to evaluate this action plan, programmatic actions must be tracked. Such tracking might include town completion of hazard mitigation plans, adoption of new laws or regulations, participation in FEMA's CRS program, and acquisition of sensitive properties.

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[218] Under Massachusetts Wetland Protection Act regulations, the elevation of the mean high water (MHW) mark is based on the average predicted MHW during the currently adopted National Tidal Datum Epoch (1983-2001). Under federal law, the high tide line (HTL, or highest tide of the year), does not have a specific reference time period defined. This ambiguity has prompted some (like the state of Connecticut Department of Transportation, see Doody 2009) to call for a definition based on predicted highest annual tides during a tidal epoch.

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MA 2007 Coastal Hazard Plan Recommendations (MEMA, 2007)

The following recommendations were included in the 2007 Coastal Hazard Plan for Massachusetts. They are being reviewed for consistency with this action plan and possibly incorporated by reference into this action plan.

Recommendation #3 Develop an RVAM for each coastal community using a standardized GIS methodology.

Lead Agency: Massachusetts Emergency Management Agency (MEMA), DCR, regional planning agencies, and municipalities
Funding Requirement: yes
Potential Funding Source: FEMA Hazard Mitigation Grant, state funds, and municipal funds
Next Steps: form task force of stakeholders to develop the standardized GIS methodology
Project Duration: 5 years

Recommendation #4: Map and model climate change and sea level rise data related to coastal hazards in Massachusetts.

Lead Agency: USGS
Funding Requirement: yes
Potential Funding Source: federal funds and state funds
Next Steps: acquire funds, assess status of current data, and develop plan to collect new data
Project Duration: 5 years

Recommendation #5: Develop a process to capture coastal conditions immediately after major storm events.

Lead Agency: CZM and MEMA
Funding Requirement: no
Next Steps: form task force to identify opportunities, make arrangements with appropriate agencies, and train the Storm Team
Project Duration: 6 months

Recommendation #6: Model potential storm damage based on historical event data to educate decision makers and the public to the magnitude of risk in the coastal zone.

Lead Agency: MEMA, DCR, and CZM for wind modeling; FEMA, USACE, and NOAA for inundation modeling
Funding Requirement: yes
Potential Funding Source: federal funds and state funds
Next Steps: acquire funds and run scenarios using appropriate models
Project Duration: 2-4 years

Recommendation #8: Evaluate the distribution of coastal hazards and emergency management information to coastal communities before and during major storm events.

Lead Agency: MEMA, CZM, and municipalities
Funding Requirement: yes
Potential Funding Source: state funds
Next Steps: acquire funds and develop survey to be distributed to residents and visitors of high-risk coastal areas
Project Duration: 1 year

Recommendation #9 (Priority): Establish a storm-resilient communities program to provide case studies for effective coastal smart growth planning and implementation.

Lead Agency: Massachusetts Executive Office of Energy and Environmental Affairs (EEA)
Funding Requirement: yes
Potential Funding Source: state funds
Next Steps: acquire funds and define the model storm-resilient community
Project Duration: 2-4 years

Recommendation #10: Finalize guidance document for state and local agencies on the implementation of Executive Orders 149 and 181 relative to publicly funded infrastructure projects, and develop guidance for the remaining sections of Executive Order 149.

Lead Agency: CZM and DEP
Funding Requirement: no
Next Steps: update and finalize draft guidance document
Project Duration: 1 year

Recommendation #18: Develop informal local coordination processes or modify bylaws to provide for the coordination of permitting and approval by local departments.

Lead Agency: chief elected municipal officials
Funding Requirement: no
Next Steps: assemble municipal agents to discuss opportunities for coordination
Project Duration: 6-12 months

Recommendation #21: Identify existing culverts and tide gates associated with transportation crossings of coastal wetlands that are priorities for replacement due to flood hazards or environmental resource concerns, and address flooding, wetlands hydrology, and maintenance in the early stages of the design and implementation of new or replacement transportation projects that cross coastal wetlands and waterways.

Lead Agency: Massachusetts Executive Office of Transportation (EOT), CZM, DEP, and USACE
Funding Requirement: yes
Potential Funding Source: state funds
Next Steps: form working group to develop strategy
Project Duration: 1 year

Recommendation #25 Identify and map potential offshore and inland sources of suitable nourishment sediment.

Lead Agency: USGS
Funding Requirement: yes
Potential Funding Source: federal funds
Next Steps: map existing data
Project Duration: 5 years

Recommendation #27: Establish a Technical Advisory Committee, consisting of a broad range of qualified professionals, to evaluate and develop construction and monitoring guidance, and recommend appropriate approval conditions for those protection approaches determined to be new and innovative.

Lead Agency: EEA
Funding Requirement: no
Next Steps: identify members and hold first planning meeting
Project Duration: ongoing

Recommendation #28: Build upon an ongoing study by WHOI Sea Grant and the Cape Cod Cooperative Extension to quantify the inherent values of Cape Cod coastal beaches for storm damage protection, recreation, and wildlife habitat to develop similar values for all Massachusetts beaches.

Lead Agency: Woods Hole Oceanographic Institution (WHOI) Sea Grant and Cape Cod Cooperative Extension
Funding Requirement: yes
Potential Funding Source: WHOI funds and Cape Cod and Islands License Plate Campaign funds
Next Steps: acquire funds and release request for response
Project Duration: 1-2 years

Recommendation #29: Develop a standardized benefit-cost analysis model using an approach adapted from that used by the USACE to justify projects that fully compares the capital, societal, and natural resource benefits and costs of proposed shoreline protection projects and appropriate alternatives.

Lead Agency: EEA and academic or research institute
Funding Requirement: yes
Potential Funding Source: private grants
Next Steps: identify lead researcher and acquire funding
Project Duration: 2 years

Action Plan 19 Protecting Public Health at Swimming Beaches

Problem

Public and private beaches are found throughout Buzzards Bay (Figure 109) and are an important recreational, aesthetic, and economic resource to the residents of the Buzzards Bay watershed and surrounding areas, and an important source of revenue for municipalities, both in the collection of fees (Table 51), and through the attraction of tourists.

Bathing beaches for many represent the only direct exposure or use of Buzzards Bay, and as such, the quality and condition of bathing beaches plays an important role in the public perception of the health and condition of Buzzards Bay. These bathing beaches also represent potential human exposure to contaminants discharged to surface waters. Of these contaminants, pathogens in particular represent the most important potential threat to public health. Exposure to pathogens by bathers can occur either by direct contact with, or ingestion of, contaminated waters, and may result in illness.

This action plan identifies ways in which local and state government can minimize threats to human health from the risks of pathogen contamination at swimming beaches. The solution to the problems outlined in this action plan will require better designed testing, improved reporting, education of the public, and action to reduce the most serious forms of pollution.

Goals

Goal 19.1. Reduce or eliminate pollution sources contributing to beach closures.

Goal 19.2. Manage beach use to reduce human exposure and health risks based on site-specific conditions.

Objectives

Objective 19.1. Reduce contaminated stormwater discharges to beach areas.

Objective 19.2. Increase public awareness about areas prone to contamination or conditions that may lead to elevated contaminant levels at beaches.

Objective 19.3. Prohibit pet use of beaches and encourage pet waste collection in stormwater drainage areas.

Objective 19.4. Develop and implement more rapid assays to document existing conditions, and where necessary implement preemptive rainfall closures.

Approaches

To meet the goals of this action plan requires two types of actions. First, pollution sources causing beach closures must be identified and eliminated. Second, beaches should be tested more rigorously to capture poor water quality after adverse conditions, such as after moderate to heavy rains. Current beach testing practices only catch these by chance. Evaluating beaches during adverse conditions will better protect the public from water borne diseases and minimize health risk. Municipalities with 15% exceedances each summer at their beaches should test their beaches at least twice per week and conduct sampling to identify sources.

Because staff may have to work after hours to collect samples for such an evaluation of adverse conditions at a beach, this creates a burden. Hiring a contractor to conduct a detailed study of the relationship between rainfall and bacteria levels at the beach may be the sound approach that could allow municipal officials to determine if rainfall conditional beach closures are warranted. MA Department of Public Health and other agencies should continue to evaluate and promote rapid assays.

Programs and regulations to eliminate pets from beaches, or to promote pet waste cleanup in coastal drainage areas can help alleviate problems.

Costs and Financing

Remediating pollution sources can be costly, especially for those beaches near a brook or drainage system where many sources may be contributing to elevated pollution loads. Most of these pollution sources will be associated with stormwater discharges, and these costs are addressed more comprehensively in Action Plan 3 Managing Stormwater Runoff and Promoting LID.

The cost of increased monitoring is relatively modest, but because laboratories charge extra fees if samples are taken at times that require processing during non-working hours, sampling analyses costs can be higher and must be budgeted. Dog waste receptacles have minimal costs and are good education tools.

Measuring Success

The final measure of success of this action plan will be the documentation in the reduction of beach closures for any given sampling scheme.

Background

Bathing beaches around Buzzards Bay are popular with residents and tourists and are an important source of revenue for municipalities (Table 51), and boost the local economies. Beaches can also pose a health risk if pollution discharges at or near the beaches are not properly managed. The most frequent illness documented from contaminated beaches are various forms of gastroenteritis (e.g. campylobacteriosis), but potentially more serious diseases may result including salmonellosis, giardiasis, and hepatitis A. In fresh water ponds, skin lesion diseases such as impetigo can also occur.

To minimize these and other disease threats, state and federal agencies have promulgated beach testing regulations that are primarily implemented by local government. In Massachusetts, bathing beach water quality is regulated by the Massachusetts Department of Public Health (MDPH) under MGL Chapter 111, Section 5S and regulations cited as 105 Code of Massachusetts Regulations 445.000: Minimum Standards for Bathing Beaches (State Sanitary Code, Chapter VII; Appendix A and B, 105 CMR 445). To protect public health, these regulations require all public and semi-public beaches to be monitored for indicator bacteria, and on occasion other environmental contamination during the beach season and closure of beaches when levels of indicator organisms exceed regulatory standards.

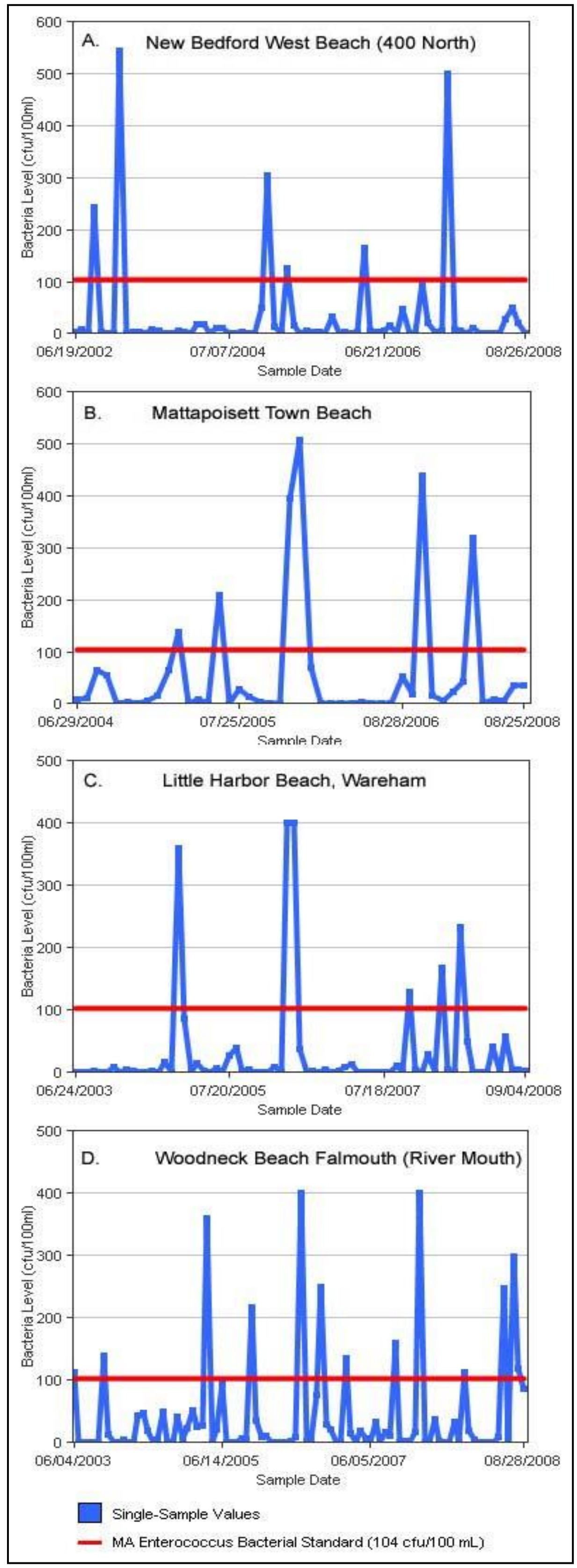
In recent years, these regulations have become more stringent, and indicator bacteria have changed, as has required testing frequency. These new regulations require local government to evaluate beaches during adverse conditions, such as after heavy rains, rather than testing on a prescribed day of the week.

Because of the resource burdens and costs related to beach water monitoring, municipalities may not meet all beach monitoring requirements. No Buzzards Bay mu-

Table 51. Municipal beach parking sticker costs.

Town	Resident/ Taxpayer	Non-Resident	Senior	Town Fee parking
Falmouth	$30	$200 (season)	not offered	3 beaches, $10-$20
Bourne	$15	$30	not offered	none
Wareham	$20	$40	$5 at 65	$5
Mattapoisett	$10	not offered	free at 65	$10
Marion	$10	$35	free	none
Fairhaven*	$25	not offered	free at 60	$5*
New Bedford	free	free	free	none
Dartmouth	$70	$100	$50 at 65	none**
Westport	$20	not offered	$10 at 60	none***

* Fairhaven is the only town with a fee ($2) for bicyclists and pedestrians. They also have a $5 auto daily parking fee for residents only.
**There is $7 parking fee at the state operated Demarest Lloyd State Park.
***There is $7 parking fee at the state operated Horseneck Beach State Reservation.



Data from Massachusetts Department of Public Health, data at mass.digitalhealthdepartment.com.

Figure 108. Selected Buzzards Bay beach monitoring site results compared to the safe swimming standards.

nicipalities have implemented preemptive rainfall conditioned beach closures, despite the fact that ample data (bacteria levels typical after heavy rains) justify such actions. Municipal officials privately admit that preemptive rainfall beach closures would be unpopular with residences and they are concerned with potential impacts to local tourism and the economy. Municipal officials are also concerned with the potential high cost of remediating stormwater related beach closures.

This action plan principally addresses minimizing human health risks from beach contamination. Loss of the use of beaches due to erosion and shifting shorelines is addressed in Action Plan 18 Planning for a Shifting Shoreline and Coastal Storms. Aesthetic and health risks associated from debris on beaches are addressed in Action Plan 14 Reducing Beach Debris, Marine Floatables, and Litter in Wetlands. Contamination of shellfish with pathogens is addressed in Action Plan 2 Protecting and Enhancing Shellfish Resources.

There are about 70 public beaches (municipal and state owned including sub areas) stretching across 13.4 miles of Buzzards Bay, with roughly an additional 40 "semi-public" beaches covering 31.9 miles[219]. A map of these beach areas is shown in Figure 109. Public beaches are available to both residents and non-residents, but parking restrictions and parking costs affect use of these beaches (see Table 51). These parking fees typically pay for lifeguards and other services, and may pay for beach water testing programs.

Semi-public beaches include some large tracts of state, municipal, and private conservation coastal lands where the public may have some right to use, and bathing may occur, but generally, these areas do not have posted lifeguards. On the other hand, semi-public beaches also include beach association and community beaches, private pay-to-use beaches, club and resort beaches, which are not open to the public, but may have intense use. The rest of Buzzards Bay's coastline is largely privately owned parcels. In Massachusetts, private property rights generally extend to the low tide mark, and these beaches are typically used for bathing only by property owners and their guests. The water quality at these beaches is usually not tested, but may be done at the owner's request and expense.

Table 52. Number of marine beach testing exceedances in Buzzards Bay in 2010 and 2011.

Data from MDPH. Only Bourne and Falmouth beaches in Buzzards Bay included in the analysis. Both public and semi-public beaches included.

2010 Results for Buzzards Bay Beaches

Municipality	# of Tests	# of Single Sample Exceedances	Number of Postings
Bourne	160	2	1
Dartmouth	141	1	1
Fairhaven	83	2	2
Falmouth	195	1	1
Marion	132	1	1
Mattapoisett	157	8	9
New Bedford	167	9	10
Wareham	225	5	5
Westport	69	2	1
Grand Total	1329	31	31
percent exceedances		2%	

2011 Results for Buzzards Bay Beaches

Municipality	# of Tests	# of Single Sample Exceedances	Number of Postings
Bourne	170	1	1
Dartmouth	144	3	4
Fairhaven	81	1	1
Falmouth	200	3	3
Marion	121	1	1
Mattapoisett	181	5	5
New Bedford	196	10	10
Wareham	204	2	2
Westport	56		1
Totals	1353	26	28
percent exceedances		2%	

Massachusetts is one of five states[220] with such property ownership to the low tide mark. Under Chapter 91 of the Massachusetts General Laws, some public rights in the intertidal zone are preserved (principally fishing, fowling, and navigation). More information on the origins of this law and public rights in the intertidal zone in Massachusetts can be found on the Buzzards Bay NEP's Public Access to Buzzards Bay and its Shore page, and Massachusetts Coastal Zone Management's Public Rights Along the Shoreline page.

[219] This total is for the 310 miles of coast for the mainland portion of Buzzards Bay, including both the Cape Cod side and western or "south coast" side of the bay. This total does not include the 9 miles of coastline of the Cape Cod Canal within the Buzzards Bay watershed, nor does it include an additional 40 miles of coastline on the bay facing side of the Elizabeth Islands. Thus the total coastline in the NEP study area is 359 miles. The length of coastline from Westport to Wareham ("South Coast") is 245 miles, and the length of public and semi-public beaches from Westport to Wareham ("South Coast") is 11.7 and 26.6 miles respectively. (source: BBNEP calculations posted at buzzardsbay.org/phbeachinfo.htm.

[220] The other states are Delaware, Maine, Pennsylvania, and Virginia.

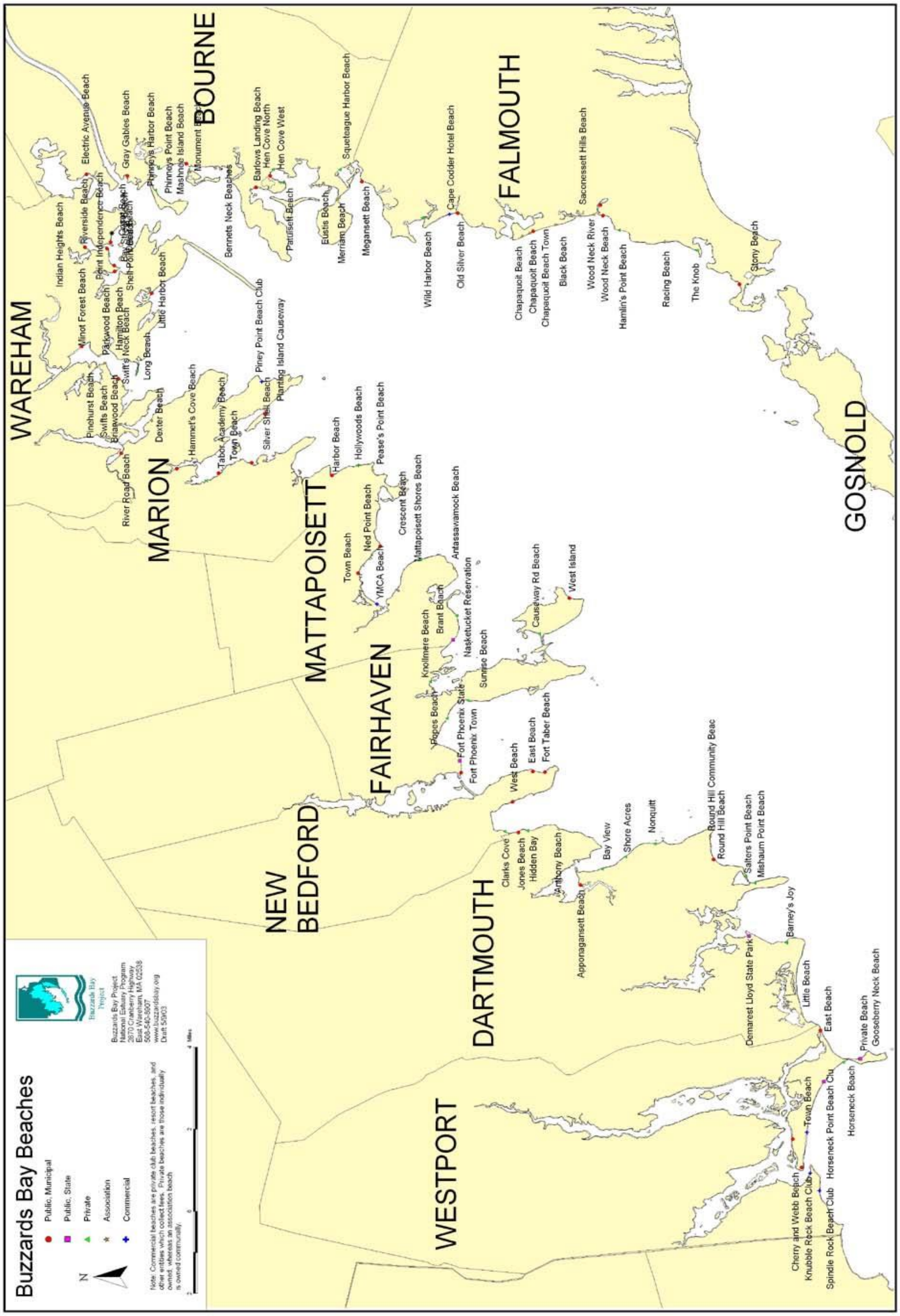


Figure 109. Principal public and private bathing beaches of Buzzards Bay.
Some smaller or lesser-used beaches are not shown.

In 2000, the U.S. Congress enacted the Beaches Environmental Assessment and Coastal Health (BEACH) Act to improve the quality of coastal recreational waters. Also in 2000, the Massachusetts Beaches Act (Chapter 248 of the Acts of 2000) was passed, with new state regulations promulgated in April 2001 (105 CMR Section 445). The act mandated that the state Department of Public Health (MDPH) establish a program to provide for monitoring, testing, and posting of public and semi-public beaches. MDPH requires beaches be tested at least weekly during the bathing season using standardized protocols with improved indicators, with the results of these efforts to be posted in a timely manner. By 2004, these new water quality standards and monitoring procedures were implemented in all Massachusetts coastal communities. This increased compliance also resulted in increases in the number of beach closures statewide due to more frequent testing.[221]

The most important elements of the Massachusetts beach testing regulations is that they required minimum weekly sampling and changed the indicator organism for marine waters to Enterococci (from fecal or total coliforms). For fresh water, the indicator organisms remained either fecal coliforms or Enterococci. In marine waters, the standard required beach closures if Enterococci exceeded 104 colonies per 100 ml or a geometric mean 35 colonies per 100 ml for the most recent five sampling dates. Beaches that do not meet these requirements must be posted with a sign that states "WARNING! NO SWIMMING. SWIMMING MAY CAUSE ILLNESS." Local boards of health could also issue such a notice after any significant rainstorm at a bathing beach where there has been a history of rainstorm related violations. However, no municipality in Buzzards Bay has adopted such a policy. While few municipalities have enacted pre-emptive closures, some have posted beaches during periods of intense rain, as well as a few for public safety reasons (i.e. jellyfish at the beach).

Major Issues

The biggest challenge for state and local health officials to reduce and minimize the frequency of beach closures is to minimize the impacts caused by stormwater discharges, particularly during heavier rains. Most of the high concentrations of Enterococci at the beaches in Figure 108 occurred after rainstorms. During exceptionally heavy rains, six to twelve beaches in Buzzards Bay may be closed; during rainfalls of 1 to 2 inches, several beaches may be closed. Because cities and towns tend to sample on prescribed days of the week rather than intentionally sampling after a heavy rain, the true extent of the rainfall related water quality health risks is underreported and underestimated.

A comparison of beach testing results for 2006 and 2007 as reported to MDPH is shown in Table 52[222]. As shown, 4.6% and 3.0% of all tests in 2006 and 2007 respectively exceeded beach closure standards. In 2006, only 53% of the beaches were posted with warnings, but in 2007, 83% of the beaches were posted as required. In addition, three Buzzards Bay beaches were listed by MDPH among the top-ten beaches in the state in the percent of results that exceeded limits. These beaches were Moses Smith Creek beach in Dartmouth, Oakdale Avenue beach in Marion, and Town Beach, Mattapoisett. Of the three, only the Mattapoisett Town Beach is heavily used. In 2004, the Town of Mattapoisett Board of Health also received a complaint from a resident that their child developed skin lesions after swimming at the beach.

Among freshwater ponds in the Buzzards Bay watershed, the Town of Falmouth has the greatest number of freshwater beaches tested. Bourne, Rochester, and Wareham follow with two ponds tested each, as well as a few dozen ponds tested in Plymouth. Each of the four towns has experienced at least one exceedance at a freshwater beach during the past five years. A number of towns (Dartmouth, New Bedford, and Westport) have closed municipal freshwater beaches due to resource issues and low use in the past several years.

In the Buzzards Bay watershed, combined sewer overflows are problematic only in the City of New Bedford. In most areas, stormwater runoff discharged from pipes, overland sources, or discharges from rivers and streams that receive appreciable stormwater discharges, are the principal causes of beach closures. Mattapoisett Town Beach (Figure 108) is affected by a culvert that discharges groundwater and stormwater. In Falmouth, Wood Neck beach (river station) is affected by stormwater discharges to a salt marsh area, but even during dry conditions, bacteria concentrations can be high during ebb tides when draining tidal creeks affect water quality in the swimming area.

Other cases of beach high bacteria counts and closed beaches have been tied to waterfowl. For example, Canada geese in particular have been known to congregate in areas to such an extent that the beach wrack line consists mostly of goose feces. In these situations, simple methods to discourage the congregation of geese, such as low fencing and shrubbery plantings, have proved cost effective. These techniques work because plantings and low fences obscure line of sight, and play on the animal's fear of hidden predators[223].

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[221] "Cape beaches rank among best in state." Hilary Russ. Cape Cod Times August 09, 2007, last accessed 10/13/2013.

[222] Marine & Freshwater Beach Testing in Massachusetts Annual Report 2007. Retrieved from www.mass.gov/eohhs/docs/dph/environmental/exposure/beach-reports/beach-annual-report07.pdf. Last accessed October 30, 2013.

[223] Department of Conservation and Recreation. 2004. "Goose Fencing a Success!" 2-page fact sheet, Lakes and Ponds Program

Another problem often documented is the role of dog waste on beaches and in neighborhoods of stormwater networks contributing to beach stormwater discharges. Because of increased government and public awareness of the problem, the state and most municipalities have banned pets from bathing beaches, provided collection bags and disposal containers in parks and other public lands, and have undertaken public education using signage in public locations (e.g. Figure 110, and Figure 111).

When beaches exceed the 104 Enterococci bacteria per 100 ml standard, public health officials are required to post warnings. More importantly, municipalities confronting frequent closures should implement programs to evaluate the closing and determine if high Enterococci are caused by stormwater discharges or other factors. Where appropriate, municipalities should implement advisory or closure programs tied to rainfall volumes. For financial and political reasons, such programs are rarely implemented.

In 2003, the Massachusetts Department of Public Health completed a GIS inventory of beaches in Massachusetts and began posting municipal water quality testing results online. By 2005, all 60 Massachusetts coastal municipalities were reporting their bathing beach data to DPH as required by law[224]. This program has helped improve public understanding of public health risks and helped create local public interest in taking action to control pollution sources contributing to beach closures. Full compliance with testing and closure posting is yet to be achieved in semi-public beaches.

In 2003, as part of a Beach Grant from the U.S. EPA, MDPH also proposed a "Public Health-Based Beach Evaluation, Classification, and Tiered Monitoring Plan.[225]" In 2006, MDPH developed a sanitary survey form for Massachusetts beaches, comparable to the sanitary surveys used previously to evaluate pollution sources to shellfish beds. The development of the tiered system and the sanitary survey forms allowed communities to apply for sampling variances according to Massachusetts' regulations (105 CMR 445.100) and also allowed MDPH to implement a tiered monitoring approach to sampling. The goal of this effort was to direct water quality monitoring resources to the beaches that pose the greatest health concerns.

Figure 110. Sign posted by Massachusetts DCR at state parks and beaches.

In the tiered system, every public and semi-public marine bathing beach was classified as "Tier One," "Tier Two," or "Tier Three." Tier One includes heavily used beaches with known pollution problems. Beaches with "multiple exceedances for three or more years" are classified as Tier One. MDPH has proposed these beaches be tested twice per week. Tier Two includes higher use beaches with some pollution. These beaches must be tested once per week. Tier Three beaches are those with no known pollution problems (zero exceedances for two or more years). MDPH requires these beaches to be tested once every two weeks or less, as determined by MDPH through the variance process.

Among Massachusetts marine beaches, there are currently seven Tier One beaches, 421 Tier Two, and 86 Tier Three beaches. In Buzzards Bay there are no Tier One beaches designated, and 11 Tier Three beaches that started a varianced sampling frequency in 2008. All other public beaches are tested weekly as required under Tier Two.

For public health officials, the biggest obstacle in utilizing water quality testing data is that it takes 24 hours to receive the results because of incubation times

Figure 111. Photograph of a bag dispenser for pet waste.

at www.foxboroughma.gov/Pages/FoxboroughMA_Conservation/1Goosefence.pdf. Last accessed October 30, 2013.

[224] Marine & Freshwater Beach Testing in Massachusetts Annual Report 2005. Retrieved from www.mass.gov/eohhs/docs/dph/environmental/exposure/beach-reports/beach-annual-report05.pdf. Last accessed October 30, 2013.

[225] Retrieved from http://www.mass.gov/eohhs/docs/dph/environmental/exposure/beach-evalplan.pdf. Last accessed October 30, 2013.

needed for bacterial growth in media. This delay increases exposure of bathers to unsafe bacterial levels, and contributes to unnecessarily long closures if an ephemeral event contributed to the closure. The testing results delay also makes it very difficult for investigators to track the origins of contamination because sources may dissipate before a field investigation begins. For these reasons, state, and federal agencies have been continuing to develop and evaluate more rapid assays.

From an evaluation perspective, certain common trends can be discerned by an examination of water quality field data. Many of these trends have been observed in site investigations with frequent monitoring at shellfish resource areas. For example, beaches near salt marshes or streams tend to have worse water quality during low and outgoing tides because discharges from land drainage sources are most likely to appear (for example, Woodneck Beach in Figure 108). These sites and others near storm drain discharges may experience heavy bacterial loadings during rainstorms.

The intensity of rainfall can have a profound effect on water quality. A storm with several inches of rain can degrade water quality for days whereas a rainfall of 0.1 inch may have a negligible impact on water quality. During periods of strong winds and heavy surf, sediments contaminated with bacteria can be suspended in the water column, elevating bacteria counts.

For all these reasons it is important for water testers to record, on their field sampling data sheets, the volumes and dates of recent rainfalls, tidal level and current direction, wind speed and direction, surf conditions, water quality, and temperature to aid in the evaluation of datasets at a later time by analysts. Not all this information is included as fields in the MDPH field data sheets, but it should be recorded to help identify site-specific closure conditions, and such information can help define a pollution source tracking monitoring plan for problematic sites.

In the end, government officials have two options to reduce health risks associated with swimming beaches. The long-term solution is to reduce pollution discharges. The short-term solution is to manage exposure through beach closures based on water testing, and to manage exposure in known problem areas by preemptive management (e.g. closing beaches or areas near stormwater pipes after certain rainfall volumes, prohibiting swimming in tidal creeks during outgoing low tides). In addition, public education and outreach is vital to ensuring best pet management at the beach. To this end, MDPH created an informational pet waste brochure available on its website and distributes it annually to local health officials. With these steps, recreational uses of bathing beaches will continue for generations.

Management Approaches

Implementation of this action plan requires more effective monitoring to assess the risks associated with pathogen contamination of beaches, and measures to reduce pollutant discharges causing beach closures. Currently beaches are monitored on a set day and time conducive to laboratory and personnel schedules. However, in realty, risks are typically associated with rain and stormwater discharges, and regularly scheduled beach testing practices only catch water quality threats by chance. Beaches with 15% exceedances each summer should automatically be tested at least twice per week and conduct sampling to identify sources. Boards of health should also conduct rain related beach testing, and upstream source testing whenever a beach has shown a history of closures coincident with heavy rains. Where warranted, boards of health should implement a rainfall conditional beach testing program. Only in this way can boards of health better characterize typical pollutant levels after different amounts of rain, which is necessary to better inform the public of what health risks might be faced at a particular beach in the hours and days after a heavy rain. Evaluating beaches during adverse conditions will better protect the public from water borne diseases and minimize health risks. Where appropriate, signage should be posted advising against bathing near outfall pipes and streams.

Where beaches are subject to greater than 15% water quality testing exceedances in a summer, municipalities should implement pollution source identification and reduction programs. In many cases, these efforts will address the needed action identified in Action Plan 3 Managing Stormwater Runoff and Promoting LID. Other programs, like efforts to reduce pet waste may contribute to the goals of this action plan.

Financial Approaches

The cost of increased monitoring is relatively modest, but because laboratories charge extra fees if samples are taken at times that require processing during nonworking hours, sampling analyses costs can increase and must be budgeted. Dog waste receptacles have minimal costs and are good education tools.

Remediating pollution sources can be costly, especially for those beaches near a brook or drainage system where many sources may be contributing to elevated pollution loads. Most of these pollution sources will be associated with stormwater discharges, and the costs of treating stormwater are addressed more comprehensively in Action Plan 3 Managing Stormwater Runoff and Promoting LID. Because pollution remediation costs can be appreciable, rainfall conditional closures and signage about particular health risks will be the most cost effective initial action.

Monitoring Progress

The success of this action plan will be defined by changes in beach closures in the Buzzards Bay watershed. The existing reporting program to the Massachusetts Department of Public Health, and the annual reports they publish will provide an adequate basis for tracking beach conditions.

Action Plan 20 Monitoring Management Action, Status, and Trends

Problem

Monitoring is used to track the effectiveness of management action or inaction. For Clean Water Act initiatives like the National Estuary Program, a key question has always been, "Are we making waters more fishable and swimmable?" This question is understood as whether government is preserving and protecting ecosystem health and the integrity of the natural environment, and whether waters meet specified "designated uses." An especially difficult challenge in all environmental monitoring programs is recognizing that static environmental conditions in the face of new development or pollution inputs is in itself a measurable success.

Increasingly, funding agencies want to know not only whether a project was completed successfully, but also whether it was successful in protecting or restoring the environment. In fact, the 1987 amendments to the Clean Water Act section 320(b)(6) specified that each NEP Management Conference shall "...monitor the effectiveness of actions taken pursuant to the plan," to meet these two goals: "measure the effectiveness of the management actions and programs implemented under the [CCMP]; and provide essential information that can be used to redirect and refocus the CCMP during implementation." Implicit in these requirements are programmatic monitoring, environmental monitoring, and some level of research to ensure that selected environmental monitoring is adequately characterizing environmental conditions and risks.

Each action plan in the Buzzards Bay CCMP includes monitoring strategies. This action plan reiterates some of the most important elements of other action plans, but also addresses some broader watershed monitoring and reporting needs to meet the broader goals of the Buzzards Bay CCMP.

Goals

Goal 20.1. To document environmental trends of water quality and living resources in order to assess the effectiveness of management actions taken, or identify the need for new actions.

Goal 20.2. Identify research and monitoring needs to understand more clearly the causes of impairments, reduce uncertainties about health risks, and better define conditions in Buzzards Bay.

Objectives

Objective 20.1. Collect and monitor programmatic actions to document implementation of Buzzards Bay CCMP recommended actions.

Objective 20.2. Ensure that regulatory agencies define essential monitoring requirements and collect data necessary to evaluate program and project success.

Objective 20.3. Ensure that funding is available to implement essential monitoring programs.

Objective 20.4. Revise and adapt monitoring programs to meet changing needs and information gaps.

Objective 20.5. Disseminate data and syntheses of information to scientists, managers, and the public.

Objective 20.6. Encourage scientists and agencies to evaluate emerging contaminants and other stressors to the environment.

Approaches

Shellfish bed closures, eutrophication data, and eelgrass bed cover are some of the key water quality measures that must be tracked, but in the long run, the state's list of impaired waters (as river miles and water acres) will be the ultimate measure of success of actions taken to comply with the Clean Water Act. This also means considerable effort will be needed to monitor and characterize the many unassessed freshwater and marine bodies in the bay and watershed.

While programmatic and environmental data are collected by the U.S. EPA, the Buzzards Bay Coalition, Buzzards Bay NEP, and DEP, more effort is needed to make this information available on line, and where needed, synthesizing and aggregating data to show watershed comparisons and trends in time.

Programmatic actions by municipalities to comply with permits and watershed TMDL goals are both short-term and long-term measures to be tracked. Government will need to expand funding to research institutions to enable managers to better discern threats from emerging issues and concerns.

Costs and Financing

Tracking programmatic actions has modest costs. The cost of field monitoring described in the various action plans in the Buzzards Bay CCMP may total hundreds of thousands of dollars annually. Some monitoring needs can be met through new permit requirements, research grants may assist in evaluating contaminants of emerging concern, or federal watershed assessment grants (604b), but most monitoring costs must be borne by agencies managing the environment.

Measuring Success

The measure of success for this action plan will be whether sufficient information exists to evaluate the success of each action plan in this Buzzards Bay CCMP.

Background

Monitoring is often a requirement in environmental permits and environmental grants. It is also an essential need to evaluate the progress or success of environmental initiatives or programs. Broader less-defined ecosystem monitoring efforts can be costly, and must be well thought out and justified. From a scientific perspective, ecological monitoring meets many needs, and can provide basic knowledge of ecological processes, provide baseline data to track changes and long-term trends, serve as an early warning system, and better define the impacts of human perturbations (see discussion Spellerberg, 2005). Lindenmayer and Likens (2010) go so far as to classify all monitoring programs into three categories: passive monitoring, which is generally devoid of specific hypotheses or underlying study design, mandated monitoring where environmental data are gathered as a stipulated requirement of government, and question-driven monitoring, which is typically guided by a conceptual model, rigorous design, and an a priori prediction that can be tested.

In recent years, there has also been an increasing trend to evaluate the success of public expenditures, thus in 1993, Congress passed the Government Performance and Results Act (GPRA) "to provide for the establishment of strategic planning and performance measurement in the Federal Government." Fifteen years later, the implementation of this law is still evolving and changing how federal agencies, and federally funded state agencies, gather information to evaluate the performance of programs and how they monitor the environment. The act required federal programs to identify measurable goals for tracking progress towards the agency's mission. To answer such a fundamental question, each program needed to adopt performance indicators that were objective and valid (see 2005 to 2009 EPA Performance and Accountability Reports to see examples of the recorded metrics, and for a critique of the approach, see Gueorguieva et al., 2009).

To meet elements of the U.S. EPA's compliance with the GPRA, all the NEPs now track CCMP actions completed, and acres of wetland and habitat protected and restored. Beyond these minimum requirements, each NEP is responsible for developing and implementing a monitoring program to track both programmatic actions recommended within a CCMP, and measures to document water quality, habitat, populations, and measures of ecosystem health and integrity.

There are many fundamental challenges faced by any program attempting to meet such goals. The most important challenge is cost. In the original Buzzards Bay CCMP, a "tiered monitoring program" was developed to answer and address a wide variety of water quality and habitat issues. Full implementation of the recommendations for new monitoring might have cost millions annually, consequently only a few new monitoring initiatives were implemented.

For example, in the mid 1990s, DEP implemented an eelgrass monitoring program (a CCMP recommendation) building upon methodology for eelgrass mapping in Buzzards Bay (Costa 1988). This program continues to the present day and is informing management and guiding policy (see recent eelgrass trends in Costello and Kenworthy, 2012). In 2001, DEP, recognizing the value of aerial surveys from its eelgrass and wetland mapping efforts of the 1990s, implemented a wetland change program based on the analysis of aerial photographs that has caught and prosecuted numerous wetland alterations (Langley, 2009).

Similarly, in 1992, the Buzzards Bay NEP created and funded a water quality monitoring program to evaluate eutrophication, in partnership with the Buzzards Bay Coalition (based on approaches identified in Costa et al., 1992; see also Taylor and Howes, 1994). This program has gone on to be one of the most successful programs in the country. The Buzzards Bay Coalition assumed all management and most of the funding of the program by 1997. In the late 1990s, and in some subsequent years, the Massachusetts legislature became the principal sponsor of the volunteer monitoring program, first by providing \$100,000 annually, then \$150,000 annually by the mid-2000s. By 2008, when a budget crisis eliminated state funding for the program, the Coalition had begun to put in place an endowment fund to help the citizen group maintain funding for this popular program.

However many other recommendations in the original Buzzards Bay CCMP monitoring plan were not implemented because state and federal funding for monitoring programs diminished greatly through the 1990s and 2000s. For example, bay wide monitoring of PCBs and other toxic constituents in seafood in Buzzards Bay to document the effectiveness of state and federal efforts to clean up the New Bedford Harbor superfund site ceased[226], despite the many uncertainties and needs identified (e.g., Farrington and Capuzzo, 1990). Other federal programs like the Mussel Watch program continued with reduced frequency of monitoring and analyte testing. These programs were once deemed essential to monitor effectiveness of efforts to reduce toxic discharges from point and nonpoint sources. Other recommendations in the Buzzards Bay monitoring plan were never funded.

[226] The original monitoring plan recommended that PCB measurements be "repeated every 5 years in the outer harbor following remediation." Contractors cleaned up the Superfund site PCB hotspots by 2001, but the lower level contaminated areas are now gradually being excavated and transferred to landfills outside of Massachusetts. This last part of the PCB cleanup may not be complete for another twenty years.

While the Massachusetts Division of Marine fisheries continued its shellfish resource area. FDA mandated water quality testing program for the past three decades, similar recommended efforts to monitor and identify upstream sources of bacteria, or to evaluate stormwater discharges to establish priorities for remediation were never implemented in a systematic way because of high costs and the lack of funding at any level of government. The Buzzards Bay NEP, municipalities, and the Buzzards Bay Coalition have attempted to address the latter issue within specific projects, but these actions have been piecemeal. In some respects, the Phase II MS4 stormwater permit program and bacteria TMDLs should address and drive some unmet monitoring needs because municipalities are required to evaluate discharges as part of their municipal stormwater systems and networks, but municipalities are also facing serious budget shortfalls, and water quality testing may remain a low priority for some time.

Besides the lack of funds to implement additional monitoring programs is the fact that there are many challenges to interpreting monitoring data and communicating the results to both the public and managers. The cost of synthesizing information and translating data into understandable findings conveyed through various communications media can sometimes exceed the cost of data collection and laboratory analysis.

In addition to the cost of data synthesis, the results of monitoring programs may fail to show clear trends. This is often the case because changes in pollutant discharges are small relative to background levels, other sources, or natural variability. In particular, seasonal rainfall amounts greatly affect those pollutants conveyed through stormwater runoff and ground water flow. For example, when evaluating eutrophication impacts, seasonal rainfall amounts strongly affect eutrophication indicators. Even if changes in land use or sewering result in theoretical increases or declines in nitrogen loading over a period of time, invariably during wet summers, eutrophication indicators will show poor water quality in most embayments, whereas during a drought summer water quality may become exceptional.

Major issues

Financial and Personnel Constraints

The information needed by government to characterize pollution problems, define health risks, document habitat impairments, and better define strategies to protect the environment often exceed the financial and staffing capacity of agencies and universities.

Conveying Information

Even for data that is available, synthesizing and communicating effectively to the public can be time consuming and sometimes expensive. Adding to the problem, multiple entities collect data on different pollution measures, with sometimes contradictory trends, making it difficult to communicate a clear message with a simple "story."

In the case of nitrogen loading, this problem led the Buzzards Bay NEP to create the Eutrophication Index for the Buzzards Bay Coalition volunteer monitoring program in 1992, combining five different parameters (chlorophyll, secchi depth, inorganic nitrogen, organic nitrogen, and oxygen concentrations) into a single water quality index. The Buzzards Bay Coalition adopted a similar approach by creating scores for a series of other numeric indicators for its State of the Bay reports beginning in 2001, renaming it a Health Index. This technique allowed the establishment of a single Bay Health Index cutting across numerous water quality and living resource issues. Environmental programs have increasingly adopted these approaches across the U.S. and elsewhere.

A non-trivial subset of problems with communicating environmental trends is the fact that there has been a substantial increase in population and development and a dramatic loss of natural habit in the coastal zone in the last 20 years. If certain water quality indicators remain steady in the face of these trends, this is in fact a management success. However, getting funding agencies and the public to appreciate such realities has been difficult at best.

A more disturbing impediment to the development and funding of new monitoring programs is that government often does not want to document the extent of existing or new problems. In this context, monitoring the environment is seen neither as an investment, nor as a mechanism to build a healthy economy. More rigorous monitoring can close swimming beaches; discourage tourism and recreation, and cost government and industry money by exposing problems that cost money to solve. An extension of this logic is that it is more appropriate to use limited government funds and budgets to solve problems already documented by earlier monitoring efforts than to implement new monitoring programs.

Programmatic versus Field Monitoring

In recognition of the financial constraints of monitoring, challenges in interpreting and communicating the results of the monitoring programs, and the practical aspects in detecting modest trends in the face of a noisy environment impacted by increasing development, certain compromises must be made to create a meaningful program to track the progress and effectiveness of the Buzzards Bay CCMP.

For example, monitoring the effectiveness of management actions on the shifting shoreline action plan is best tracked by regulatory and non-regulatory management actions taken. Perhaps the true effectiveness of actions taken in preparation of catastrophic storm flooding can only be judged after another category 3 hurricane (like the hurricane of 1938) strikes Buzzards Bay, but even then each storm presents unique circumstances that define its effects. Similarly, the success of management recommendations in Action Plan 10 Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies will best be judged by tracking municipal per capita water use. In fact, throughout the action plans, programmatic and management action monitoring is the principal tracking mechanism.

Other measures of the environment, like eelgrass habitat area, wetland area, endangered species population counts, bacteria concentrations (and the documentation of resulting beach and shellfish bed closures), and eutrophication indicators will remain the direct indicators of overall ecosystem integrity, program success, and the effectiveness of government actions.

As was the case with the original Buzzards Bay CCMP monitoring plan, most water quality and living resource problems around Buzzards Bay are highly localized, and are related to local land use around each embayment. Conditions in the central bay remain generally good. Consequently, this monitoring action plan remains focused on evaluating water quality and living resources within the context of coastal embayments and their contributing watersheds. The action plan also supports efforts to monitor the effectiveness of individual projects and BMPs. In all these endeavors, funding is a severe constraint. Consequently, in the case of evaluating BMPS, public funds should only be expended to evaluate new or novel applications of technologies. Some monitoring needs can also be met through conditions of permits.

The goals and objectives of the Action Plan 20 Monitoring Management Action, Status, and Trends remain focused on gathering information necessary to evaluate the effectiveness of management action recommendations specified by the Buzzards Bay CCMP, both individually, and cumulatively. The mechanisms to evaluate the outcome of each action plan recommendation are already specified throughout this document under the "measuring success" heading under each action plan recommendation. The recommendations in Action Plan 20 Monitoring Management Action, Status, and Trends focus on mechanisms to support those more specific recommendations, as well as more broader actions to implement successful efforts to monitor the environment and communicate those findings.

Data Availability and Reporting Results

To be meaningful to scientists, managers and the public, monitoring data must be made readily available both in its raw form, and in more synthesized forms that can be understood by the lay public. This increased availability makes the action of government more accessible and transparent to the public.

On the other hand, efforts involving online relational databases merging disparate data have not proven widely useful, and can be expensive to maintain. Data should be made available in its native or original format (spreadsheets, GIS shapefiles, etc), for use by scientists and analysts to import into their own software or statistical programs. Data analysis and synthesis, which can be costly, should be reserved for specific programs.

To communicate other aspects of tracking Buzzards Bay CCMP progress and outcomes, the Buzzards Bay NEP established a Status and Trends web page (buzzardsbay.org/trends.htm) that includes a variety of water quality, living resource, and management tracking parameters. The Buzzards Bay Coalition created a complimentary State of the Bay page on their website[227]. Both programs collaborate when evaluating datasets to ensure the data and information presented on these web pages are consistent. The Buzzards Bay NEP also continues to track and post information on Buzzards Bay CCMP implementation projects with links and information on their outcomes.

Other state and federal agencies are making individual datasets available online. Some websites, like the Massachusetts Department of Public Health beach monitoring results website[228] are very popular with the public and the increased transparency and availability of the data in some cases has focused municipal efforts to address pollution problems or issue precautionary rainfall advisories.

Research Needs

While the monitoring efforts described in this section will be used to track progress in meeting the goals and objectives of this Buzzards Bay CCMP, there is an ongoing need for research to study the many uncertainties and unanswered questions that remain about the threats facing Buzzards Bay. Some important research questions include:

What are the impacts of pharmaceuticals and other emerging contaminants?

What are the synergistic or additive effects of pollutants and other stressors?

How will shifts in precipitation, water temperatures, and ocean acidification caused by green house gas emissions alter coastal ecosystem structure and function, including populations of non-natives?

What are the human health threats of low-level contaminants in seafood?

How are invasive species altering coastal and inland ecosystem?

[227] www.savebuzzardsbay.org/Document.Doc?id=11. Last accessed October 11, 2013.

[228] mass.digitalhealthdepartment.com/public_21/index.cfm. Last accessed October 11, 2013.

Management Approaches

Lindenmayer and Likens (2010) argue that the major characteristics of effective monitoring programs typically include: (1) good questions, (2) a conceptual model of an ecosystem or population, (3) strong partnerships between scientists, policy-makers and managers, (4) frequent use of data collected. These should be the principals that drive monitoring programs in Buzzards Bay.

In the face of shrinking environmental program budgets, more than ever, tracking environmental progress will be met through cost effective strategies of monitoring indicator species like herring abundance using field counters, or through remote sensing for eelgrass and wetland coverage. Tracking of water quality stressors like nitrogen in receiving waters by the Coalition's volunteer water quality testing program must continue, and this program must be expanded to incorporate nitrogen TMDL sentinel stations. Other cost effective programs must be implemented to serve other environmental assessments in this document. Some needs, like the systematic monitoring of stormwater discharge to rank them for prioritization, or monitoring the fate and pathways of toxic compounds in the environment will be costly endeavors, even with innovation.

Tracking of programmatic action (permits issued, acres protected, etc.) will remain an essential tool, and the programmatic monitoring approach will be used to evaluate land protection, water withdrawals and water conservation measures, and shellfish bed closures to name a few examples. Because of the self-reporting required under various state and federal permit programs, it is essential that regulators continue to require and expand well-reasoned monitoring requirements, and make this data readily available for analysis.

Financial Approaches

Monitoring programmatic actions has modest costs. The cost of field monitoring described in the various action plans in the Buzzards Bay CCMP may total hundreds of thousands of dollars annually. Some monitoring needs can be met through new permit requirements, research grants may assist in evaluating contaminants of emerging concern, or federal watershed assessment grants (604b), but most monitoring costs must be borne by agencies managing the environment.

Monitoring Progress

This action plan is primarily concerned with ensuring sufficient data and information is collected to evaluate progress on all the other action plans. The success of this action plan will be defined by whether the information is readily available and communicated to ensure that agencies and the public can evaluate the success of the Buzzards Bay CCMP. In this respect, the status and trends webpages on the Buzzards Bay NEP and Buzzards Bay Coalition websites, and related outreach documents clearly and concisely communicate this information.

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The Buzzards Bay Volunteer Monitoring Program: A Buzzards Bay Success Story

One of the hallmarks of monitoring in Buzzards Bay has been the Buzzards Bay volunteer-based water quality monitoring program, which was initially jointly implemented by the Buzzards Bay Coalition (then called the Coalition for Buzzards Bay) and Buzzards Bay National Estuary Program in the spring of 1992. The program was designed by Dr. Joe Costa and Dr. Brian Howes to address the need to monitor and evaluate nitrogen impacts to coastal waters as outlined in the Buzzards Bay Comprehensive Conservation and Management Plan. The Coalition organizes and trains the volunteers and coordinates data collection and entry.

The volunteers measure dissolved oxygen concentrations with Hach Kits™, secchi depth, salinity, and temperature approximately 15 times between June 1 and September 30. The volunteers also collect 2-4 water samples during summer, which are analyzed for dissolved, and particulate organic nitrogen, nitrate + nitrite, ammonia, orthophosphate, and chlorophyll. Generally, the program monitors 2 to 4 sites within each embayment. In some smaller embayments, only one site is monitored; in larger embayments, 5 or more sites were sampled. The volunteers take samples for nutrient analyses during outgoing tides, while oxygen and secchi data included both incoming and outgoing tides because the oxygen measurements are needed in the early morning hours, generally taken between 6-9 AM, as indicated by Taylor and Howes, (1994).

One key innovation of the program was its attempt to combine a basket of indicators into a single Eutrophication Index. The Buzzards Bay Eutrophication Index was created by Dr. Joe Costa in 1992 as a tool to present a simplified summary of the volunteer monitoring program data (read the first Baywatchers Report, issued December 1992). The Index was modeled after a water quality index adopted by Hillsborough County in Florida to evaluate changes in Tampa Bay water quality. This approach to create a water quality index was based on defining, for each water quality parameter used, a "poor" water quality value (0 points), and an "excellent" water quality value (100 points). The adoption of the 0 and 100-point values was made after consultation with Dr. Brian Howes, who had set up the monitoring program with Dr. Costa. The values are log transformed in the formula for calculating the index because of the lognormal ecosystem response to nitrogen loading. More details on the methodology are provided on our Eutrophication Index page.

In the first 4 years of the program, the Buzzards Bay NEP funded the startup of the program and provided nearly all the funds necessary to operate the program, which included funds to the Buzzards Bay Coalition for a monitoring program coordinator and funds to a research laboratory to provide for water quality analyses. Since 1996, the program has been managed exclusively by the Buzzards Bay Coalition, with technical support first from UMass Dartmouth and later by the Marine Biological Laboratory Ecosystems Center. In the mid-1990s, the Buzzards Bay NEP suspended funding to the water quality monitoring program due to federal cutbacks. During that time, the Coalition continued the program with grants and donations. They also received roughly $10,000 annually from Buzzards Bay municipalities. In later years, the Coalition was able to secure state funding through an earmark of the state legislature of $50,000 to $150,000, which covered a large portion of monitoring costs, and enabled the Coalition to expand nutrient testing further upstream in some estuaries. Today, the Buzzards Bay National Estuary Program continues to provide between $20,000 and $30,000 annually to support the program. Through the years, the Coalition has continued to fund unmet needs through private donations and fund raising.

In 2002, Massachusetts DEP began using the data from this program to develop watershed nitrogen TMDLs in the Massachusetts Estuaries Project and this effort is continuing today. The Buzzards Bay NEP remains a strong advocate for this effort, and is using these data to evaluate the success of efforts to protect and restore Buzzards Bay.

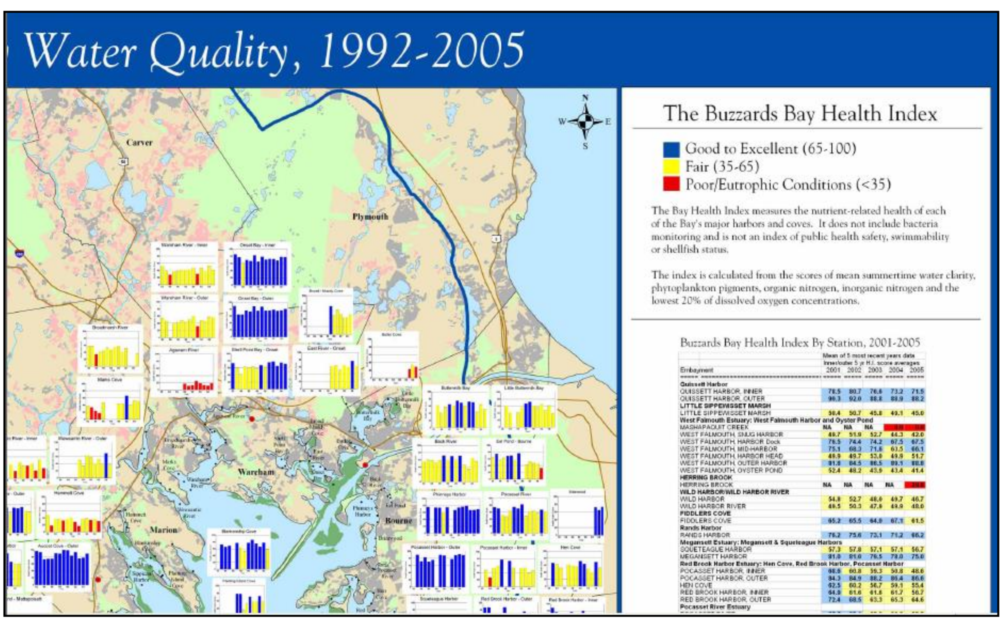

Figure 112. Portion of a poster prepared by the Buzzards Bay NEP for the Buzzards Bay Coalition, showing 13 years of water quality results collected through the volunteer water quality monitoring program.

Action Plan 21 Enhancing Public Education and Participation

Problem[229]

Government can be slow to address environmental problems because of work force or financial constraints, political pressures, concerns of potential economic impacts, or failure of legislative and executive bodies to revise or adopt new laws and regulations. In a democracy, the response of government to any problem is strongly driven by the public's concerns and understanding of the issues. While it is true that given the same set of facts, persons can disagree about the proper course of actions depending on individual priorities and values, a common vocabulary in defining problems can facilitate the development of consensus among disparate parties. If the public is ill informed on a particular environmental problem, or if it does not have a clear understanding of important technical and regulatory issues, they may fail to appreciate the costs and benefits of management actions, or inaction. Contributing to the problem, people, first as children, then as adults, may not have been educated about concepts like groundwater flow, pollution pathways in local watersheds, how wastewater is treated and disposed, or the connection between ground and surface waters.

Because many of the recommendations in the Buzzards Bay CCMP are directed toward local government, and may require voter approval or approval by town meeting or local boards, it is particularly important to have an informed citizenry to help make these decisions. Citizen groups and environmental non-governmental organizations can provide a crucial role in educating adults and children that will ultimately lead to the necessary social, political, regulatory, legislative, and legal actions to support efforts to protect and restore Buzzards Bay and surrounding watershed. The contribution of these non-governmental partners will be most important when legislative bodies and governmental boards must make specific planning, regulatory, and budgetary decisions.

Many action plans in this document include elements of outreach and education. This action plan addresses some statewide and regional issues that should be addressed to meet the broader goals of the Buzzards Bay CCMP.

<u>Goals</u>

Goal 21.1. To expand the public's knowledge of the natural resources and water quality of Buzzards Bay and surrounding watershed and the threats they face.

Goal 21.2. To increase public participation in actions that support the goals, objectives, and recommendations in the Buzzards Bay CCMP.

<u>Objectives</u>

Objective 21.1. To better convey concepts of watersheds and the flow of water from precipitation along the land surface and in the ground.

Objective 21.2. To better convey an understanding of pollution sources and pathways in the environment.

Objective 21.3. To improve the public understanding of human and natural effects on plant and animal populations and ecosystems.

Approaches

The Massachusetts education curriculum needs to convey more effectively a basic understanding of local watersheds and the pathways of water and pollution through ground and surface waters. To address this problem, the University of Massachusetts developed a primary school teacher education program called "Our Town, Our City" to help teachers adopt local curriculum that incorporates local history and environmental information into their school programs, including showing local watershed maps. This approach should be emulated throughout the Buzzards Bay watershed and local school districts could teach essential concepts about water and pollution flow through watersheds as part of earth science curricula.

Advocacy and education by leaders and citizen groups will remain a core strategy to promote the adoption of regulatory and non-regulatory actions by local, state, and federal government. Both private groups and public agencies should better utilize alternate strategies for communicating information including videos on local cable access channels and the internet, and social media.

Costs and Financing

Annual public education costs can be appreciable or negligible, depending on the approach and type of campaign. Schools, government agencies, and non-governmental agencies must prioritize outreach programs based on their resources. Potential funding includes various, state, federal, and private sources depending upon initiative.

Measuring Success

There is no simple way to determine if education efforts are successful. One potential method of quantifying the success is to periodically conduct baseline public opinion surveys of attitudes and knowledge. This is a long-term, generational, and unending task.

[229] This action plan was not in the 1991 Buzzards Bay CCMP.

Background

In recent decades, as our understanding of the effect of individual and cumulative environmental impacts of human activity has improved, environmental standards to protect the environment have become stricter, and new tools have been developed and implemented by all levels of government. While there have been continued and ongoing successes in Massachusetts and elsewhere in controlling point-source and certain nonpoint source pollution, water quality improvements have begun to taper off because of unabated development pressures on the coast, together with reductions in state and federal budgets for environmental restoration, regulatory limitations, or limited staffing of state and federal agencies to address certain types of environmental degradation.

Simply put, we have collectively picked the low-hanging fruit by fixing the largest problem point discharges, but have left many watershed-level nonpoint source pollution problems lingering. This situation arose because of the complexity, scale, and costs associated with addressing the cumulative impacts of nonpoint source pollution at the watershed level. Although restoration actions will continue under federal mandates like the Clean Water Act, the actual implementation of unfulfilled programs will be difficult without broader public support and awareness of the problems. In many cases, technology alone will not solve problems, and individual decisions and behavior driven by socio-economic pressures, will define long-term solutions to protect the environment. Adoption of these solutions will often require the public to have a better understanding of the fundamental relationships between human activity and the environment[230].

The costs of solving certain problems, such as meeting bacteria and nitrogen TMDLs will be immense, and consequently unpopular. To enable fruitful discussions, a common understanding of the problems must be developed among the people. If the public is ill informed about a particular environmental problem, or if it does not have a clear understanding of important technical and regulatory issues, they may fail to appreciate the costs and benefits of management action, or inaction.

To address these problems, government officials, local leaders, and citizen groups need to educate and communicate problems, solutions, and costs, especially to the voting public. Similarly, educators should promote a clearer understanding of pollution and watershed issues in our schools to create a better-informed public for the future.

On one level, comprehensive watershed management plans have little practical significance or importance to most residents. In fact, it is generally true that public participation on environmental issues is driven principally by two forces. The first is "not in my back yard" reactions to specific problems or development projects. The second force is the propensity of residents to focus on environmental issues from which they will most likely receive benefits, or incur costs. These attitudes often lead to serendipitous (but often successful), collaborative efforts to implement specific environmental protection or restoration projects. For example, a group of residents may mobilize town meeting members to purchase a particular parcel for open space in which they see important values.

There are also residents involved with broader environmental causes and issues, or promoting environmental education to the public. These efforts may be activity-focused like nature walks and watershed bike rides. These efforts can be especially important in connecting the public to the environment, a need ever more important to be addressed as both children and adults become increasingly detached from the natural world because of technology or new forms of social networking. Simply put, there is less public support to protect the local environment when they are detached from it or have no experience or memories of it.

Given these realities, government managers can acknowledge that it is relatively unimportant whether many of the 250,000 residents in the Buzzards Bay watershed understand that a watershed plan exists for Buzzards Bay. However, it is essential that government recognize that the public must have a good grasp of the basic ideas and principles that are the basis of environmental protection goals contained in that management plan. To this end, local government has opportunities to improve understanding of important scientific principles through primary education of children and broader education efforts for adults. For both categories, non-governmental organizations can help fill the void in not

Figure 113. The Buzzards Bay Coalition's watershed bike ride and bay swim help build public awareness of Buzzards Bay as a place and a watershed ecosystem.

230 A broader discussion of the global needs for environmental education is contained in Day and Munroe (2000), *Environmental Education & Communication for a Sustainable World*.

only the education and mobilizing of the public, but also in pressing government and initiating political action to address the most challenging issues. This awareness and education is a necessary element for successfully implementing this Buzzards Bay CCMP.

In each of the action plans in this Buzzards Bay CCMP, recommended actions are identified for the Buzzards Bay NEP, other agencies, and NGO partners like the Buzzards Bay Action Committee and the Buzzards Bay Coalition. This action plan discusses certain broader principles that address public outreach and education needs in support of this watershed management plan.

In the 1980s, the Buzzards Bay NEP had a "Citizen Advisory Committee" or CAC that was part of the program and was helping with the evaluation of pollution and identification of management options to protect and restore Buzzards Bay. This CAC broke off from the Buzzards Bay NEP and eventually became two independent, not-for-profit organizations. The first organization called itself The Coalition for Buzzards Bay (now called the Buzzards Bay Coalition). It was a '501(c)3' educational and outreach citizen-based group. The second became the Buzzards Bay Action Committee, a nonprofit organization composed of municipal officials, that has become more involved with state, local, and federal legislative and regulatory issues. Today, both organizations are on the Buzzards Bay NEP's Steering Committee, and both have adopted, as one of their major goals, the implementation of recommendations contained in the Buzzards Bay Comprehensive Conservation and Management Plan.

As noted in Chapter 1, the roles of the Buzzards Bay NEP, Buzzards Bay Action Committee, and the Buzzards Bay Coalition have all evolved over the years. Today the Buzzards Bay Action Committee principally acts as a liaison between the towns and the Buzzards Bay National Estuary Program, but also works to improve the consistency and coordination in municipal laws and regulations. BBAC municipalities have also participated in efforts to increase resident awareness of problems and solutions. Examples include harbormasters participating in the BBAC sponsored bilge sock program, handing out free oil trapping bilge socks and literature to boat owners and including BBAC produced lawn fertilizer practices brochure to residents through water bills and town hall displays. The Coalition has focused on outreach and education relating to their water quality and natural resource monitoring programs, and land protection efforts. The Buzzards Bay Coalition had implemented primary education programs in the past, and in 2011 received additional federal funding for environmental education, and the BBAC has entered into this field as well.

Major Issues

One of the most important foundations for protecting the environment is the concept of watersheds in defining

Citizen Action and the Clean Water Act

One of the more profound tools available under the Clean Water Act (CWA) is the ability to file "citizen lawsuits" against EPA and other enforcers of the CWA, in order to enforce government compliance with the act. This provision has helped protect and restore the coastal waters in Massachusetts. For example, the upgrade of the Deer Island sewage facility and the construction of the new ocean outfall in Boston, and the upgraded wastewater facility in New Bedford, were prompted by court orders that followed CWA lawsuits filed by the Conservation Law Foundation in the 1980s.

State and federal agencies achieve compliance with the CWA through the regulatory process, as well as civil enforcement, fines, and criminal prosecution. Congress empowered citizens to bring their own lawsuits to stop illegal pollution discharges when state and federal agencies fail to act. The citizen suit authority is found in subchapter V, General Provisions, Section 505, of the CWA (USC 33, Section 1365). If a person or entity is adversely affected by a pollution discharge, they can request injunctive relief (court orders prohibiting the pollution from continuing), civil penalties, as well as reimbursement of legal costs. If a regulatory agency fails to take enforcement actions against a violator, or if they do not get acceptable results from their enforcement actions, citizens have the right to file these citizen suits against the state regulatory agency or the EPA.

A citizen seeking to utilize this provision of the CWA must first send a letter to the EPA administrator, and a copy to the delegated state agency (in Massachusetts, this is the Department of Environmental Protection) that it intends to file a law suit after sixty days under Section 505(b) of the CWA. Generally this letter very specifically describes which CWA provisions have been violated, and specifically describes the adverse effect experienced by the citizen (that is, their standing), and includes any supporting data and information. This letter gives both the state and federal agencies that enforce the CWA time to review the case and determine its legal merits. In many cases, this "60-Day Notice of Intent to File" letter is enough to prompt action by EPA or the state to take action to address the concern of the citizen or citizen group. This grace period may also prompt voluntary action by the violator.

After 60 days, if the violation continues, and if the regulatory agencies fail to require compliance with the CWA, a citizen may then attempt to intervene with the filing of a lawsuit. Civil actions would normally involve just the plaintiffs (the regulatory agency) and the defendants (the polluter), but persons with an interest in the suit can seek to become a party in the lawsuit by filing a Motion to Intervene. A citizen suit must be filed in the judicial district in which the violation occurred and a copy of its complaint or suit must also be sent to the U.S. EPA Administrator and the U.S. Attorney General. The district court that oversees the citizen suit would then try the case, and potentially enforce the CWA by mandating certain actions by EPA and the defendant under a court order. The judge can also order civil penalties up to $25,000 per day per violation.

the pathway and flow of rainwater, groundwater, and the pollutants they convey. The lack of appreciation and understanding of this concept, by both members of the public and sometimes municipal officials, is often evident in public meetings. In particular, residents are often skeptical that groundwater and surface waters are connected, or that a town's drinking water is derived (in most cases) from rain falling on that town or its neighboring communities. Some believe that groundwater comes from some distant source conveyed by underground rivers.

Part of the problem is that schools generally do not teach watershed concepts as part of the standard Curriculum Framework[231], except at the high school level in an optional earth and space sciences class. At grade levels 3-5, the water cycle is taught, however the diagrams used showing the cycling of rain falling on mountains, and flowing to the ocean sow later seeds of confusion by not communicating the local scale of these pathways, or the connection between surface waters and groundwater. This problem can be easily remedied at the grade school level through use of simple models and diagrams, and through the Massachusetts Division of Conservation and Recreation's Project WET (Water Education for Teachers).

Two particular issues in the Buzzards Bay CCMP pose the greatest communication challenge because of their immense cost: managing nitrogen loading and stormwater discharges to coastal waters. Because these issues will cost billions of dollars to address in the Buzzards Bay watershed alone, a special focus is needed to communicate the long-term social and economic benefits of achieving Clean Water Act goals.

Management Approaches

To address some of the shortcomings in the primary school education curriculum, in 2006 the University of Massachusetts developed a teacher education program called "Our Town, Our City" which developed local curriculum models to help teachers develop programs that better communicate lessons that illustrate local relevance[232]. The program was initiated because a survey found that 80% of Massachusetts K-12 teachers do not live in the communities where they teach, and 97% of those teachers say they "know very little" about the history and culture of the community where they teach. The program leads concluded, "Most teachers do not have the background and experience they need to follow the productive teaching avenues available through place-based education."

The Our Town, Our City approach included a component to use local watershed maps for lessons on the water cycle and watersheds. The effort was developed in partnership with the Massachusetts Bays Program NEP, The UMass Natural Resources and Environmental Conservation Department, and the Massachusetts Watershed Initiative. One of the goals of the initiative was to provide a science knowledge base to help students and adults understand watershed specific problems. This approach could be more widely implemented in the Buzzards Bay watershed.

A similar program was developed by the Hitchcock Center[233] called "Wild About Water." The program addresses the curricula for grade levels 2-8 in history and social science and science and technology. The program helps students and teachers answer the questions: "Where does our drinking water come from? How much water do we need? How do we protect this precious resource?"

With respect to adult education and increasing awareness of environmental problems and solutions in the Buzzards Bay watershed, citizen groups like the Buzzards Bay Coalition, the Westport River Watershed Alliance, and area land trusts must continue initiative-specific outreach campaigns, as well as broader efforts to educate the public, and to better connect them to the environment. The latter focus is increasingly problematic because fewer programs involve young people in the outdoors. For this reason, efforts like beach cleanups, watershed rides, and nature hikes help people connect with and appreciate the environment.

Ultimately, the goal of all these efforts is to promote individual behaviors that are protective of the environment, and to encourage residents to participate in government, either at the ballot box, or through serving as elected or appointed officials. A broader goal of these education efforts must be a change in values and behaviors toward sustainability and environmental conservation (Thompson et al., 2010).

Financial Approaches

While EPA and other environmental agencies often provide grants to foster environmental education, mem-

[231] As required under the Massachusetts Education Reform Act of 1993, the Massachusetts Board of Education has developed a Curriculum Framework which forms the basis of local curricula. The 2006 Earth and Space Science curricula framework is retrieved from www.doe.mass.edu/frameworks/scitech/1006.pdf. Although local communities can use the state frameworks to develop more specific curriculum individual schools or districts may not implement such specific elements, such as watershed pollution concepts.

[232] The UMass Amherst Natural Resources and Environmental Conservation Department developed a primary school curriculum of "materials, training, and demonstration projects to build a constituency of educators and general public who can ably teach the science and environmental civics of watershed protection and engage others, including youth, in problem solving and action to protect the environment and.... for involving youth in building environmentally healthy and sustainable watershed communities." See: www.msp.umb.edu/OurTown/.

[233] See: www.hitchcockcenter.org.

bership dues and private donations from individuals and trusts form the basis of most environmental education programs conducted by non-governmental agencies.

On the other hand, government agencies must set aside funds for outreach and education. Some municipal outreach efforts are mandated, like reporting to residents about the results of drinking water testing. Other educational efforts like encouraging participation in recycling programs or in hazardous waste pickup days can save towns money in the end.

Monitoring Progress

The success of individual training and education programs can be evaluated through surveys and questionnaires among participants (Thomson et al., 2010), but longer term behavioral changes are more difficult to assess due to the length of time to evaluate and many confounding factors. Some evaluations of education programs will fall into the realm of academic research. Other assessments, like the success of public service announcements, will be easier to document if it measures participation in a particular event, such as participation in a hazardous waste recycling event. The success of early education and adult education efforts are inherently more difficult to assess, although the passage of articles at town meeting or at local elections will be arguably measures of success of specific outreach campaigns. Periodical local public opinion surveys of attitudes and knowledge could be conducted, but the cost and value of such efforts may often be better dedicated to environmental education programs instead.

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Chapter 5. Implementing the Buzzards Bay CCMP

The CCMP in Perspective

Threats to Buzzards Bay from increased development along its shores and decades of dumping industrial and municipal wastes into its waters, led to the initial calls in the 1980s to restore and protect the bay. The Buzzards Bay Project (later the Buzzards Bay National Estuary Program) was created to assess these threats, and then formulated with its many partners, the 1991 Buzzards Bay Comprehensive Conservation and Management Plan (CCMP) to address these issues[234].

Even with the creation of the first Buzzards Bay CCMP, it was recognized that no single planning document could hope to address all watershed environmental issues in a comprehensive way. Like many of the first National Estuary Program CCMPs, there were numerous challenges in creating, implementing, and monitoring outcomes (Colt, 1994; Imperial and Hennessey, 1996). Nonetheless, despite their limitations, these ecosystem-based management plans, and the programs that implemented them, would become models for other watershed initiatives around the country. As noted by Schneider et al. (2003), NEPs have helped establish less coercive community based solutions that have fostered regional networks. These networks "span more levels of government, integrate more experts into policy discussions, nurture stronger interpersonal ties between stakeholders, and create greater faith in the procedural fairness of local policy, thus laying the foundation for a new form of co-operative governance."[235]

Figure 114. Buzzards Bay watershed boundary sign.

It is essential that residents understand the sources of pollution in their watershed, where their drinking water comes from, and where their wastewater is disposed. As a cost savings measure, the state removed these signs in 2008.

Buzzards Bay remains an estuary in transition, subject to continuing stresses from new development and cumulative discharges of pollution. In this *Buzzards Bay Comprehensive Conservation and Management Plan 2013 Update*, we have sought to address some of the omissions of the 1991 CCMP, and avoid certain limitations in our original approach. The 2013 Update still lays out the general environmental issues facing Buzzards Bay and its watershed, the general management framework that exists to address these problems, and the likely strategies to solve those problems. We have avoided, however, including highly prescriptive site or town-specific recommendations. Instead, we recognize there are inherently many tools and solutions that can be employed to address complex watershed problems and the cumulative impacts of pollution and development. At its core, the document still recognizes the importance of community based solutions and the continued collaboration of a network of stakeholders as a recipe for success.

The Players and Their Roles

This chapter provides a broader overview of the key organizations and agencies who will be most involved in implementing actions needed to achieve the stated goals presented in the action plans of Chapter 4. We also call out the some of the most important challenges that will be faced in meeting the goals and objectives laid out in this document.

Each action plan in the CCMP identifies agencies and organizations that are either responsible for taking those steps, or could be partners in achieving the specified goals. These entities include regulatory and planning agencies at the federal, state, regional, and local level, legislative bodies, research and academic institutions, citizens groups, land trusts, and other non-governmental organizations. Table 53 shows the likely lead entities that can best achieve the goals and objectives in the action plans.

For some of the specific actions identified in the action plans, a single organization can achieve the desired result. For still other actions, the implementing responsibility may rest with one entity, but another may be able to provide technical or financial assistance. Because many of the entities and organizations identified in this document have authorities, responsibilities, or interests

[234] The program followed draft guidance subsequently formalized in EPA 1992.

[235] Although collaborative solutions are not necessarily a panacea to complex environmental problems (Lubell, 2004).

that overlap, communication and coordination among partners can help ensure success.

Federal and state regulatory agencies, such as the U.S. Environmental Protection Agency (EPA) and Massachusetts Department of Environmental Protection (DEP), have regulatory powers to require specific actions. However, most strategies identified in the CCMP will require local government action because municipalities have the greatest capacity and authority to address the cumulative impacts of growth and nonpoint source pollution. The responsibility and burdens to local government have only been growing as state and federal agencies have been aggregating nonpoint source pollution to require comprehensive solutions. This is particularly evident in the issuance of Phase II MS4 stormwater permits that require comprehensive management of municipal stormwater infrastructure, and the adoption of TMDLs for nitrogen by DEP and EPA. Because the Massachusetts constitution provides considerable home rule authority, this also means that the specific management strategy to address these cumulative impacts will vary among municipalities.

While it is true that the burden to address many pollution sources has increasingly shifted to municipalities, this document recognizes that many goals can only be achieved by an integrated intergovernmental approach. This is essential because the cost and scale of some of the problems are so great, it is impossible for local government to carry the load. This is particularly evident in meeting bacteria and nitrogen TMDLs, where the cost of sewering and stormwater treatment to meet these TMDLs will likely cost several billion dollars. It is therefore essential that federal and state agencies, and regional planning agencies, provide scientific and technical information, technical assistance staff, and funding to guide municipal actions, laws, and regulations. It is also important for state and federal government to provide financing to help leverage or fund local implementation. State and federal agencies can further support and complement local decisions with additional regulatory actions and policies.

While the preceding discussion acknowledges the leading role of local government to address many land-based problems, the Commonwealth of Massachusetts has specific responsibilities that relate to tidelands and land under the ocean. First, the Commonwealth is responsible for ensuring public access to the intertidal zone for fishing, fowling, and navigation as defined in Chapter 91 of the Massachusetts General Laws. Second, the Commonwealth owns, on behalf of the public, all rights in tidal waterways beyond the low water mark (land under the ocean). The responsibility of the Commonwealth in managing activities offshore was further expanded by the Massachusetts Ocean Act and defined by the 2009 Massachusetts Ocean Plan and other documents. These rights are held "in trust" for the benefit of the public.

Table 53. Primary lead entities that must implement the Buzzards Bay CCMP action plans.

	Action Plan	Primary Leads
1	Managing Nitrogen Sensitive Embayments	Municipalities, EPA, DEP
2	Protecting and Enhancing Shellfish Resources	Municipalities, DMF
3	Managing Stormwater Runoff and Promoting LID	Municipalities, EPA, DEP
4	Improving Land Use Management and Promoting Smart Growth	Municipalities
5	Managing Onsite Wastewater Disposal Systems	Municipalities, DEP
6	Managing Impacts from Boating, Marinas, and Moorings	Municipalities, DEP, CZM
7	Protecting and Restoring Wetlands	Municipalities, DEP
8	Restoring Migratory Fish Passage	Municipalities, DFW
9	Protecting Bio-Diversity and Rare and Endangered Species Habitat	Municipalities, MEPA, DEP
10	Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies	Municipalities, DEP
11	Managing Invasive and Nuisance Species	EPA, DEP
12	Protecting Open Space	Municipalities, EEA
13	Protecting and Restoring Ponds and Streams	DEP, DFW
14	Reducing Beach Debris, Marine Floatables, and Litter in Wetlands	Municipalities, Citizen Groups
15	Managing Coastal Watersheets, Tidelands, and the Waterfront	Municipalities, EEA
16	Reducing Toxic Pollution	DEP, EPA, Municipalities
17	Preventing Oil Pollutio	DEP, USCG, EPA
18	Planning for a Shifting Shoreline and Coastal Storms	Municipalities, CZM, DEP
19	Protecting Public Health at Swimming Beaches	Municipalities, DPH
20	Monitoring Management Action, Status, and Trends	Buzzards Bay NEP, BBC, DMF, DEP
21	Enhancing Public Education and Participation	BBC, Buzzards Bay NEP, DEP

This responsibility of stewardship of these public trust lands[236] and protecting the integrity of the Buzzards Bay ecosystem is reflected in several action plans.

With respect to implementing actions, it is important to recognize that the public will not automatically embrace the management recommendations presented in the Buzzards Bay CCMP, or any other planning document for that matter, merely because they are good ideas.

[236] A full discussion of the Public Trust Doctrine is contained in Slade, 1997.

There is a political element too that may be driven by costs, individual or collective hardships, property rights, or any of a number of other issues. Some municipal actions will require the support from a majority of voters. Some local initiatives just need vocal leaders demanding action. Underlying all these actions is the need for public involvement. The need for increased public awareness and understanding of environmental issues is the reason why the 2013 CCMP includes the new Action Plan 21 Enhancing Public Education and Participation.

At all levels of government, better planning is one of the most important elements to prevent worsening water quality and habitat conditions. Good planning can also set a course for restoration and pollution reduction strategies. During the 1980s and 1990s, efforts to manage growth in Massachusetts municipalities often failed and instead promoted sprawl because policies and regulations were poorly thought out and had unanticipated impacts. The resulting patterns of development also increased financial burdens to local government. A good example of these impacts can be seen in large lot size zoning without clustering, where the cost per home for infrastructure and services (repaving and plowing of roads, water and sewer service, school bus costs, etc.) skyrocketed. Buzzards Bay communities should learn from these past mistakes and engage in better land use planning, and adopt smart growth and low impact development techniques to manage the impacts of future growth.

To achieve all the goals of the 2013 Buzzards Bay CCMP will likely take decades. This is because some particularly intractable problems, like stormwater management and nitrogen reductions, will cost billions of dollars and immense levels of effort among local, regional, state, and federal entities. Continued cooperation among the different levels is essential to protect and enhance the viability of the bay and its watershed resources because no one level of government can solve all the problems. Implementation will require improved regulatory programs, planning for the future, establishing a regional perspective, taking legislative action, and institutionalizing the recommendations contained in the Buzzards Bay 2013 CCMP.

Table 53 shows the primary leads for actions identified in the CCMP. Throughout this document more specific actions and strategies are defined involving many more agencies and organizations than shown in this table. However, not all agencies or entities face equal levels of effort. In the sections below, we identify the greatest challenges that face the three levels of government.

Federal Challenges

In Massachusetts, EPA has primary responsibility for issuing wastewater discharge permits (both wastewater and stormwater) under the National Pollutant Discharge Elimination System (NPDES), although most permits are issued after consultation with DEP. EPA also has principal authority in enforcing the Clean Water Act, and ensuring compliance of TMDLs and water quality standards. Given the scale and scope of addressing stormwater and nutrient pollution problems, and in complying with pathogen and nutrient TMDLs, EPA must take a more proactive stance in assisting local government to take action. EPA must also facilitate state action necessary to implement these programs and achieve the goals of the Clean Water Act.

In 2000, EPA developed an improved (but still imperfect) set of indicators for evaluating and classifying swimming beaches. About the same time, the FDA made some minor changes in how they classified shellfish beds and assessed risks associated with pathogens in the water. Both agencies must continue their efforts studying and evaluating new approaches and developing water indicators to assess public health risk associated with pathogen contamination of coastal waters.

During the past 20 years, the U. S. Department of Agriculture (USDA) Natural Resource Conservation Service has expanded its efforts considerably to protect and restore wetland habitats and water quality. While these efforts have been admirable, more effort is required to encourage farmers to implement best management practices to minimize pollutant runoff from farmlands. USDA should also ensure that farm plan agreements are adhered to and enforced through the various USDA farm loan programs. The USDA should continue to work with farmers to minimize the offsite transport of agrichemicals and better manage water use.

Federal agencies are undertaking a variety of planning activities to help meet the goals and objectives relating to shifting shorelines and sea level rise. The Federal Emergency Management Agency has recently updated floodplain boundaries in Buzzards Bay municipalities. The agency should continue to work with the municipalities and state to help develop hazard mitigation plans and encourage municipalities with large numbers of structures at risk to participate in the Community Rating System. Other agencies should support other climate adaptation measures.

State Challenges

DEP is the major regulatory authority for environmental protection in Massachusetts, and as such, has the responsibility for most state recommendations contained in this management plan. EPA issues NPDES permits after consultation with DEP. In this regard, this agency is on the frontline in ensuring the goals and requirements of those programs are met.

Perhaps DEP's greatest responsibility in the next decade will be to encourage towns to adopt management strategies to meet nutrient and bacteria TMDLs. Their responsibility is all the more crucial given recent legal decisions affirming limits to EPA's abilities to manage certain nonpoint sources of pollution. The agency can achieve this goal through its grant programs, permit programs, and through enforcement action.

Local Challenges

Most streams and ponds in the Buzzards Bay watershed and near coastal waters of Buzzards Bay are affected by small yet cumulatively significant and numerous nonpoint sources of pollution. Increasingly, through permit programs like the MS4 NPDES stormwater program and through implementation of TMDLs, state, and federal government has directly shifted responsibility for action to local government. In Massachusetts, because a considerable amount of authority has been delegated to municipalities, these discharges can and should be managed by local boards and municipal departments. This will not happen automatically, or quickly, because local government has neither the financial capacity for massive infrastructure changes, nor personnel to implement many of the needed programs.

Many Buzzards Bay communities are handicapped in their efforts to implement local regulatory programs because they lack personnel with either the requisite technical expertise, or they lack a sufficient number of staff to handle all the new responsibilities thrust upon them by the state and federal government. Some smaller Buzzards Bay communities lack professional staff like planners and conservation agents or full time health agents. Many municipalities do not have staff and software to undertake the simplest of GIS analyses. Due to the wide range of disciplines required of any one local employee, even the communities that retain staff are hard-pressed to deal expertly with the many complex environmental issues that they must confront. It is for these reasons that the Buzzards Bay NEP directs so much of its operation toward providing technical and financial assistance to Buzzards Bay municipalities.

To focus local efforts, each municipality should establish a water quality committee, and staff to support the committee. This committee can meet MS4 permit requirements and other goals within the municipality. The responsibilities of the committee, and a water quality coordinator to staff it, would be to:

- Establish water quality goals and objectives for the town so that municipal departments and boards clearly understand the critical water quality and living resource issues that need to be addressed.
- Review the community's present management and regulatory policies and recommend necessary modifications.
- Advise selectmen and other policy makers as to appropriate actions necessary to meet these goals and objectives.
- Review relevant environmental data collected by state and federal agencies and local departments, and integrate this information into the local management program.

This recommendation was in the original Buzzards Bay CCMP, but was rarely implemented[237]. Efforts to develop comprehensive water management plans, Phase II MS4 permits, and state and federally imposed TMDLs make such a committee all the more important.

As noted above, Buzzards Bay communities need to better plan for growth and development in a way that protects environmental quality. Adopting "smart growth" and "low impact development" techniques and regulations are essential to meet this goal.

Establishing a Regional Perspective

While pollution in Buzzards Bay is often localized, it is also important to view Buzzards Bay and the living resources in its watershed as a regional resource shared by municipalities. This is particularly true in the case of nitrogen loading and stormwater discharges influencing water quality and habitat in the estuaries around the bay because these problems typically cross municipal bounds. Because restoration efforts will often require coordination among two or more communities, and because addressing nitrogen and stormwater impacts will cumulatively cost billions, regional or intermunicipal collaborations might be one mechanism to reduce costs.

The appreciation of Buzzards Bay as a regional resource became evident for the wrong kind of reason after the *Bouchard 120* oil spill in 2003. The spill bound together municipal first responders and other local officials, state, and federal legislators, and the public in a way that sped up the cleanup of Buzzards Bay and fostered improvements to navigation and oil transport in Buzzards Bay.

Bay-wide organizations, like the Buzzards Bay Coalition, the Buzzards Bay Action Committee, and the Buzzards Bay NEP have all been instrumental during the past 20 years encouraging regional and intermunicipal collaborations, and raising the awareness of residents and local officials as to their common interests in protecting Buzzards Bay, but more effort is needed. The protection of a resource the size and complexity of Buzzards Bay requires cooperation and consistency of approach among the communities sharing these resources. It is for this reason that these three Buzzards Bay regional organizations, together with regional planning agencies like SRPEDD, and the Cape Cod Commission, continue to implement initiatives that cross municipal boundaries and enhance watershed awareness.

[237] After the first CCMP was approved, the Town of Bourne established what is now called the Selectmen's Task Force on Local Pollution, which remains in existence to this day. The task force over the years has developed programs and plans to reduce pathogen and nutrient pollution in the Town's coastal waters.

Institutionalizing the Buzzards Bay CCMP

It is unimportant whether the average Buzzards Bay resident knows or understands that a Comprehensive Conservation and Management Plan exists for Buzzards Bay and its watershed. What *is* important is that both young people and adults understand the sources of pollution and environmental degradation, and what actions, both individually and collectively, need to be taken to protect the environment. They must also understand the costs of action and inaction. Without an informed citizenry, inaction will be the norm.

However, even with the noblest intentions, failure to act may occur because of high costs. This is why it is vital that regulations and the burden of restoring degradation be placed on those causing the degradation. More importantly, public policies and regulations must be structured so that new development and redevelopment not only prevents new impacts, but also helps mitigate existing impacts. In this way, the cost of restoring the environment becomes incorporated into the cost of development.

The CCMP is not a regulatory document, so successful implementation will require continued commitment and collaboration of all the partners. The Buzzards Bay NEP staff has successfully forged strong institutional arrangements with local, state, and federal stakeholders during the past twenty years. The emphasis has been on fostering partnerships with town regulatory boards because most Buzzards Bay CCMP actions are directed at local government, which has the greatest burden to implement the Buzzards Bay CCMP, and because Buzzards Bay NEP technical and financial assistance is most needed by them. The staff's focus has been on providing technical assistance to planning boards, boards of health, and conservation commissions. This assistance takes the form of bylaw development, workshops, open space planning, septic system tracking, stormwater treatment designs, GIS capability, and other useful implementation tools. Since the Buzzards Bay CCMP's approval by the EPA in 1992, Buzzards Bay NEP staff has had the opportunity to work in all major Buzzards Bay watershed towns to varying degrees. The staff's expertise has strengthened local capacity and accelerated Buzzards Bay CCMP implementation.

Besides technical assistance, the Buzzards Bay NEP has helped local grant writers with proposals, and secured highly competitive state and federal funds that were probably otherwise out of reach.

The Buzzards Bay NEP's ability to strengthen local capacity and facilitate Buzzards Bay CCMP implementation can be seen in numerous examples. In the 1990s, the NEP could be seen in the deployment of SepTrack (on-site septic system software) and grants to provide GIS capability to the communities, and to enhance the towns' abilities to work with GIS data, prepare for oil spills, and provide funding for professional staff to boards of health and conservation commissions. In the 2000s, efforts continued through expansion of stormwater GIS databases, assistance on the update of open space plans, and an expanded municipal grant program, supplemented with state funds, to help leverage many new actions.

Beyond establishing strong local relations, the Buzzards Bay NEP has also developed a solid working arrangement within state government. This starts with the program being housed within the Massachusetts Office of Coastal Zone Management (CZM), which provides a special institutional advantage. The program has used the prestige of CZM and the expertise of key staff to further the accomplishment of many program priorities within the Buzzards Bay watershed. CZM also provides valuable administrative support and framework to the program.

The Buzzards Bay Action Committee (BBAC) has been an essential partner guiding the Buzzards Bay NEP's grant and technical assistance program. The monthly meetings of the BBAC have also been effective in furthering local partnerships. These sessions have allowed discussions that both promote the Buzzards Bay NEP's activities and provide an opportunity to hear from town representatives about community needs. The BBAC has used these forums to help the Buzzards Bay NEP establish funding priorities, and to ensure that the municipal needs are incorporated into the program's annual work plan.

The Buzzards Bay Coalition has become a leader of environmental action, advocacy, and education in the Buzzards Bay watershed. It is a membership-supported non profit organization, which, because of strong leadership and public support, has grown into a nationally recognized organization with an annual budget of over a million dollars, and more than 20 regular staff. As noted on their website, the Coalition is dedicated to the restoration, protection and sustainable use and enjoyment of Buzzards Bay and its watershed. The Bay Coalition works to improve the health of the bay ecosystem for all through education, conservation, research, and advocacy. The vision of the Coalition is:

A Bay shoreline defined by safe swimming beaches, open shellfish beds, and stretches of scenic open spaces for all to enjoy.

Healthy waters that support abundant fish, shellfish, and wildlife populations.

A Bay safe from the threats of oil spills, industrial and sewer discharges, and ocean dumping.

The Coalition has also collaborated with the Buzzards Bay NEP on the program's EPA grant and other initiatives for many years. The organization has been instrumental in assisting Buzzards Bay municipalities to seek and receive grants from the NEP and other state and federal agencies in their efforts to meet the goals of the organization and the CCMP.

Massachusetts Coastal Zone Management (CZM) has supported the Buzzards Bay NEP, and included elements and recommendations in the CCMP in its program plan and other documents. Other elements of the CCMP will be considered in future CZM program updates submitted to NOAA. CZM has a well-established and effective review process for evaluating projects, especially federal actions that may affect the state's coastal zone. This process can address priorities in the Buzzards Bay CCMP and Buzzards Bay watershed that are not currently addressed in the state program plan[238].

At the state and federal level, the Buzzards Bay CCMP can continue to be institutionalized into other programs as has been done during the past decade. This includes providing priority funding to projects that implement Buzzards Bay CCMP recommendations, and refocusing state and federal programs to achieve Buzzards Bay CCMP goals. EPA has already implemented such a policy in its 319 NPS pollution program and in its 604(b) watershed programs.

Because nitrogen management is a key component of the original Buzzards Bay CCMP, the Buzzards Bay NEP focused much of its early efforts in promoting state and local action on nitrogen related issues. The Buzzards Bay NEP was instrumental in assisting the Massachusetts Department of Environmental Protection (DEP) to incorporate nitrogen management issues into its rewrite of the state onsite septic system code in 1994 and in 1996, and in the adoption of new policies and regulations for the adoption and use of innovative wastewater systems. This work also set some of the groundwork for nutrient and pathogen TMDLs that were adopted by DEP and the Massachusetts Estuaries Project in the 2000s. It is important the Buzzards Bay NEP continue to support DEP's efforts to develop and adopt TMDLs, and in assisting municipalities to implement actions to meet those TMDLs once approved. It is also essential that the Buzzards Bay NEP work on stormwater management issues and assist towns in their efforts to treat stormwater and implement programs to improve water quality and meet bacteria TMDLs.

A key responsibility of the Buzzards Bay NEP is to monitor the implementation of actions by municipal, state, and federal government, and the private sector, that support the goals of the CCMP. Another responsibility is to facilitate those actions whenever possible through financial or technical assistance. The Buzzards Bay NEP, a unit of the Massachusetts Office of Coastal Zone Management, works under the guidance of its Steering Committee[239]. It is essential that the members of the Steering Committee meet periodically to assess progress and action, improve coordination and collaboration of the partners, ensure participation of other entities and organizations, and promote actions within their programs that further CCMP goals. These activities are essential in the broader effort to protect and restore water quality and living resources in Buzzards Bay and its surrounding watershed.

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[238] This has already occurred in several instances such as in comments submitted by CZM to MEPA on large groundwater wastewater discharges outside of the Massachusetts coastal zone, but within the Buzzards Bay watershed, that would cause environmental degradation due to nitrogen loading. Reauthorization of the Coastal Zone Management Act in the 1990s expanded state authority to go beyond the designated coastal zone.

[239] The Steering Committee currently consists of the Massachusetts Office of Coastal Zone Management, U.S. Environmental Protection Agency New England, Massachusetts Department of Environmental Protection, Southeastern Regional Planning & Economic Development District, Buzzards Bay Action Committee, and the Buzzards Bay Coalition.

Chapter 6. Resources for Financing the Buzzards Bay CCMP

Current Approach

In each action plan, there are estimates on the costs to achieve various goals or to implement certain programs. To better organize and clarify the responsibilities and costs associated with various programs, we used our best professional judgment to identify specific costs and financing options. Certain efforts, such as managing and treating stormwater and nitrogen discharges to meet water quality goals and TMDLs, will likely total billions of dollars, and take decades to achieve. Achieving other goals and objectives will be far less costly.

In this chapter, we summarize likely total costs identified in the action plans, and major past and future funding sources and mechanisms. We also identify those grant and government programs that need additional resources. We present only brief descriptions of options, and we refer the reader to more comprehensive assessments and evaluations such as those now being undertaken by the Water Infrastructure Finance Commission set up by the Massachusetts Legislature,[240] various wastewater financing reports available at the Cape Cod Commission website,[241] and reports from the Cape Cod Water Protection Collaborative.[242]

Financing the implementation of a CCMP is not the same as financing a NEP, but they are related. For the goals of a non-regulatory document like the Buzzards Bay CCMP to be achieved, not only must progress be tracked, but also approaches and actions refined and improved upon, and new adaptive efforts must be initiated to overcome government and public inertia. This is a key role for NEPs and their partners. For this reason, this chapter also discusses the financing of the Buzzards Bay NEP and its partners. In particular, we discuss past and future funding of the NEP's two longstanding partners on its EPA cooperative agreements, the citizen NGO, the Buzzards Bay Coalition, and the municipal NGO the Buzzards Bay Action Committee.[243]

In the end, however, it is local government that will likely bear most of the costs and burdens of implementing the Buzzards Bay CCMP, and municipalities remain the principal authority to adopt and implement the policies, regulations, and programs needed to achieve water quality and habitat restoration goals. Some recommendations in the Buzzards Bay CCMP have a high cost and require years of sustained funding. The Buzzards Bay NEP believes that Buzzards Bay municipalities will succeed only if regional, state, and federal government also share in the regulatory and financial burdens of municipal efforts.

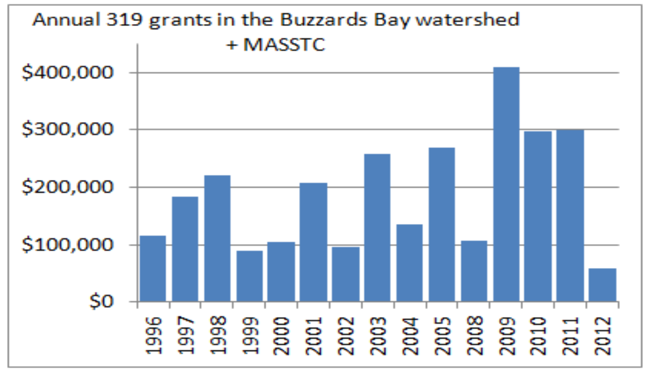

Figure 115. EPA funded DEP 319 program grants to Buzzards Bay municipalities to manage nonpoint source pollution, and related initiatives.

The figure includes funding for the Massachusetts Alternative Septic System Test Center (MASSTC), which was initially operated by the Buzzards Bay NEP, but is now solely managed and operated by the Barnstable County Department of Health and the Environment.

Past Funding

To understand opportunities to fund the recommendations in the Buzzards Bay CCMP 2013 Update, it is important to appreciate past funding sources of the Buzzards Bay NEP, its NGO partners, and the municipalities. Understanding how municipalities have funded and implemented past recommendations is particularly important because municipal government bears the greatest responsibility and cost in implementing the recommendations in the management plan.

Buzzards Bay NEP

The twenty-seven-year history of funding of the Buzzards Bay NEP can be broken into three broad periods. Between 1985 and 1992, large amounts of federal dollars were received to characterize environmental problems, develop the first Buzzards Bay CCMP, and undertake environmental demonstration projects. Funding during this period averaged close to $1 million per year. Between 1993 and 2001, the Buzzards Bay NEP continued to receive federal base funding, but at dramatically reduced levels. To offset these losses, the Buzzards Bay

[240] Their June 2011 initial report, Toward Financial Sustainability, is retrieved from mwwa.memberclicks.net/assets/documents/Advocacy/june%2029%20final%20initial%20report%20as%20voted%20by%20water%20infrastructure%20commission.pdf.

[241] See at Enhancing Wastewater Management on Cape Cod: Planning, Administrative and Legal Tools Report to Barnstable County July 2004 at www.capecodcommission.org/resources/waterresources/WWToolsRept.pdf.

[242] See particularly, Comparison of Costs for Wastewater Management Systems Applicable to Cape Cod retrieved from www.ccwpc.org.

[243] Both the Buzzards Bay Coalition and the Buzzards Bay Action Committee were created as offshoots from the Buzzards Bay NEP's Citizen Advisory Committee.

NEP brought in additional grant dollars through various grant programs for special initiatives like the Massachusetts Septic System Test Center and Toxics Use Reduction Program. During this period, the Buzzards Bay NEP also received two congressional earmarks totaling $1 million dollars, and state earmarks totaling $400,000. These earmarks were directed into the municipal grant program.

After 2001, the Buzzards Bay NEP changed its financing strategy and used federal funding to fund core staff and a technical assistance and grant program. The focus of this new strategy was for municipalities to receive grant money directly by helping them develop competitive and viable restoration projects. A core element of this strategy has been the Buzzards Bay municipal grant program that often initiates projects that are subsequently funded by larger state and federal grant programs.

This new approach had several advantages. The Buzzards Bay NEP did not have to act as an administrative agent to other state or federal grant programs, nor was it reliant on increasing state and federal dollars. This approach allowed the Buzzards Bay NEP to refocus its efforts on technical assistance and grants to municipalities and our partners to implement specific initiatives. Any additional state or federal funds received by the program above federal base levels (initially around $500,000 per year, later $600,000 per year) were principally directed to the Buzzards Bay NEP's grant program.

Buzzards Bay Coalition

The Buzzards Bay NEP Citizens Advisory Committee (CAC) split in 1987 to form a citizens non-profit called the Coalition for Buzzards Bay (renamed in 2011 as the Buzzards Bay Coalition), and an affiliation of municipal officials called the Buzzards Bay Advisory Committee. After its formation in 1987, the Buzzards Bay Coalition received considerable funding from the Buzzards Bay NEP to implement and initiate education, outreach, and water quality monitoring programs. This funding, together with private donations, helped firmly establish the Coalition during its formative years, and helped it create a strong membership base. The Coalition cut back on some efforts during the mid 1990s when their funding from the Buzzards Bay NEP was reduced. However, by the late 1990s, with new strong leadership, new initiatives focusing on land and habitat protection, and successful and creative financial development programs, the Coalition grew to an annual budget of $1.5 million and 15 staff members by the mid 2000s. Today the Coalition is funded by a roughly equal mix of membership dues, donations, special endowments, and grants.

Buzzards Bay Action Committee

In 1989 the Buzzards Bay Advisory Committee, an advisory committee of Buzzards Bay NEP since 1987, re-formed as a non-profit municipal organization called the Buzzards Bay Action Committee (henceforth, the BBAC). Initially the BBAC was funded by a grant from the Buzzards Bay NEP that primarily paid the salary of their executive director. When funding from the Buzzards Bay NEP diminished in the mid 1990s, the BBAC reorganized with a part time director funded solely by dues from the member municipalities. This funding proved adequate for the organization with some funds available for special projects like the stormwater mapping project with the New Bedford Voc-Tech High School. The BBAC also occasionally received small grants from state and federal sources and sometimes hired temporary staff under these grants.

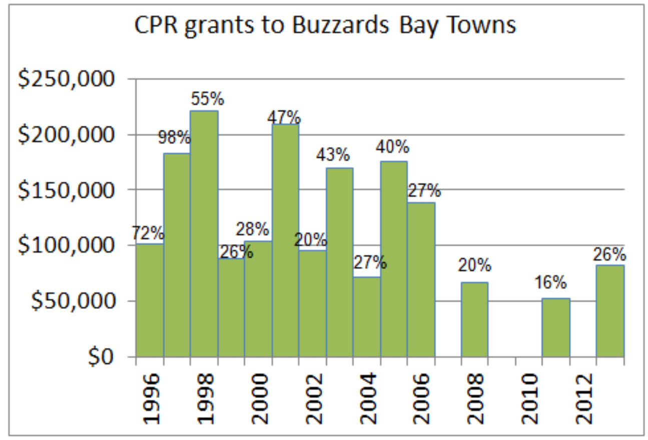

Figure 116. Annual dollars awarded by the CZM Coastal Pollution Remediation grant program to Buzzards Bay watershed towns, 1996-2013.

Also showing percent of statewide total award.

Buzzards Bay Municipalities

The Buzzards Bay NEP has had a highly effective municipal grant program in place since 1990 that has assisted Buzzards Bay municipalities. This program, funded through EPA Section 320, EPA demonstration project funds, Congressional add-ons, and state match programs, has been highly effective at facilitating Buzzards Bay CCMP actions and remains a core function of the Buzzards Bay NEP, an important financial resource to local government.

Several other state programs have been invaluable to Buzzards Bay municipalities. These include the Coastal Pollution Remediation program (CPR, actually an offshoot of a state Buzzards Bay NEP earmark[244]), CZM

[244] In both 1994 and 1996, the Buzzards Bay NEP received $200,000 under the state transportation bond for stormwater treatment grants. The NEP received these funds to match federal funding. The program was so popular and successful, Massachusetts CZM made it a permanent feature of the state transportation bond funding, and renamed the program the Coastal Pollution Remediation program and made it available to all Massachusetts coastal municipalities. In the first few years, CPR had to match

NPS grant program, the Massachusetts 319 NPS program, and the Clean Vessel Act program. The latter three programs are federally funded. In many case, the Buzzards Bay NEP assisted towns to develop grant proposals or projects that were funded under these programs.

Besides these grant programs, the state's Clean Water State Revolving Fund remains the principal mechanism to fund several key environmental restoration efforts, particularly sewage treatment plant upgrades and sewer expansion in Massachusetts, although the program is flexible enough to be used for other purposes.

For example, Buzzards Bay municipalities account for 12.5% of all Massachusetts coastal communities, yet through the CPR program, grants to Buzzards Bay communities, for projects in the Buzzards Bay watershed, account for more than 26% of all CPR grants. Similarly, Buzzards Bay municipalities account for less than 4% of all Massachusetts municipalities eligible for Section 319 nonpoint source funding, and Buzzards Bay NEP towns and partners have accounted for nearly 26% of all grants (and 14% of dollars awarded) between 1994 and 2007.

The financing of implementation activities and leveraging of Buzzards Bay CCMP actions is part of an ongoing aggressive strategy by the Buzzards Bay NEP to tap into various state and federal financial and technical assistance programs. Other Buzzards Bay NEP Partners have similarly had success in attracting state and federal dollars. For example, for its water quality monitoring program the Coalition received $100,000 in 2004; and $150,000 per year between 2005 and 2007.

The success of grant and other funds acquired by the Buzzards Bay NEP and partners is illustrated by the leveraged funds reports prepared by the Buzzards Bay NEP for the U.S. EPA. These reports indicate that modest federal "base funding" through the NEP has paid big dividends for Buzzards Bay with 2 to 4 times the federal dollars being leveraged by nonfederal sources.

Costs of Implementing the Buzzards Bay CCMP

To achieve the goals of the CCMP (and to achieve full compliance with the federal Clean Water Act, will likely cost more than $5 billion and take decades to implement. These costs do not include the more than $1 billion in costs to clean up all the superfund sites in the watershed. The $5 billion cost is largely driven by the costs of complying with two federally mandated Clean Water Act elements: compliance with pollutant TMDLs and compliance with the NPDES program, particularly Phase II municipal stormwater (MS4) system permit compliance.

targets to Buzzards Bay municipalities in order to meet Buzzards Bay NEP match commitments.

Table 54. Summary of possible costs over a 20-year period (approximate mid-range estimates) by action plan.

Values should be considered approximate and based on best professional judgment.

Action Plan	approximate mid range costs
1: Managing Nitrogen Sensitive Embayments	$2 billion
2: Protecting and Enhancing Shellfish Resources (costs other than stormwater)	$10,000,000
3: Managing Stormwater Runoff and Promoting LID	$1 billion
4: Improving Land Use Management and Promoting Smart Growth	>$10, 000,000
5:Managing Onsite Wastewater Disposal Systems	$1,000,000
6: Managing Impacts from Boating, Marinas, and Moorings	$17,000,000
7: Protecting and Restoring Wetlands	$20,000,000
8: Restoring Migratory Fish Passage	$25,000,000
9: Protecting Bio-Diversity and Rare and Endangered Species Habitat	$50,000,000
10: Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies	$100,000,000
11: Managing Invasive and Nuisance Species	$10,000,000
12: Protecting Open Space	$100,000,000
13: Protecting and Restoring Ponds and Streams	$6,000,000
14: Reducing Beach Debris, Marine Floatables, and Litter in Wetlands	$1,000,000
15: Managing Coastal Watersheets, Tidelands, and the Waterfront	$3,000,000
16: Reducing Toxic Pollution (excludes $1 billion+ Superfund cleanup costs)	$10,000,000
17: Preventing Oil Pollutio	$5,000,000
18: Planning for a Shifting Shoreline and Coastal Storms	$2,000,000
19: Protecting Public Health at Swimming Beaches	$1,000,000
20: Monitoring Management Action, Status, and Trends	$40,000,000
21: Enhancing Public Education and Participation	$20,000,000
Approximate Total	$3,500,000,000

The TMDL requirements under the Clean Water Act will eventually result in most of the urbanized portions of Buzzards Bay being sewered or connected to advanced wastewater treatment systems to remove nitrogen. The Buzzards Bay NEP estimates the sewer expansion, together with the construction of advanced wastewater facilities of various scales, will likely cost $3 to $4 billion.

Similarly, the Phase II municipal MS4 stormwater permits may cost up to $1 billion for municipalities to treat all stormwater discharges from public infrastructure to keep bacteria levels below water quality standards in impaired areas. This program will be driven to a large degree by needed compliance with bacterial TMDLs for Buzzards Bay, which will require that stormwater discharges not discharge above impairment levels for state listed impaired waters. In practical terms, particularly in areas with closed shellfish beds, this means that the first flush of stormwater to surface waters would need to be eliminated at hundreds of sites.

Most other Buzzards Bay CCMP recommendations will cost far less to implement, and some have virtually no cost. A summary of costs by action plan are shown in Table 54.

The Future

The Buzzards Bay NEP, together with our partners, expect continued success in securing state and federal competitive grants to fund specific implementation projects. Moreover, state, and federal agencies are increasingly willing to dedicate their own limited internal resources to help implement the recommendations contained in the Buzzards Bay CCMP.

Key State and Federal Grant Programs to fund Buzzards Bay CCMP recommendations

5 Star Restoration Program
Agency: U.S. Environmental Protection Agency
The Five Star Restoration Program brings together students, conservation corps, other youth groups, citizen groups, corporations, landowners and government agencies to provide environmental education and training through projects that restore wetlands and streams. The program provides challenge grants, technical support, and opportunities for information exchange to enable community-based restoration projects

Eligibility: non-profit community-based organizations, conservation organizations, local governments, and school districts.

Website: water.epa.gov/grants_funding/wetlands/restore/index.cfm
Contact: Myra Price
202-566-1225
price.myra@epa.gov

604(b) Water Quality Management Planning Grants
Agency: Department of Environmental Protection (DEP)
Assists regional planning agencies and other eligible recipients in providing water quality assessment and planning assistance to local municipalities.

Eligibility: Regional planning agencies, municipalities, councils of government, and conservation districts

Website:
www.mass.gov/eea/agencies/massdep/water/grants/watersheds-water-quality.html#3
Contact: Gary Gonyea
617-556-1152
gary.gonyea@state.ma.us

Agricultural Environmental Enhancement Program
Agency: Department of Agricultural Resources (DAR)
For the purchase of materials to implement agricultural conservation practices that improve water quality, conserve water, reduce greenhouse gas emissions, or conserve energy.

Eligibility: Farmers/growers/shellfish growers as identified by Massachusetts General Laws (MGL) engaged in commercial agriculture production.

Website:
www.mass.gov/eea/agencies/agr/about/divisions/aeep.html
Contact: Laura Maul
617-626-1739
laura.maul@state.ma.us

Buzzards Bay Watershed Municipal Grant Program
Agency: Buzzards Bay National Estuary Program (Buzzards Bay NEP)
The Buzzards Bay National Estuary Program offers these grants to assist interested Buzzards Bay watershed municipalities in the protection of open space, rare and endangered species habitat, and freshwater and saltwater wetlands, and to help restore tidally restricted salt marshes, to purchase oil spill containment equipment, to restore fish runs, and to remediate stormwater discharges threatening water quality. These funds have been made available in accordance with U.S. EPA National Estuary Program Cooperative Agreements and are part of an ongoing Buzzards Bay Watershed Municipal Grant Program implemented by the Buzzards Bay National Estuary Program.

Eligibility: Eligible towns include Fall River, Westport, Dartmouth, New Bedford, Acushnet, Fairhaven, Rochester, Mattapoisett, Marion, Wareham, Middleborough, Carver, Plymouth, Bourne, Falmouth, and Gosnold. Projects must lie principally within the Buzzards Bay watershed.

Website: buzzardsbay.org
Contact: Dr. Joe Costa
508-291-3625
joe.costa@state.ma.us

Clean Vessel Act Grant Program
Agency: Department of Fish and Game (DFG)
Grants are made available to municipalities for the construction, operation, and maintenance of pump out facilities for recreational boaters.

Eligibility: Municipalities, private boating facilities, and non-profits, see federal guidance 50 CFR 85

Website:
www.mass.gov/eea/agencies/dfg/dmf/programs-and-projects/clean-vessel-act.html
Cecil French
(978) 282-0308 x 119
cecil.french@state.ma.us

Clean Water State Revolving Loan Fund Program
Agency: Department of Environmental Protection (DEP)
For the purpose of water pollution abatement projects, this program was established to provide a low cost funding mechanism to assist municipalities seeking to comply with federal or state requirements to meet water quality standards. The State Revolving Fund now provides increased emphasis on watershed management priorities. New projects receive a state-subsidized 2% interest loan.

Eligibility: Cities, towns, and wastewater districts

Website:
www.mass.gov/eea/agencies/massdep/water/grants/clean-water-state-revolving-fund.html
Contact: Dave Delorenzo
617-292-5774
David.DeLorenzo@state.ma.us

Coastal and Estuarine Land Conservation Program (CELCP)
Agency: Coastal Zone Management (CZM)
The NOAA Coastal and Estuarine Land Conservation Program (CELCP) protects "important coastal and estuarine areas that have significant conservation, recreation, ecological, historical, or aesthetic values, or that are threatened by conversion from their natural or recreational state to other uses." This program gives "priority to lands which can be effectively managed and protected and that have significant ecological value." CZM, through its Coastal and Estuarine Land Conservation (CELC) Plan provides guidance on the priority areas for land conservation in Massachusetts and the types of coastal and estuarine resources important for protection. CZM provides the coordinating and facilitating role for the solicitation of highly competitive coastal and estuarine land conservation projects within the Commonwealth, and takes the lead in selecting and nominating projects to NOAA for further consideration under the national CELCP selection process. CZM will nominate to NOAA those projects believed to be most beneficial to the Commonwealth and most competitive in the federal selection process.

Eligibility: The only coastal states and territories eligible to participate in this competition are those with a Coastal Zone Management Program or National Estuarine Research Reserve which has been approved under the CZMA, and which have submitted a draft CELCP plan on or before February 24, 2009.

Website: www.mass.gov/eea/agencies/czm/program-areas/coastal-habitat/celcp/
Contact: David Janik
508-291-3625 x 20
david.janik@state.ma.us

Coastal Pollution Remediation (CPR) Grant Program
Agency: Coastal Zone Management (CZM)
Provides funding at the local level to improve coastal water quality by reducing or eliminating nonpoint sources of pollution, specifically those that are transportation-related. The program is particularly focused on NPS pollution caused by rainfall or snowmelt moving over and through the ground, and conveying natural and human-made pollutants, and depositing them into coastal waters.
Criteria: "Eligible projects include, but are not limited to:
1) the treatment of stormwater pollution from roadways;
2) assessment to identify the source(s) of pollution from roadways and parking lots and design of best management practices (BMPs) to remediate the identified sources;
3) implementation of BMPs to treat stormwater pollution from roadways and parking lots; and
4) construction and design of boat pumpout facilities to remediate nonpoint source pollution from recreational marine vessel discharges."

Eligibility: Municipalities located within the Greater Massachusetts Coastal Watershed

Website: www.mass.gov/eea/agencies/czm/program-areas/coastal-water-quality/cpr/
Contact: Jan Smith
617-626-1231
Jan.smith@state.ma.us

Conservation Partnership Grant
Agency: Division of Conservation Services (DCS)
This program is intended to provide funding to assist non-public, not-for-profit corporations in acquiring and holding interests in lands suitable for conservation or recreation purposes. Those considering submission of a response are encouraged to review the BioMap and Living Waters assessments, as proposals for protecting parcels lying within identified Core and Supporting areas are a priority of this grant program.

Eligibility: This grant program is open to qualified IRS 501(c)(3) organizations that have been formed for one of the purposes described in Section 4 of Chapter 180 of the General Laws. An organization must have 501(c)(3) status at the time an application is submitted. Municipalities are not eligible for funding.

Website: www.mass.gov/eea/grants-and-tech-assistance/grants-and-loans/dcs/grant-programs/conservation-partnership-grant.html
Contact: Melissa Cryan
617-626-1171

melissa.cryan@state.ma.us

Drinking Water Supply Protection Grant Program
Agency: Department of Environmental Protection
To protect key parcels of land believed critical to the protection of current and future water supplies.
Eligibility: Municipalities and other water supply entities recognized by state law.

Eligibility: municipalities, as well as public water systems established by a legislative act to provide drinking water to the public.

Website:
www.mass.gov/eea/agencies/massdep/water/grants/watersheds-water-quality.html
Contact: Catherine Sarafinas
617-556-1070
catherine.sarafinas@state.ma.us

Drinking Water State Revolving Loan Fund Program
Agency: Department of Environmental Protection (DEP)
Provides low-cost financing to help community public water suppliers comply with federal and state drinking water requirements. The program's goals are to protect public health and strengthen compliance with drinking water requirements while addressing the Commonwealth's drinking water needs. The program incorporates affordability and watershed management priorities.

Eligibility: Public water suppliers

Website:
www.mass.gov/eea/agencies/massdep/water/grants/watersheds-water-quality.html
Contact: Kathy Romero
(617) 292-5727
Kathleen.Romero@state.ma.us

Federal Land and Water Conservation Fund
Agency: Division of Conservation Services (DCS)
The Federal Land & Water Conservation Fund (P.L. 88-578) provides up to 50% of the total project cost for the acquisition, development, and renovation of park, recreation, or conservation areas.

Eligibility: Municipal conservation commissions, park departments, and certain agencies within EEA. Municipalities must have a current open space and recreation plan to apply, and the land must be open to the public.

Website: www.mass.gov/eea/grants-and-tech-assistance/grants-and-loans/dcs/grant-programs/massachusetts-land-and-water-conservation-fund.html
Contact: Melissa Cryan
(617) 626-1187
Melissa.cryan@state.ma.us

Flood Mitigation Assistance Program Grants
Agency: Massachusetts Emergency Management (MEMA)
Cost-shared grants for flood mitigation planning and projects for communities (pre- and post-disaster).

Eligibility: Municipalities with repetitive flood loss properties participating in the National Flood Insurance Program.

Website: www.mass.gov/eopss/agencies/mema/hazard-mitigation/
Contact: Rich Zingarelli
(617) 626-1406
Richard.Zingarelli@state.ma.us

Hazard Mitigation Grant Program
Agency: Massachusetts Emergency Management (MEMA)
Cost-shared grants for natural hazard mitigation planning and projects for communities (post-disaster). Dependent on future Presidential disaster declarations.

Eligibility: Municipalities, state agencies, certain non-profits.

Website: www.mass.gov/eopss/agencies/mema/hazard-mitigation
Contact: Rich Zingarelli
(617) 626-1406
Richard.Zingarelli@state.ma.us

Governor's Seaport Advisory Council Seaport Improvement Grants
Agency: Seaport Advisory Council
The Governor's Seaport Advisory Council (SAC) approves grant projects, with the Lt. Governor as Chair. The Office of Waterways issues grants approved through the Rivers and Harbors Grant Program to municipalities. These grants are available pursuant to Chapter 28 of the Acts and Resolves of 1996, the Seaport Bond bill, for the "revitalization and development of the Commonwealth's seaports." Grants are awarded for "the preparation of plans, studies, construction, alteration, and improvement of various state, municipal, and other properties, and for the purpose of improving the economy and infrastructure of the Commonwealth" (C.28, 1996).

Eligible Applicants: Primarily designated port cities and other municipalities

Contact: Ellen Cebula
(781) 740-1600 x102
ellen.cebula@state.ma.us

Lakes and Ponds Program
Agency: Department of Conservation and Recreation (DCR)
To protect, manage, and restore valuable aquatic resources, this program provides technical assistance, helps to monitor water quality at various public beaches to ensure public safety, and provides educational materials to the public about various lake issues.

Eligibility: Municipalities, citizens group, and other local nonprofit groups.

Website: www.mass.gov/eea/agencies/dcr/water-res-protection/lakes-and-ponds
Contact: Tom Flannery
617-626-4975
tom.flannery@state.ma.us

Landowner Incentive Program
Agency: Department of Fish and Game (DFG)
The purpose of this grant is to restore or create wildlife habitat for the benefit of species-at-risk on private lands in the Commonwealth of Massachusetts. The grants are aimed to establish a partnership between the Massachusetts Division of Fisheries and Wildlife and private landowners.

Eligible Applicants: Private landowners, sportsmen's clubs, land trusts, and non-profit groups

Website: www.mass.gov/eea/agencies/dfg/dfw/wildlife-habitat-conservation/landowner-incentive-program-lip.html
Contact: Tracy Grazia
(508) 389-6387
tracy.grazia@state.ma.us

Local Acquisitions for Natural Diversity (LAND) Grant
Agency: Division of Conservation Services (DCS)
This program is intended to provide funding to assist municipal conservation commissions in acquiring interests in lands suitable for conservation purposes, to protect undeveloped lands, unique ecosystems, rare species and Priority Habitats, and working lands, and to preserve the Commonwealth's rich natural heritage for the future. It is a reimbursement program.

Eligibility: Municipal conservation commissions that have open space and recreation plans that are approved or currently under review

Website: www.mass.gov/eea/grants-and-tech-assistance/grants-and-loans/dcs/grant-programs/massachusetts-local-acquisitions-for-natural.html
Contact: Celia Riechel
617-626-1187
Celia.Riechel@state.ma.us

Marine and Anadromous Fish Habitat Restoration Grants
Agency: Fish America Foundation/National Oceanographic and Atmospheric Association
FishAmerica, in partnership with the NOAA Restoration Center, awards grants to local communities and government agencies to restore habitat for marine and anadromous fish species. Successful proposals have community-based restoration efforts with outreach to the local communities.

Eligibility: Non-profit organizations such as local sporting clubs and conservation associations, educational institutions, and local and state governments may apply for funding. Non-profit organizations must provide a proof of non-profit status (i.e. 501(c)(3) letter from the IRS). Local and state agencies, educational institutions and other government entities must provide their EIN number.

Website: www.fishamerica.org/grants.html#
Contact: pegan@asafishing.org
703-519-9691

Massachusetts Environmental Trust Grants
Agency: Massachusetts Environmental Trust (MET)
The Trust's mission is to develop, coordinate, and fund projects that encourage cooperative efforts to raise environmental awareness and enable innovative approaches that can restore, protect, and improve water and water-related resources of the Commonwealth.

Eligibility: Nonprofit organizations

Website: www.mass.gov/eea/grants-and-tech-assistance/grants-and-loans/mass-enviro-trust/met-grants.html
Contact: William Hinkley
617-626-1177
william.hinkley@state.ma.us

Municipal Sustainability Grant Program
Agency: Department of Environmental Protection (DEP)
Description: Provides cities, towns, schools and certain regional government entities with equipment, outreach materials, technical assistance, and funding for waste reduction, water conservation, household hazardous waste and mercury diversion, and air quality programs and projects.

Eligibility: Massachusetts municipalities and regional governments

Website:
www.mass.gov/eea/agencies/massdep/recycle/grants/
Contact: Tina Klein

617-292-5704
Tina.Klein@state.ma.us

Parkland Acquisitions and Renovations for Communities (PARC) Grant Program
Agency: Division of Conservation Services (DCS)
This program is intended to provide funding to cities and towns to acquire and develop land for park and outdoor recreation purposes for urban populations.

Eligibility: municipalities that have open space and recreation plans that are approved or currently under review

Website: www.mass.gov/eea/grants-and-tech-assistance/grants-and-loans/dcs/grant-programs/
Contact: Melissa Cryan
617-626-1171
Melissa.Cryan@state.ma.us

Recreational Trails Grants Program
Agency: Department of Conservation and Recreation (DCR)
The Recreational Trails Program provides grants ranging from $2,000 to $50,000 on a reimbursement basis for a variety of trail protection, construction, and stewardship projects throughout Massachusetts. It is part of the national Recreational Trails Program, which is funded through the Federal Highway Administration (FHWA) to develop and maintain recreational trails and trail-related facilities for both non-motorized and motorized recreational trail uses.

Website: www.mass.gov/eea/agencies/dcr/services-and-assistance/grants-and-technical-assistance/recreational-trails-grants-program.html
Contact: Amanda Lewis
(413) 586-8706 ext. 19
amanda.lewis@state.ma.us

Rivers and Harbor Grant Program (Dredging Grants)
Agency: Department of Conservation and Recreation (DCR)
The purpose of this program is to enable municipalities to address various types of waterways-related problems and provide for financial and technical assistance during engineering, design, permit acquisition, construction management, construction, and related efforts. Typical types of projects qualifying for the program are:

- dredging of channels, harbors and inland waterways to improve navigation, tidal flushing, flood storage, water habitat;
- improving public access, including rehabilitation of publicly owned piers, seawalls, wharves, jetties, bulkheads and revetments;
- rehabilitation or construction of flood control measures, including dikes, weirs, check dams, tide or floodgates and flood control internal drainage systems;
- lake and pond restoration, or management activities to benefit public access, water-dependent recreation or habitat enhancement purposes;
- beach nourishment for barrier beach maintenance, habitat enhancement or recreational purposes;
- coastal or inland wetlands restoration;
- and stream bank and shoreline erosion control protection.

Eligibility: Municipalities, local or county commissions or local authorities. Other public or nonprofit organizations or associations can be co-applicants with municipality or county commissions.

Website: www.mass.gov/eea/grants-and-tech-assistance/grants-and-loans/eea-grants-guide/water-grants.html
Contact: (781) 740-1600

Riverways Program Grants for River Restoration and Revitalization Priority Projects
Agency: Department of Fish and Game (DFG)
Funds are intended to further the goals of the DFG by restoring the ecological integrity of rivers and streams throughout the Commonwealth working in partnership with federal, state, and municipal governments, watershed associations and other organizations. Riverways supports sustainable river restoration projects that restore natural processes, remove ecosystem stressors, increase the resilience of the ecosystem, support riverine habitat, and promote passage of fish and wildlife through dam and other barrier removal. Support is also provided for urban stream revitalization projects that improve the inter-connection between water quality, aquatic ecology, physical river structure, and land use, while taking into consideration the social, cultural, and economic landscape.

Eligibility: Open to public agencies and 501(c)(3) certified non-profit organizations, including, but not limited to state agencies, cities and towns, regional planning agencies, watershed organizations, and land trusts for work on selected priority projects.

Website: www.mass.gov/eea/agencies/dfg/der/aquatic-habitat-restoration/river-restoration/
Contact: Nick Wildman
(617) 626-1527
nick.wildman@state.ma.us

Section 319 Nonpoint Source Grant Program
Agency: Department of Environmental Protection (DEP)
Provides grants to organizations expressly to prevent, control, and abate nonpoint source pollution through the

implementation of structural and nonstructural Best Management Practices (BMPs). Must meet federal EPA guidelines

Eligibility: Massachusetts public or private entity

Website:
www.mass.gov/eea/agencies/massdep/water/grants/watersheds-water-quality.html

Contact: Jane Peirce
508-767-2792
jane.peirce@state.ma.us

Stream Team Implementation Awards
Agency: Department of Fish and Game (DFG)
For implementation projects from Stream Team Action Plans that further watershed and stream protection or to help start new Stream Teams. In areas where Stream Teams are well established, priority will be given to implementation projects.

Eligibility: Each year two Massachusetts watersheds are selected for eligibility. Groups may submit proposals through a nonprofit organization with 501(c)(3) status or a municipality (by the conservation commission, planning board, etc.), and must be directly related to Stream Teams or Stream Team work. Stream Teams are encouraged to work in partnership with their watershed associations, land trusts, conservation commission, and other town boards.

Website: www.mass.gov/eea/agencies/dfg/der/technical-assistance/stream-teams.html
Contact: Carrie Banks
413-579-3015
Carrie.Banks@state.ma.us

Water Conservation Grant Program
Agency: Department of Environmental Protection (DEP)
The purpose of this program is to address drinking water supply and distribution systems water losses. Projects funded under this program must conduct water audit, leak detection surveys, or implement a water conservation outreach program for the public. The Department encourages all types of eligible, competitive proposals from all public water systems, although preference may be given to those applicants with public water systems where:

- withdrawal points are located within a stressed basin (per the Water Resources Commission);
- that are undergoing a 5-year Water Management Act (WMA) Program review;
- where the water supply is having difficulty meeting demand;
- or where the WMA permit conditions could be better achieved by a reduction in demand.

Eligibility: Any Massachusetts public water system

Website:
www.mass.gov/eea/agencies/massdep/water/grants/watersheds-water-quality.html
Contact: Malcolm Harper
508-767-2795
malcolm.harper@state.ma.us

Wetlands Restoration Program (WRP) Grants for Priority Projects
Agency: Department of Fish and Game (DFG)
The mission of the Wetlands Restoration Program is to help property owners voluntarily restore degraded or destroyed former wetlands and the valuable services they provide. The agency works with many federal, state, and local partners. WRP pursues this mission with activities in the following core program areas: partnerships, project implementation, restoration planning, education and outreach, and monitoring.

Eligibility: Open to any Massachusetts public or 501(c)(3) certified non-profit organization, including, but not limited to state agencies, cities and towns, regional planning agencies, watershed organizations, and public schools. The proposed work must be done on Wetlands Restoration Program Priority Projects—these have been designated through an annual open and competitive call for nominations.

Website: www.mass.gov/eea/grants-and-tech-assistance/grants-and-loans/eea-grants-guide/water-grants.html
Contact: Hunt Durey(617) 626-1245
Hunt.Durey@state.ma.us

Appendix A. Memorandum of Understanding

The *Coalition for Buzzards Bay*

Buzzards Bay
National Estuary Program

Buzzards Bay Action Committee

MEMORANDUM OF UNDERSTANDING

Between the Buzzards Bay Project National Estuary Program,
the Buzzards Bay Action Committee,
and The Coalition for Buzzards Bay

In 1991, the Commonwealth of Massachusetts and U.S. EPA approved the Buzzards Bay Comprehensive Conservation and Management Plan (CCMP), a blueprint to protect and restore water quality, habitat, and living resources of Buzzards Bay and its surrounding watershed. This watershed management plan was developed by the Buzzards Bay Project National Estuary Program as part of a collaborative effort of state, federal, and regional agencies working with the municipalities and citizens of Buzzards Bay. A special milestone that led to the approval of the CCMP, was the creation of the Buzzards Bay Action Compact, signed in January 1991 by 12 Buzzards Bay municipalities in support of the draft CCMP. For the first time, these communities united in officially recognizing that “the future of the Bay depended on the ability of neighboring communities to control the quality of their environment through regional communication and cooperation among municipal, state, and federal agencies responsible for managing the Bay and its watershed.” This achievement helped ensure the long-term success of efforts to protect and restore the invaluable water quality and shared resources of Buzzards Bay and its watershed.

After the completion of the Buzzards Bay CCMP, three organizations dedicated themselves toward implementing the goals and recommendations contained in that document. These organizations were the Buzzards Bay Action Committee, a nonprofit organization composed of municipal officials seeking regional strategies for protecting the environment; The Coalition for Buzzards Bay, a nonprofit, membership organization dedicated to the restoration, protection and sustainable use and enjoyment of Buzzards Bay and its watershed; and the Buzzards Bay Project National Estuary Program, a planning and advisory unit within the Massachusetts Office of Coastal Zone Management whose mission is to facilitate implementation of the CCMP.

In order to continue our success, these three Buzzards Bay organizations wish to formally recommit our energies to those basic goals contained in the CCMP. These goals included:

- Control stormwater runoff from existing and new sources
- Better management of individual septic systems
- Protect coastal and inland wetlands and marine habitats
- Reduce and eliminate toxic pollution
- Protect and enhance shellfish resources
- Prevent oil pollution
- Protect, enhance, and restore natural ecosystems and habitats such as state mapped core habitats, vernal pools, watershed biodiversity, impaired marine and freshwater wetlands, and anadromous fish runs
- Protect marine and freshwater quality and quantity to ensure plentiful and clean water for people and wildlife.

We agree that our number one environmental priority as a region is to continue to implement the goals of the CCMP. In order to achieve a better exchange of information and ideas to expedite the region’s ability to implement sound and consistent environmental regulations and bylaws, and to assist future planning strategies to protect and enhance the mutual resources of Buzzards Bay and its watershed, we wish to clearly state our collective and individual responsibilities.

Specifically, the Buzzards Bay Action Committee will:

- Act as a liaison between the towns and the Buzzards Bay Project National Estuary Program to facilitate coordination of grant applications based on town needs;
- Work with Planning Boards, Public Works Departments, and Conservation Commissions to more effectively address stormwater management and remediation through improved consistency in developing regional regulations and zoning by-laws and implementation of Phase II stormwater programs;
- Work with Shellfish Departments and Boards of Health to increase shellfish resources for recreation and commercial use;
- Work with municipalities to pursue Clean Vessel Act funds to protect Buzzards Bay water quality;
- Work cooperatively with The Coalition for Buzzards Bay and the Buzzards Bay Project, to review ongoing municipal efforts to address regional goals to implement recommendations in the CCMP;
- Work with municipalities to minimize oil pollution in Buzzards Bay;
- Work with municipalities to address the continued need for household hazardous waste collections.

Specifically, The Coalition for Buzzards Bay will:

- Maintain comprehensive water quality and natural resource monitoring programs, to better understand the Buzzards Bay ecosystem and its response to human-related impacts in order to help identify restoration and protection needs, and to provide up-to-date, accurate information to the Buzzards Bay Project National Estuary Program, Buzzards Bay Action Committee, federal, state, and local agencies and the public about the environmental health of Buzzards Bay;
- Increase the rate of land protection and the amount of protected land in the Bay watershed by pursuing a Bay-focused watershed land protection strategy and educating private landowners about land conservation;
- Actively participate in the formation of public policy and pursue the restoration and protection of the Bay ecosystem through direct citizen advocacy and through the regulatory and legal process at the local, state, and federal levels;
- Restore bay water quality, habitats and living resources through active programs which identify degraded areas and involve the public in their restoration;
- Provide public education to create an informed public today and a generation of future bay stewards who will understand the Buzzards Bay ecosystem and support its restoration and protection.

Specifically, the Buzzards Bay Project will:

- Provide technical assistance to municipalities, businesses, nonprofits, and other interested parties in their efforts to implement the recommendations contained in the CCMP;
- Help municipalities develop and implement nitrogen management plans, open space plans, environmental regulations and bylaws, and other watershed planning efforts to protect water quality, habitat, and living resources;
- Help towns and land trusts acquire valuable wetlands, habitat, and other open space;
- Assist municipalities with the writing of grant proposals and identifying funding sources for project that help further the implementation of the CCMP;
- Assist The Coalition for Buzzards Bay and the Buzzards Bay municipalities use and interpret the results of the Volunteer Water Quality Monitoring Program and other data;
- Help municipalities and the Massachusetts Department of Environmental Protection evaluate and promote wastewater disposal strategies including the use of alternative onsite systems and community wastewater systems where appropriate;
- Help municipalities and the Massachusetts Department of Environmental Protection identify and implement nitrogen management strategies to meet nitrogen loading limits recommended by the Massachusetts Estuary Program and comparable efforts;
- Assist and train Conservation Commissions in the protection and delineation of inland and coastal wetlands, update wetland bylaws, and identify impaired wetlands for restoration;
- Assist municipal boards to acquire and use Geographic Information Systems and other data tracking techniques to assist in local planning and decision-making;
- Help Planning Boards, Boards of Health, and Conservation Commissions address existing and future potential stormwater issues including site plan review, remediation design, implementation of stormwater remediation projects, and to help them adopt Low Impact Development strategies, and effective stormwater regulations and non-regulatory approaches;
- Help municipalities upgrade and restore anadromous fish runs;
- Assist municipalities in their efforts to have adequate oil spill containment equipment and training as a first response until state and federal coordinators are on scene;
- Track and monitor the implementation of the CCMP, and identify new needs and recommend changes to meet CCMP goals.

Mark Rasmussen Executive Director Coalition for Buzzards Bay	Joseph E. Costa, PhD Executive Director Buzzards Bay National Estuary Program	Leonard Gonsalves Executive Director Buzzards Bay Action Committee

Date: adopted spring of 2005 by each organization

Appendix B. Glossary of Terms, Acronyms, and Abbreviations

AAL: Allowable Ambient Limit in air.
Abiotic: Any factor in the environment that is nonliving (soil, weather, water).
Accretion: The increase of land by the action of natural forces.
ACEC: Area of Critical Environmental Concern. A Massachusetts resource area designation.
ACO: Administrative Consent Order.
ACOE: U.S. Army Corps of Engineers.
Aerobic: Living, active, or occurring only in the presence of oxygen.
Algal Bloom: A condition resulting from excessive nutrient levels or other physical and chemical conditions that enable algae to reproduce rapidly.
Amphipods: A group of small, laterally compressed crustaceans.
Anadromous: A species of fish (salmon, alewives, or river herring) born in fresh water, that spends a large part of its life in the sea, and returns to freshwater rivers and streams to procreate.
Anaerobic: A biological process occurring in the absence of free oxygen.
ANEP: Association of National Estuary Programs. A non-profit organization that promotes the 28 National Estuary Programs.
ANG: The Massachusetts Air National Guard.
Anoxic: A condition in which dissolved oxygen is absent. Anoxic water quality conditions often result in fish kills and shellfish mortality.
Anthropogenic: Human related effects [to the environment]. Anthropogenic impacts to water quality include wastewater from septic systems and treatment plant discharges, road and agricultural runoff, and acid rain.
Antidegradation provision: Standards in the Clean Water Act that regulate activities in order to maintain and protect existing water uses in designated areas.
APCC: Association for the Preservation of Cape Cod.
AR: Administrative Record.
ARAR: Applicable or Relevant and Appropriate Requirement.
Area of Critical Environmental Concern (ACEC): An area encompassing land and water resources of regional or statewide importance, designated by the Massachusetts Secretary of the Executive Office of Energy and Environmental Affairs (in accordance with 301 Commonwealth of Massachusetts Regulation 12.00).
Aromatic Hydrocarbons: Compounds that contain at least one 6-carbon ring. These compounds are often important components of fuel oils.
Attenuation: The process by which a compound is reduced in concentration over time or distance through absorption, degradation, or transformation.
Barrier Beach: A narrow low-lying strip of land generally consisting of coastal beaches and coastal dunes extending roughly parallel to the trend of the coast. It is separated from the mainland by a narrow body of fresh, brackish, or saline water or by a marsh system.
Baseline data: basic information gathered before a program or activity begins, to be used later to provide a comparison for assessing impacts; the primary line, the one from which others are measured; often considered the natural state of a system.
Bathymetry: The measurement of ocean depth.
BBP: Buzzards Bay Project (National Estuary Program), now called simply the Buzzards Bay NEP.
BAT or BDAT: Best Available Technology or Best Demonstrated Available Technology.
BDL: Below Detection Limit.
Beneficial Uses: Uses designated in Massachusetts Surface Water Quality Standards for public water supply, for protection and propagation of fish and other wildlife, and for primary and secondary contact recreation and any other uses that do not impair these designated uses.
Benthic: Living on the bottom of the ocean or other body of water.
Benthos: The community of aquatic bottom dwelling life.
Best Management Practice (BMP): A method for preventing or reducing the pollution resulting from an activity. The term originated from rules and regulation in Section 208 of the Clean Water Act. Specific BMPs are defined for each pollution source.
Bioaccumulation: The process by which a contaminant accumulates in the tissues of an individual organism. For example, certain chemicals in food eaten by a fish tend to accumulate in its liver and other tissues.
Bioassay: Appraisal of the biological activity of a substance by testing its effect on an organism and comparing the result with some agreed standard.
Biochemical Oxygen Demand (BOD): A measure of the organic material that can be readily oxidized through microbial decomposition, consuming oxygen dissolved in water. BOD is often used to assess the effects of a discharge, especially sewage.
Biodiversity: The variety of living organisms considered at all levels, from genetics through species, to higher taxonomic levels, and including the variety of habitats and ecosystems.
Biogeochemical cycle: A natural process or cycles of compounds or atoms in the environment that are affected by living organisms. Examples included carbon, oxygen, water, and nutrients such as nitrogen and phosphorus.
Biomass: The total mass of a defined organism or group of organisms in a particular community or an ecosystem as a whole.
BMP: Best Management Practice. A method that has been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.
Board of Health: A municipal, elected or appointed authority, responsible for administering the State Environmental Code, including Title 5, and local bylaws addressing public health, safety, and welfare issues.
BOD: Biological Oxygen Demand. The amount of oxygen consumed by bacteria in a water sample while decomposing organic matter under aerobic conditions. BOD5 is the amount of oxygen demand exerted over a 5-day period.
BOH: Board of Health. A Massachusetts Municipal board, elected or appointed, responsible for septic system permits and inspections, restaurant inspection, beach closures, and other public health matters.
Bordering Vegetated Wetlands (BVW): As defined in 310 CMR 10.55, the Wetlands Protection Act Regulation, freshwater wetlands that border on creeks, rivers, streams, ponds, and lakes. The types of freshwater wetlands are wet meadows, marshes, swamps, and bogs. They are areas where the topography is low and flat, and where the soils are saturated at least part of the year.
BRP: the Massachusetts DEP Bureau of Resource Protection.
BTEX: Acronym on some analytical reports meaning the combined quantity of Benzene, Toluene, Ethylbenzene and Xylene.
Buildout Analysis: A parcel-by-parcel analysis to estimate the total number of existing and developable units, based on current zoning and other land use regulations. Such an analysis is essential for managing or limiting the impacts of growth and development.
Buzzards Bay: An inlet of the Atlantic Ocean in southeastern Massachusetts, bounded by Cape Cod to the east, the Elizabeth Island chain to the south, and along Massachusetts to near the border with Rhode Island.

BWP: the Massachusetts DEP Bureau of Waste Prevention.
BWSC: the Massachusetts DEP Bureau of Waste Site Cleanup.
Bycatch: The harvest of organisms other than the species for which the fishing gear was set; also called incidental catch.
C: either Celsius or Centigrade or units Conversion factor.
CAA: the federal Clean Air Act administered by the U.S. EPA.
CAFE: Corporate Average Fuel Economy [standard].
CAG: the U.S. EPA's Carcinogen Assessment Group.
Cape Cod Commission (CCC): A regional planning agency, formerly known as the Cape Cod Planning and Economic Development Commission (CCPEDC), which includes Buzzards Bay's eastern shore municipalities, Bourne, and Falmouth. Because of legislative action and local approval, this agency has review authority over land use decisions throughout Cape Cod. The CCC also provides technical assistance, coordinates inter-municipal activities, and serves as a depository for regional information.
Carapace: The shield like structure that covers the anterior portion of some crustaceans.
Carcinogen: A substance that causes cancer.
Carrying Capacity: The limit of a natural or man-made system to absorb perturbations, inputs, or population growth.
Catadromous: A freshwater species of fish that spawns in salt water (e.g. eels). Sometimes lumped in the term Diadromous.
Catch per unit effort (CPUE): The number of fish caught by an amount of effort; typically a combination of gear type, gear size, length of time gear is used.
Catch: The total number or poundage of fish captured from an area over some period of time; includes fish that are caught but released or discarded instead of being landed; may not necessarily be brought ashore (landed).
CCC: Cape Cod Commission.
CCCGA: Cape Cod Cranberry Growers' Association.
CCMP: Comprehensive Conservation and Management Plan. A watershed management plan required by Section 320 of the Clean Water Act for National Estuary Programs.
CDC: Centers for Disease Control.
CDF: Confined Disposal Facility.
CEP: Critical Exposure Pathway.
CERCLA: Comprehensive Environmental Response, Compensation and Liability Act of 1980, the federal law regulating Superfund and other hazardous waste sites.
CERCLIS: Comprehensive Environmental Response, Compensation, and Liability Information System.
Cesspool: A covered pit with a perforated lining in the bottom into which raw sewage is discharged: the liquid portion of the sewage is disposed of by seeping or leaching into the surrounding porous soil; the solids, or sludge, are retained in the pit to undergo partial decomposition before occasional or intermittent removal. Cesspools are no longer permitted for waste disposal.
CFC: chlorofluorocarbon.
CFR: Code of Federal Regulation.
USCG: United States Coast Guard.
Ch. 21E: Massachusetts General Law Chapter 21E. The state law regulating the cleanup of hazardous wastes.
Charter boat: A boat available for hire, normally by a group of people for a short period.
Chlorinated Hydrocarbons (CHCs): All aromatic and non-aromatic hydrocarbons containing chlorine atoms. Includes certain pesticides, polychlorinated biphenyls, and other solvents.
CIP: Community Involvement Plan.
CMO: Chief Municipal Officer.
CMR: Code of Massachusetts Regulation.
Coastal Bank: As defined in 310 CMR 10.30 (2), the Wetlands Protection Act Regulation, the seaward face or side of any elevated landform, other than a coastal dune, which lies at the landward edge of a coastal beach, land subject to tidal action, or other wetland. A typical working definition is "the first major break in slope above the 100-year flood elevation, but this definition may not apply in certain special circumstances.
Coastal Wetland: As defined in Massachusetts General Law Chapter 131, Section 40, the Wetlands Protection Act Regulation, any bank, marsh, swamp, meadow, flat, or other low land subject to tidal action or coastal storm flowage and such contiguous land as the Commissioner of the Department of Environmental Protection deems necessary.
Coastal Zone Management Program: A federally funded and approved state program under the Federal Coastal Zone Management Act of 1972. The program reviews federal permitting, licensing, funding, and development activities in the coastal zone for consistency with state policies.
Coastal Zone: In Massachusetts, officially defined in 301 CMR 20.00, the zone that extends landward to 100 feet beyond specified major roads, rail lines, or other visible rights-of-way; includes all of Cape Cod, Martha's Vineyard, Nantucket, and Gosnold; and extends seaward to the edge of the state territorial sea.
COD: Chemical Oxygen Demand. The total quantity of oxygen required to fully oxidize a material into carbon dioxide and water. Compare to BOD.
Cohort: A group of organisms spawned during a given period, usually within a year.
Combined Sewer Overflow: also called a CSO. A pipe that, during storms, discharges untreated wastewater from a sewer system that carries both sanitary wastewater and stormwater. The overflow occurs because a system does not have the capacity to transport and treat the increased flow caused by stormwater runoff. New Bedford is the only Buzzards Bay municipality with CSO discharges.
Combined Sewers: A system that carries both sewage and stormwater runoff. In dry weather, all flow from sewer lines and street drains goes to the wastewater treatment plant. During heavy rains, treatment plants usually can handle only part of this flow, and the sewer system is overloaded. The overflow mixture of sewage and stormwater is discharged untreated into the receiving water.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): A federal law administered by the Environmental Protection Agency, dealing with the assessment and remediation of hazardous material disposal sites. Superfund activities are performed under this Act.
Conservation Commission: An appointed municipal agency in Massachusetts responsible for administering the Wetlands Protection Act at the local level.
Contaminant: Substances that are not naturally present in the environment or is present in unnatural concentrations that can, in sufficient concentration, adversely alter an environment. Federal regulations (40 CFR 230) for the discharge of dredged or fill material into navigable waters regulated by Section 404 of the federal Clean Water Act define a contaminant as a chemical or biological substance in a form that can be incorporated into, onto, or be ingested by and that harms aquatic organisms, consumers of aquatic organisms, or users of the aquatic environment.
CRA: Comprehensive Response Action.
Crustacean: class of animals that typically live in water and are characterized by 10 jointed legs, segmented bodies, and hard external skeletons (e.g. crabs, lobster, shrimp).
Cryptic species: distinct species that show little or no outward morphological differences, and thus are difficult to distinguish.
CS: Chemical Spill.
Cumulative Effects: The combined environmental impacts that accrue over time and space from a series of similar or related individual actions, contaminants, or projects. Although each action may seem to have a negligible impact, the combined effect can be serious.

Cumulative impact: The combined outcome of numerous actions and stresses, where a group of relatively minor impacts may add up to severe habitat degradation or loss.
CWA: the federal Clean Water Act.
CZM: The Massachusetts Coastal Zone Management Office; also MCZM.
dB: Decibel.
DCR: The Massachusetts Division of Conservation Services, formerly named Department of Environmental Management.
DDT: The pesticide 1,1,1- trichloro- 2,2-bis(p- chlorophenyl)ethane, banned in the U.S. in 1972.
Decapod: A group of crustaceans with five pairs of walking legs and a well-developed carapace.
DEIR: Draft Environmental Impact Report.
DEM: The Massachusetts Department of Environmental Management, renamed in 2004 as the Division of Conservation Services.
Demersal: organisms that live on or near the bottom.
DEP: The Massachusetts Department of Environmental Protection.
Department of Environmental Management (DEM): The state agency responsible for managing natural resources, including, but not limited to, water resources. DEM administers the Massachusetts Ocean Sanctuaries Act.
Department of Environmental Protection (DEP): The state agency, formerly known as the Department of Environmental Quality Engineering, responsible for administering laws and regulations protecting air quality, water supply, and water resources, such as Chapter 91 and Title 5, and for administering programs such as the Wetlands Protection Program and Wetlands Restriction Program. It is also responsible for overseeing the cleanup of hazardous waste sites and responding to hazardous waste emergencies and accidents.
Depuration: purification of shellfish by transplanting in clean waters.
DEQE: the Massachusetts Department of Environmental Quality Engineering, which is the former name of the Massachusetts Department of Environmental Protection (DEP).
Designated Uses: For each water classification in the Massachusetts Surface Water Quality Standards (q.v.), these are the uses specified in 314 CMR 4.05 and 314 CMR 4.06, whether or not they are being attained. For example, in marine waters classified as SA, the waters are designated as "an excellent habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. In certain waters, excellent habitat for fish, other aquatic life and wildlife may include, but is not limited to, seagrass. Where designated in the tables to 314 CMR 4.00 for shellfishing, these waters shall be suitable for shellfish harvesting without depuration (Approved and Conditionally Approved Shellfish Areas). These waters shall have excellent aesthetic value."
Designated Port Areas: defined in Chapter 91 Regulations as portions of certain urban harbors where maritime-dependent industrial uses are encouraged to locate. This concentration of uses maximizes public investments in dredging, bulkheads, piers, and other port facilities.
DFA: The Massachusetts Department of Food and Agriculture.
DFW: The Massachusetts Division of Fish and Wildlife, a section of DFWELE.
DFWELE: The Massachusetts Department of Fisheries, Wildlife, and Environmental Law Enforcement.
DHM: the Massachusetts DEP Division of Hazardous Materials.
Dissolved oxygen: oxygen that is dissolved in water. Generally measured as-ppm or % saturation.
Division of Marine Fisheries (DMF): The agency within the Massachusetts Executive Office of Environmental Affairs responsible for managing the Shellfish Sanitation Program, overseeing shellfish relays, depuration plants, commercial fishing licenses, and management and stock assessment of Massachusetts fisheries.
DMF: The Massachusetts Division of Marine Fisheries, a section of DFWELE.
DNAPL: Dense Non- Aqueous Phase Liquid.
DO: Dissolve Oxygen. May be reported as ppm or percent saturation.
DOD: the U.S. Department of Defense.
DOE: the U.S. Department of Energy.
DOI: the U.S. Department of the Interior.
DOJ: the U.S. Department of Justice.
DOT: the U.S. Department of Transportation.
DPH: the Massachusetts Department of Public Health.
Drainage Basin: The land that surrounds a body of water and contributes fresh water, either from streams, groundwater, or surface runoff, to that body of water, also called a watershed.
Dredging: The removal of materials including, but not limited to, rocks, bottom sediments, debris, sand, refuse, and plant or animal matter in any excavating, cleaning, deepening, widening or lengthening, either permanently or temporarily, of any tidelands, rivers, streams, ponds or other waters of the Commonwealth, as defined in 310 CMR 9: 04..
DWPC: the Massachusetts DEP Division of Water Pollution Control.
DWS: the Massachusetts DEP Division of Water Supply.
DWW: DEP Division of Wetlands and Waterways.
Easement: The privilege of using something that is not your own (as using another's land as a right of way to your own land); also covers "natural derivatives" of public rights of fishing, fowling and navigation, and the right to pass freely over any intertidal areas in order to engage in such an activity.
Ecosystem based management (EBM): EBM is an approach that seeks to manage a multitude of human activities and natural stressors to the greatest benefit of healthy and natural ecosystems. It integrates knowledge of ecological interrelationships to manage impacts within an ecosystem; effective implementation of EBM should: (1) consider ecological processes that operate both inside and outside ecosystem boundaries, (2) recognize the importance of species and habitat diversity, and (3) accommodate human uses and associated benefits within the context of conservation requirements.
Ecosystem: A community of living organisms interacting with one another and with their physical environment, such as a salt marsh, an embayment, or an estuary. A system such as Buzzards Bay is considered a sum of these interconnected ecosystems.
EDB: Ethylene Dibromide.
EEA: The Massachusetts Executive Office of Energy and Environmental Affairs, also abbreviated EEA, formerly EOEA, Executive Office of Energy and Environmental Affairs.
Eelgrass (*Zostera marina*): A marine flowering plant that grows subtidally in sand and mud. In Buzzards Bay, eelgrass is widespread and grows to depths of 20 feet. Eelgrass beds are an important habitat and nursery for fish, shellfish, and waterfowl.
EEZ: Exclusive Economic Zone. Those marine areas under the jurisdiction of the federal government. Generally, the area between the three-mile state waters jurisdiction and federal waters 200-mile boundary.
EF: Exposure Frequency.
Effluent: The outflow of water, with or without pollutants, usually from a pipe.
Effort: The amount of time and fishing power used to harvest fish; fishing power can include gear size, boat size, and horsepower.
EIR: Environmental Impact Report. A document that may be required by the Massachusetts MEPA office upon submission of an ENF.
EIS: Environmental Impact Statement. Specifically, the document required by federal agencies pursuant to the National Environ-

mental Policy Act for major projects or legislative proposals significantly affecting the environment. The EIS is a decision-making tool, and includes the positive and negative effects of the undertaking and includes possible alternative actions.

ELCR: Excess Lifetime Cancer Risk.

Embayment: A small bay or coastal lagoon, or any small semi-enclosed coastal water body whose opening to a larger body of water is restricted.

ENF: Environmental Notification Form. An application form submitted under the Massachusetts Environmental Protection Act. Generally, ENFs are required only for large projects that meet certain thresholds.

Enteromorpha: A strand like or tubular green algae often found in eutrophic areas along the U.S. seaboard. Has been reclassified as *Ulva* sp.

Environmental Protection Agency (EPA): The federal agency principally responsible for administering the Clean Water Act, National Estuary Program, CERCLA, Superfund, and other major federal environmental programs.

EPA: the U.S. Environmental Protection Agency.

Epibiota: organisms living on the seafloor surface; organisms that attach to other organisms.

Essential fish habitat (EFH): A designation by the National Marine Fisheries Service for all federally managed fishery species; 'those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity', as defined by NMFS.

Estuary: A semi-enclosed body of water having a free connection with the open ocean and within which seawater is measurably diluted with fresh water.

ETI: 1) extraction, treatment, and infiltration when dealing with plumes and groundwater contamination. 2) Environmental Technology Initiative: an EPA program of the late 1990s to promote new environmental technologies, including the Massachusetts Alternative Septic System Test Center.

Eutrophication (coastal): The process of nutrient over enrichment generally caused by excessive nitrogen in marine waters and phosphorus in freshwater. Coastal eutrophication results principally from human activities such as sewage disposal, fertilizer use, and atmospheric inputs. The addition of nitrogen to coastal waters stimulates algal blooms and growth of bacteria, and can cause broad shifts in ecological communities present and contribute to anoxic events and fish kills. In freshwater systems and in parts of estuaries below 5 ppt salinity, phosphorous is likely to be the limiting nutrient and the cause of eutrophic effects.

FACES: Falmouth Associations Concerned with Estuaries and Salt Ponds.

FDA: Food & Drug Administration.

Fecal Coliform: Bacteria that are present in the intestines and feces of warm-blooded animals and that are often used as indicators of the sanitary quality of water. Their degree of presence in water is expressed as the number of bacteria per 100 milliliters of the sample. The greater the number of fecal coliforms, the higher the risk of exposure to human pathogens. The indicator is used by the Massachusetts Division of Marine Fisheries in determining shellfish bed classification and local Boards of Health on swimming beach conditions.

Federal Consistency Review: Authority of Coastal Zone Management agents to review and approve federal activities in a state coastal zone to ensure that federal actions are consistent with CZM program policies and meet state standards. Includes any coastal project that requires a federal license, is implemented by a federal agency, or is carried out with federal funds.

Federal Waters: generally waters from 3 miles offshore to a 10-mile limit or 200-mile economic zone.

FEIR: Final Environmental Impact Report.

FEIS: Final Environmental Impact Statement.

FID: Flame Ionization Detector; a device used in a gas chromatograph.

FIFRA: the Federal Insecticide, Fungicide, and Rodenticide Act.

Fisheries independent data: data collected on fish by scientists who catch the fish themselves, rather than depending on fishermen and seafood dealers.

Fishery dependent data: data collected on a fish or fishery from sport fishermen, commercial fishermen, and seafood dealers.

Fishery resource: Any fishery, any stock of fish, any species of fish (commercial and non commercial species), any prey species, and any habitat of fish; all the living and nonliving resources, substrate and ecological systems which fish species need to survive.

Fishery: All of the activities involved in catching a species of fish or group of species; one or more stocks of fish which can be treated as a unit for purposes of conservation and management and which are identified on the basis of geographical, scientific, technical, recreational and economic characteristics.

Fishing mortality: A measurement of the rate of removal of fish from a population by fishing. It is an "instantaneous" rate per given unit of time, generally one year.

Floodplain: The area of shore lands extending inland from the normal yearly maximum stormwater level to the highest expected stormwater level in a given period of time (e.g., 5, 50, 100 years).

Flushing Time: The mean length of time for a pollutant entering a water body to be removed by natural forces such as tides and currents; also referred to as residence time or turnover time, although there are important technical distinctions in their definitions.

FOIA: The federal Freedom of Information Act. The Massachusetts counterpart is called the Public Records Act.

FONSEI: Finding Of No Significant Environmental Impact.

Food and Drug Administration (FDA): The federal agency that is responsible for, among other things, administering the National Shellfish Sanitation Program.

Fork length: The length of a fish as measured from the tip of its snout to the fork in the tail.

Fouling organisms: organisms that live attached to human made surfaces such as boats and pilings (e.g. bryozoans, sponges).

FS: 1) feasibility study 2) fuel spill.

FTE: full time employee.

FY: Fiscal Year.

GAO: the U.S. General Accounting Office.

GC: Gas chromatography.

GEIR: Generic Environmental Impact Report.

General Bylaws: Local laws that can be adopted with a simple majority vote at the town meetings. Cities adopt ordinances by a simple majority vote of the city council. Compare to Zoning bylaws.

Geographic Information Systems (GIS): A computerized system of organizing and analyzing any spatial array of data.

GIS: Geographic Information System. Computer software that allows the recording and mapping of information and images in a map coordinate system.

gpm: gallons per minute.

Grandfathering: A provision from Massachusetts General Law Chapter 40 that allows existing land uses or structures to remain without coming into compliance with upgraded zoning or building requirements.

Greenhouse effect: The increase in the earth's temperatures that results from the presence of carbon dioxide and other heat trapping gases in the atmosphere.

GW: Ground Water.

Habitat: The specific area or environment in which a particular type of plant or animal lives. An organism's habitat must provide all the basic requirements for survival.

HAZWOPER: Hazardous Waste Operations and Emergency Response Standard developed by the Occupational Safety and Health Administration' (OSHA). This training is need by individuals who respond to land or water spills of oil and other hazardous materials.

HAZWRAP: Hazardous Waste Remedial Actions Program.

HDPE: High- Density Polyethylene.

Heavy Metals: A group of elements that is present in the environment from natural and anthropogenic sources and can produce toxic effects. This group includes mercury, copper, cadmium, zinc, and arsenic.

HMTA: Hazardous Material Transportation Act.

HPLC: High- performance liquid chromatography. A laboratory method used to fingerprint and identify hydrocarbons and other materials.

Hazardous Waste: A waste substance that has the potential to cause, or significantly contribute to human illness or death, or injury to the environment.

Hypoxia: A condition in which oxygen is deficient.

Hypoxic: A condition in which dissolved oxygen is low or deficient. Hypoxic conditions stress marine plants and animals.

IDL: Instrument Detection Limit.

Impervious Material: With respect to Title 5 Regulations, a material or soil having a percolation rate greater than 30 minutes per inch, including, but not limited to, bedrock, peat, loam, and organic matter.

Impervious Surface: A surface that cannot be easily penetrated. For instance, rain does not readily penetrate asphalt or concrete pavement.

Incidental catch: See Bycatch.

Industrial Pretreatment: The removal or reduction of certain contaminants from industrial wastewater before it is discharged into a municipal sewer system. Reduced loading of contaminants from industries can reduce the expense of managing and designing municipal treatment facilities.

Infauna: The aquatic animals that burrow in the substrate (e.g. clams).

Infiltration: The penetration of water through the ground surface into subsurface soil. Some contaminants are removed by this process.

IR: Infrared (as in photography).

IRA: Immediate Response Action.

IRAC: Immediate Response Action Completion [Report].

IRAP: Immediate Response Action Plan.

IRIS: U.S. EPA's Integrated Risk Information System.

IROD: interim record of decision.

IRP: Installation Restoration Program. The federal-state initiative to contain and clean up groundwater plumes on Cape Cod that were associated with activities on the Massachusetts Military Reservation (MMR).

IT: Innovative Technology.

IWPA: Interim Wellhead Protection Area. For public water supply systems 100,000 gpd or greater, a management area with a one-half mile radius, other formula and criteria apply.

JPAT: Joint Process Action Team. For the cleanup of hazardous waste plumes on Cape Cod, the JPAT reviews technical plans and cleanup recommendations and advises the Senior Management Board on other Installation Restoration Program (IRP) issues.

Juvenile: An organism that has not yet reached sexual maturity.

Kettle Holes: A small, glacially formed freshwater body.

kg: kilogram.

l: liter.

Landings: The number or poundage of fish unloaded at a dock by commercial fishermen or brought to shore by recreational fishermen for personal use; reported at the points which fish are brought to shore (not necessarily areas where caught).

LC50: Lethal Concentration, 50%. The concentration of a material in air or water that causes the death of 50% (one-half) of a group of test animals.

LD50: Lethal Dose, 50%. The amount of a material, given all at once (e.g. ingestion), which causes the death of 50% (one-half) of a group of test animals, also defined as the short-term poisoning potential or acute toxicity of a material.

Leaching Facility: An approved structure used for the dispersion of septic-tank effluent into the soil. More properly called soil absorption systems, they include leaching pits, galleries, chambers, trenches, and trenches as described in 310 CMR 15.11 through 15.15.

Littoral: The zone between the highest and lowest springtide shorelines; the intertidal zone.

LSP: A Licensed Site Professional is required to oversee the cleanup of hazardous waste under Massachusetts General Law Chapter 21E.

LUST: Leaking Underground Storage Tank.

m: meter.

DEP: Massachusetts Department of Environmental Protection.

MA ANG: Massachusetts Air National Guard.

Marine invasive species (also aquatic nuisance species): Nonnative plants and animals that are transported into the environment via commercial shipping, as fouling organisms on recreational boats, through the release of unwanted aquarium contents, or through a variety of other human related transport vectors. These species often have great potential for rapid colonization and are already having significant impacts on the biodiversity and integrity of aquatic habitats.

Marine protected area: Any area of the marine environment that has been reserved by federal, state, territorial, tribal or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein (as defined by Executive Order ; May, Federal Register).

Massachusetts Environmental Policy Act (MEPA): Massachusetts General Laws Chapter 30, the state law, administered by the MEPA unit within the Executive Office of Energy and Environmental Affairs, establishing a uniform system of environmental impact review.

Massachusetts General Law Chapter 111 various sections vests municipal boards of health with the broad authority for maintaining the health, safety, and welfare of the public. Sanitary regulations are promulgated under this act through 310 CMR 15.0.

Massachusetts General Law Chapter 131, Section 40: The Wetlands Protection Act (WPA) administered by conservation commissions on the municipal level and by the Department of Environmental Protection on the state level.

Massachusetts General Law Chapter 40: The state zoning law for which the municipal planning boards and the zoning boards of appeal are responsible.

Massachusetts General Law Chapter 41 Sections 81K-81GG: The state law governing subdivisions, administered by municipal planning boards and zoning boards of appeal.

Massachusetts General Law Chapter 91: The Waterways Licensing Program governing waterfront development in Massachusetts, administered by the Department of Environmental Protection and the Office of Coastal Zone Management.

Massachusetts Ocean Sanctuaries Act: Administered by the Department of Environmental Management, the state law governing activities and structures in the ocean, seabed, or subsoil that would have an adverse affect on the "ecology or appearance" of the ocean sanctuary. Buzzards Bay is included in the Cape and Island Ocean Sanctuary.

Massachusetts Ocean Act: A Massachusetts law that passed in 2008, and which amended the Ocean Sanctuaries Act. The law required by December 2009 the preparation of a comprehensive plan to manage development in its state waters, balancing natural resource preservation with traditional and new uses, and required projects in these state waters to conform to the plan. One outcome of the law and planning process was to allow the siting of electric generating facilities in certain coastal waters.

Massachusetts Surface Water Quality Standards: The regulations, as required by MGL Chapter 21, Sections 26 through 53, that are defined by 314 CMR 4.00. The purpose of the regulations is to "protect the public health and enhance the quality and value of the water resources of the Commonwealth," and to "take all action necessary or appropriate to secure to the Commonwealth the benefits of the Clean Water Act, 33 U.S.C. §1251 et seq. The objective of 33 U.S.C. §1251 et seq. is the restoration and maintenance of the chemical, physical, and biological integrity of the Nation's waters. To achieve the foregoing requirements, DEP has adopted the Massachusetts Surface Water Quality Standards, which designate the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained, and protected. The standards prescribe the minimum water quality criteria required to sustain the designated uses; and which contain regulations necessary to achieve the designated uses and maintain existing water quality including, where appropriate, the prohibition of discharges."

MCP: Massachusetts Contingency Plan. A document required under 310 CMR 40.0 to provide for the protection of health, safety, public welfare and the environment by establishing requirements and procedures for the prevention and control of the release of oil and/or hazardous material; and defines notification, evaluation, cleanup requirements and cost recovery related to the cleanup.

MDL: Method Detection Limit.

MDPH: Massachusetts Department of Public Health.

Mean High Water (MHW): The average height of all high tides (both spring and neap tides) over a 19-year period. MHW is often used as the basis of the coastline on nautical and topographic maps.

Mean Low Water (MLW): The average height of all low tides (both spring and neap tides) over a 19-year period. MLW is often used as the basis depths on nautical and topographic maps, although sometimes Mean Lower Low Waters (spring low tides) may be used.

MEPA: Massachusetts Environmental Policy Act Unit. A unit within EEA.

Metadata: Summary data providing content, quality, types and spatial information about a data set; used in GIS mapping and other applications.

mg: milligram.

MGD: million gallons per day.

MGL: Massachusetts General Law.

MCL: Maximum Contaminant Level. The greatest amount of a contaminant allowed in drinking water without (presumably) causing a risk to human health.

MMR: Massachusetts Military Reservation. A military facility on Cape Cod owned by the Commonwealth of Massachusetts, with areas leased to the U.S. Air Force.

MOA: Memorandum of Agreement.

MOU: Memorandum of Understanding.

Mounded Septic System: Similar to a typical septic system except the leaching facility, in order to maintain an adequate separation to groundwater, is installed in mounded or filled material above the naturally occurring ground elevation. The mounds are typically planted with grass vegetation. In the velocity zone, some mounded systems are armored with riprap, but this approach conflicts with CZM policies.

MSDS: Material Safety Data Sheet. A publication prepared by the manufacturer or distributor of a hazardous material that gives toxicological information, safety information, physical properties, and health information about a product.

MSL: Mean Sea Level.

National Estuary Program: A Grant program within the U.S. Environmental Protection Agency, established under Section 320 of the Clean Water Act of 1987, to designate estuaries of national significance and to incorporate scientific research into planning activities into a Comprehensive Conservation and Management Plan (CCMP). Buzzards Bay was designated an Estuary of National Significance in 1985, and joined the NEP in 1988. Currently there are 28 NEPs.

National Pollutant Discharge Elimination System (NPDES): A requirement in the federal Clean Water Act for dischargers to obtain permits. EPA is responsible for administering this program in Massachusetts.

ND: either Not Detected or Non- Detect.

Nearshore: referring to shallow waters close to the coast.

NEFMC: New England Fisheries Management Council.

NEPA: National Environmental Policy Act.

Neritic: The pelagic or ocean environment above the continental shelf.

NERRS: National Estuarine Research Reserve System. A coastal watershed management program established and administered by NOAA. The NERRS program focuses on research and education.

ng: nanogram.

Nitrogen sensitive embayment. A term created in the 1991 Buzzards Bay CCMP, and used in this document, to define embayments that are either degraded by nitrogen inputs, or likely to be degraded with nitrogen inputs from development. The term was later adopted in the 1996 re-write of Title 5 (310 CMR 15.0), where it is defined for the purposes of regulating onsite wastewater discharges as "an area of land and/or natural resource area so designated by the Department in accordance with 310 CMR 15.215, which identifies Zone 2s for public wells, and "nitrogen sensitive embayments or other areas which are designated as nitrogen sensitive for purposes of 310 CMR 15.000 shall be mapped based on scientific evaluations of the affected water body and adopted through parallel public processes pursuant to both 310 CMR 15.000 and in the Massachusetts Water Quality Standards - 314 CMR 4.00." As of 2012, DEP has not designated any embayment watershed as nitrogen sensitive.

NMFS: The U.S. National Marine Fisheries Service.

NOAA: The U.S. National Oceanographic and Atmospheric Administration.

NON: Notice of Noncompliance.

Nonpoint-Source Pollution (NPS): Pollution that is generated over a relatively wide area and dispersed rather than discharged from a pipe. Common sources of nonpoint pollution include stormwater runoff, failed septic systems, and marinas.

NOS: National Ocean Service, a unit within NOAA.

Notice of Intent: A form submitted to the municipal conservation commission and DEP, which serves as the application for an Order of Conditions under the Wetlands Protection Act. It includes information on the site's wetland resources and the proposed work.

NOx: 1) Nitrous Oxides. 2) Symbolism for Nitrates (NO3) plus Nitrites (NO2) in water.

NPDES: National Pollutant Discharge Elimination System. Authorization to discharge into surface waters of the U.S. issued by the Environmental Protection Agency in Massachusetts, pursuant to the 1977 Clean Water Act. Massachusetts is one of two non-delegated states.

NPDWSA: Non-Potential Drinking Water Source Area.

NPS: Nonpoint Source Pollution. Generally diffuse or multiple small sources of pollution discharged from a geographic area of any size. Generally, refers to the cumulative input of many pollution sources that do not require separate regulatory permits.

NRD: Natural Resource Damages.

NRDA: Natural Resources Damage Assessment. State and federal activities to characterize impacts to the environment of oil spills.

NSSP: National Shellfish Sanitation Program.

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.

O&M: Operation and Maintenance.

OANGB: Otis Air National Guard Base.

Offshore: referring to deeper waters far from the coast.

Opportunistic species: Species that have short life spans typically, or have the ability to reproduce quickly in large numbers, and which have generalized environmental requirements.

Order of Conditions: The document, issued by a conservation commission, containing conditions that regulate or prohibit an activity proposed in the resource area defined in MGL Chapter 131 Section 40.

ORW: Outstanding Resource Water.

On- Scene Coordinator: a federal official responsible for monitoring or directing responses to all oil spills and hazardous substance releases reported to the federal government.

OSHA: the U.S. Occupational Safety and Health Administration.

OTA: [Massachusetts] Office of Technology Assistance.

Ova: eggs.

Oviparous: An animal that releases eggs.

PAHs: Polycyclic (or Polynuclear) Aromatic Hydrocarbons.

Paralytic shellfish poisoning (PSP). A condition caused when humans eat shellfish that have become contaminated with the toxin present in the dinoflagellates that cause red tides.

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

PAVE PAWS: Precision Acquisition Vehicle Entry - Phased Array Warning System. A military monitoring system on Cape Cod.

Pb: Periodic Table symbol lead.

PCBs: Polychlorinated Biphenyls. Any of the 209 possible molecules having multiple chlorine atoms attached to the carbon atoms of a biphenyl (two-carbon ring) nucleus.

PCE: Perchloroethylene (Tetrachloroethylene).

Pelagic: The area of the open sea. The organisms that inhabit the water column/open sea, and spend relatively little time on the sea bottom.

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.

Perturbation: The disturbance of the quality of natural resources caused by human activity/use or natural processes.

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

PGP: Programmatic General Permit (ACOE). A simplified wetlands filling Army Corp permit issued for wetland fillings below a certain size threshold. Under the PGP, projects are categorized as I or II. Category I projects represent minor impacts to State waters and are non-reporting to the ACOE. Category II projects represent more than minor impacts to State waters and must be reviewed at a monthly screening meeting where appropriate State and Federal agencies review the project.

Phytoplankton: Microscopic algae suspended in the water column. They contain pigments known as chlorophylls and phaeophytons that make eutrophic waters look green or brown.

Plankton: The plants and animals that are found drifting in the water.

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

Polychlorinated Biphenyls PCBs. A class of chlorinated aromatic compounds composed of two fused benzene rings and two or more chlorine atoms; used in heat exchange, insulating fluids and other applications. There are 209 different PCBs. PCBs are present in marine sediments in New Bedford Harbor where their cleanup is being coordinated by the U.S. EPA Superfund Program. They, as well as other toxic contaminants, are not monitored as part of the Buzzards Bay Volunteer Water Quality Monitoring Program.

Porous Pavement: A hard surface that can support some vehicular activities, and which can allow significant amounts of water to pass through.

POTW: Publicly Owned Treatment Works.

ppm: parts per million, also equal to milligrams per liter (mg/l).

ppt: in the measurement of salinity, equals parts per thousand, or grams per liter (g/l); for low-level contamination it may also be the abbreviation for parts per trillion or nanograms per liter.

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

Publicly Owned Treatment Works (POTW): Any sewage treatment system operated by a public agency.

Pumpout: The process through which septage is removed from a septic tank or boat holding tank, usually by a mobile tank attached to a truck, and taken to a wastewater treatment plant for disposal.

PVC: Polyvinyl Chloride.

QA/QC Plan: Quality Assurance Quality Control. A plan to ensure that data collected is reliable and accurate.

QA: Quality assurance.

QC: Quality control.

RAO- P: Response Action Outcome - Partial.

RCRA: Resource Conservation and Recovery Act of 1976.

Recruitment: The measure of the number of organisms that enter an age class during some period, such as the spawning class or fishing size class.

Relative abundance: An index of fish population abundance used to compare fish populations from year to year; does not measure actual numbers of fish, but shows population changes over time.

Remote sensing: Any technique for analyzing landscape patterns and trends using low altitude aerial photography or satellite imagery; any environmental measurement that is done at a distance.

Request for Determination of Applicability: A written request made by any person to a conservation commission or to the Department of Environmental Protection for a determination as to whether a site or work on that site is subject to the Wetlands Protection Act.

RFP: Request for Proposals. A solicitation for services; a term used principally by municipal government and some granting agencies.

RFR: Request for Responses. A solicitation for services or bids released by the Commonwealth of Massachusetts.

RI/FS: Remedial Investigation and Feasibility Study. A detailed study designed to gather data needed to determine the nature and extent of contamination at a Superfund site, establish site cleanup criteria. It may identify preliminary alternatives for remedial action, and support technical and cost analyses of alternatives. The remedial investigation usually includes a feasibility study, which is an analysis of the practicability and cost-effectiveness of the proposed cleanup strategy and alternatives.

ROD: Record of Decision.

RP: responsible party (for a spill of hazardous materials).

Runoff: The part of precipitation that travels overland and appears in surface streams or other receiving water bodies.

Salt Marsh: A coastal wetland that extends landward up to the highest annual high tide line, that is, the highest spring tide of the year, and is characterized by plants that are well adapted to living in saline.

Salt Pond: A shallow, enclosed, or semi-enclosed saline water body that may be partially, or totally, restricted by barrier beach. Salt ponds may receive fresh water from small streams emptying into their upper reaches or groundwater springs in the salt pond itself.

SARA: the federal Superfund Amendments and Reauthorization Act.

SCUBA: Self- Contained Underwater Breathing Apparatus.

Secondary Treatment: The process used to reduce the amount of dissolved organic matter and further reduce the amount of suspended solids and coliform in wastewater.

Seed: When referring to shellfish, a seed clam or seed are juveniles (typically considered non-reproductive) below the legal catch size. Seed clams are used in aquaculture and in shellfish propagation efforts.

Seine: A large fishnet that hangs vertically, with floats at the top and weights at the bottom that will enclose fish when it is pulled in.

Septage: That material removed from any part of an individual sewage disposal system.

Septic System: A wastewater disposal facility, also called an onsite system, used for the partial treatment and disposal of sanitary wastewater, generated by individual homes or small business, into the ground. Includes both a septic tank and a leaching facility.

Septic Tank: A watertight receptacle that receives the discharge of sewage from a building sewer and is designed and constructed so as to permit the retention of scum and sludge, digestion of the organic matter, and discharge of the liquid portion to a leaching facility.

SERO: DEP Southeast Regional Office.

Sessile: permanently attached to the substrate and not free to move about (e.g. barnacles).

Sewerage/Sewage: Liquid or solid waste that is transported through drains or sewers to a wastewater treatment plant for processing.

Shellfish Bed: An area where shellfish may be particularly abundant.

Shellfish Resource Area: An area, designated by the Division of Marine Fisheries, which contains shellfish beds, and is used for establishing shellfish resource area closure boundaries. May also be called a Shellfish Growing Area.

Shellfish Resource Area Closures: Closure, due to potential health risks, of shellfish resource areas to shellfish harvesting. Closure decisions are made by the Division of Marine Fisheries, using a current standard that specifies that if the geometric mean of 15 samples equals or exceeds 14 fecal coliform per 100 milliliters of sample water or if 10% of the samples exceed 49 fecal coliform per 100 milliliters of sample water, the station can be closed. The five shellfish-bed classifications are approved, conditionally approved, restricted, conditionally restricted, and prohibited.

SIC: Standard Industrial Classification.

Sludge: Solid or semisolid material resulting from potable or industrial water supply treatment or sanitary or industrial wastewater treatment.

SO2 - Sulfur Dioxide.

Soil Conservation Service (SCS) now called Natural Resource Conservation Service (NRCS). A branch of the U.S. Department of Agriculture that, among other things, provides technical assistance in resource management and planning and implementation of agricultural BMPs. SCS works closely with Agricultural Stabilization and Conservation Services (ASCS) and County Extension Services to achieve their goals.

SOP: Standard Operating Procedure.

Southeastern Regional Planning and Economic Development District (SRPEDD): A regional planning agency to which all of the Buzzards Bay municipalities belong, except Bourne, Falmouth, and Gosnold (see Cape Cod Commission). The agency provides technical assistance, reviews projects for MEPA, coordinates inter-municipal activities, and acts as a clearinghouse for regional information.

Species richness: A measure of the number of species in a region, site, or sample.

Spring Tides: Higher than normal high tides observed every 2 weeks when the earth and moon align (new moon or full moon).

State waters: generally extending from coastline to three nautical miles offshore, with the exception of areas within Massachusetts Bay, Cape Cod Bay, and Nantucket Sound that extend further due to bay closure lines established by the U.S. Supreme Court.

Stock assessment: An estimation of the amount or abundance of the resource, an estimation of the rate at which it is being removed due to harvesting and other causes, and one or more reference levels of harvesting rate and/or abundance at which the stock can maintain itself in the long-term.

Stormdrain: A system of gutters, pipes, or ditches used to carry stormwater from surrounding lands to streams, ponds, or Buzzards Bay. In practice, storm drains carry a variety of substances such as oil and antifreeze that enter the system through runoff, deliberate dumping, or spills. This term also refers to the end of the pipe where the stormwater is discharged.

Stormwater: Also Storm Water. Precipitation that is often routed into drain systems in order to prevent flooding.

Subdivision: A means for dividing a large parcel of land into more than one buildable lot, administered in Massachusetts under MGL Chapter 41, Sections 81K-81GG.

Submerged lands: Tidelands lying seaward of the low water mark; under state jurisdiction.

Substrate: The type of bottom or material on or in which an organism lives.

Superseding Determination: A Superseding Determination of Applicability is issued by the regional office of the Department of Environmental Protection deciding whether the area and activity are subject to the regulations under the Wetlands Protection Act. This determination supersedes or overturns a local Conservation Commission determination decision.

Superseding Order of Conditions: A document issued by the regional office of the Department of Environmental Protection containing the conditions necessary for a project to proceed and still protect the interests and resource areas specified in the Wetlands Protection Act. These conditions supersede Orders of Conditions issued by the local conservation commissions under the state regulations. Superseding Orders cannot overturn an order issued under the authorization of a local bylaw. These superseding orders can be requested by a number of people who may not be satisfied with the local Order of Conditions.

Suspended Solids: Organic or inorganic particles that are suspended in and carried by the water. The term includes sand, mud, and clay particles as well as organic solids in wastewater.

Swales: Vegetated areas used in place of curbs or paved gutters to transport stormwater runoff. They also can temporarily hold small quantities of runoff and allow it to infiltrate into the soil.

Synergistic interaction: An interaction that has more than additive effects, such as the joint toxicity of two compounds being greater than their combined, independent toxicities.

Taxa: Plural form of taxon. A taxon is a named group or organisms of any rank, such as a particular species, family, or class.

Territorial waters: State waters extending from the shoreline to miles offshore, except for Massachusetts Bay and Cape Cod Bay.

Tertiary Treatment: The wastewater treatment process that exceeds secondary treatment; could include nutrient or toxic removal.

Tidal Flat: Any nearly level part of the coastal beach, usually extending from the low water mark landward to the more steeply sloping seaward face of the coastal beach or separated from the beach by land under the ocean, as defined in 310 CMR 9: 04.

Tidelands: All lands and waters between the high water mark and the seaward limit of the Commonwealth's jurisdiction, as defined in 310 CMR 9: 04. Tidewaters are synonymous with tidelands.

Title 5: The state sanitary regulations (CMR 15.00) that provide for minimum standards for the protection of public health and the environment when circumstances require the use of individual systems for the disposal of sanitary sewage. The local board of health is responsible for enforcement of these regulations and may upgrade them.

TMDL: Total Maximum Daily Load. A regulatory limit, generally a mass load or concentration, needed to protect living resources. In the U.S. Clean Water Act, Section 303(d), and state regulations, a TMDL is the quantity of a pollutant that can be assimilated by a water body and still meet water quality objectives.

TN: Total Nitrogen [in a water sample]. Calculated by either adding TKN + Ammonia, or by adding TON plus NOx using the persulfate method.

TOC: Total Organic Carbon.

Topography: The configuration of a surface area including its relative elevations and the position of its natural features.

Total Nitrogen (TN): A measure of all forms of nitrogen (for example, nitrate, nitrite, ammonia-N, and organic forms) that are found in a water sample.

Toxic: Poisonous, carcinogenic, or otherwise directly harmful to life.

Trophic level: A nourishment level in a food web. Plants and other primary producers constitute the lowest level, followed by herbivores and a series of carnivores at higher levels.

Turbidity: The amount of particulate matter suspended in water.

µg: microgram. 1 micrograms per liter is equal to 1 part per billion (ppb).

Ulva: Genera of green sheet-like or tubular seaweed commonly called "sea lettuce" and the new name for the genera *Enteromorpha*.

Upweller: An upweller is a floating shellfish seed-culturing device that consists of seed containers, called silos, attached to a float-like apparatus attached to a pier or raft. The young shellfish are placed in the silos, and a wave driven pump system brings a continual flow of water over the shellfish.

U.S. EPA: the United States Environmental Protection Agency.

USACE: U.S. Army Corps of Engineers; also goes by the acronym ACOE.

USAF: U.S. Air Force.

USCG: U.S. Coast Guard.

USDA: U.S. Department of Agriculture.

USGS: U.S. Geological Survey.

UTM: Universal Transverse Mercator. The grid system found on USGS topographic maps.

UV: Ultra-Violet.

VOC: Volatile Organic Compound.

Wastewater: Water that has come into contact with pollutants as a result of human activities and is not used in a product, but discharged as a waste stream.

Water Column: The water located vertically over a specific point or station.

Watercourse: Any natural or man-made stream, pond, lake, wetland, coastal wetland, swamp, or other body of water. This includes wet meadows, marshes, swamps, bogs, and areas where groundwater, flowing or standing surface water, or ice provide a significant part of the supporting substrate for a plant community for at least five months of the year, as defined in 310 CMR 15: 01. Boards of Health can adopt the definition of wetlands in 310 CMR 10.0 or broader language in Title 5 as a "watercourse" in determining setbacks.

Watershed: The land that surrounds a body of water and contributes freshwater, from streams, groundwater, or surface water runoff, to that body of water.

WBNERR: Waquoit Bay National Estuarine Research Reserve.

Wetlands: Habitats where the influence of surface water or groundwater has resulted in the development of plant or animal communities adapted to aquatic or intermittently wet conditions. Wetlands include tidal flats, shallow subtidal areas, swamps, marshes, wet meadows, bogs, and similar areas.

WPA: Wetlands Protection Act. The Massachusetts state law (MGL 130) for the protection of wetlands. Also establishes the authority of municipal Conservation Commissions.

WQBELs: Water Quality-Based Effluent Limits applied to discharges when mere technology-based limitations would cause violations of water quality standards. Usually applied to discharges into small streams.

WQS: Water Quality Standards are adopted by law or regulation, pursuant to the Clean Water Act, and consist of the beneficial designated use or uses of a water body, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular water body, and an antidegradation statement.

Wrack: Algae, plant and animal matter, and drift material (including solid wastes and other pollutants) that accumulate on beaches, usually at the high tide mark.

WWTF: Waste Water Treatment Facility. Equivalent to WWTP.

WWTP: Waste Water Treatment Plant. Equivalent to WWTF.

Year class: The fish spawned and hatched in a given year, a "generation" of fish.

Zoning Bylaws: Local laws that designate areas of land for different uses at established densities. These bylaws require a two-thirds majority vote of town meeting or city council.

Zone 2: The principal zone of contribution (ZOC) and hydrogeologically defined wellhead protection area for public supply wells.

Zooplankton: The heterotrophic, animal component of plankton.