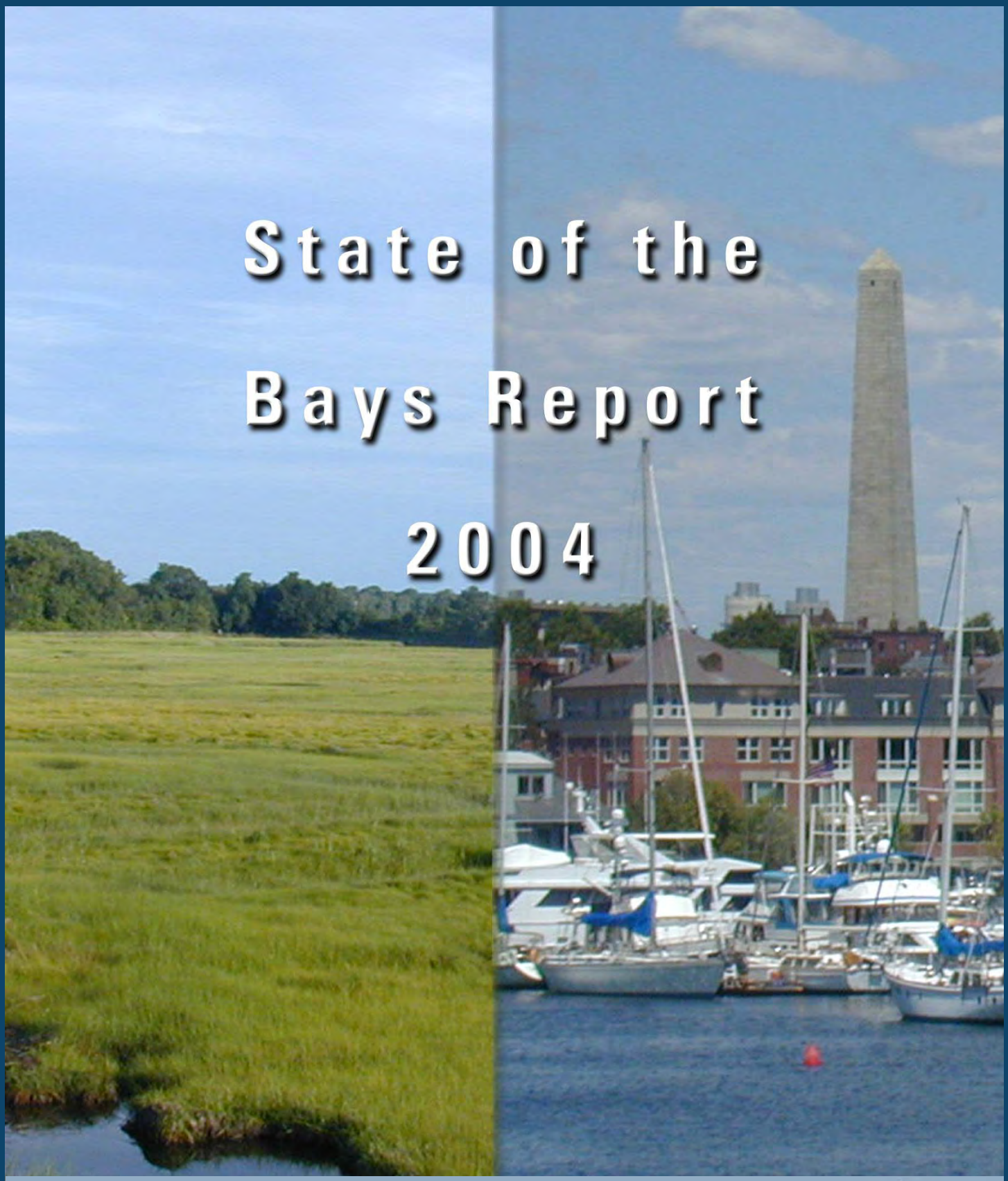

State of the Bays Report 2004

Massachusetts Bays Program

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Kerry Healey, Lieutenant Governor

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About the Massachusetts Bays Program

The Massachusetts Bays Program is a partnership of citizens, communities, and government that strives to protect and enhance the coastal health and heritage of Massachusetts and Cape Cod Bays.

The Massachusetts Bays Program (MBP) was launched in 1988 to address the mounting threats to the health of Massachusetts and Cape Cod Bays. In 1990, the U.S. Environmental Protection Agency (EPA) accepted the MBP into the National Estuary Program, which was established to identify nationally significant estuaries threatened by pollution, development, or overuse, and to promote the preparation of comprehensive management plans to ensure their health. The MBP developed a Comprehensive Conservation and Management Plan (CCMP) for the Bays region with the help of nearly 300 individuals representing a wide array of private, government, and community interests. This large network of partners, called the Management Conference, directs and implements the MBP. The final CCMP, published in 1996 and revised in 2003, is a blueprint for coordinated management and protection of the Bays' resources. It features 17 action plans containing 87 specific actions for preventing pollution, preserving habitat, and restoring the Bays' degraded resources.

To ensure that each of the MBP's 50 communities receives its share of attention, the Program partners with watershed associations and Regional Planning Agencies to provide regional coordinators in five subregions: Upper North Shore, Salem Sound, Metro Boston, South Shore and Cape Cod. This unique structure enables MBP staff to identify and solve environmental problems that require a local focus. Thanks to this effective and efficient partnership, the MBP leverages significant funding to conduct a wide variety of local and regional projects benefiting the Bays, from coordinating volunteers to help monitor the success of wetland restoration projects to helping local officials reduce land use impacts on their community's coastal resources.

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Boston skyline as seen from Massachusetts Bay

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Introduction

"What Is the State of Massachusetts and Cape Cod Bays?"

Ask three different people about the state of the Bays and you'll likely get three different answers. The beachgoer might look across the Bays on a beautiful July day and say that it couldn't get much better. The quahogger waiting for the local flats to reopen for shellfishing might remark that there's a lot of work to be done. The longtime resident of a small coastal town might take note of increasing development and worry about the future of the community and others like it.

So why ask about the state of the Bays? We ask because the Bays form an ecosystem in which humans and wildlife, economy and environment, and ocean and land constantly interact, and by periodically asking and answering this question we can better understand the changes, good or bad, that are occurring.

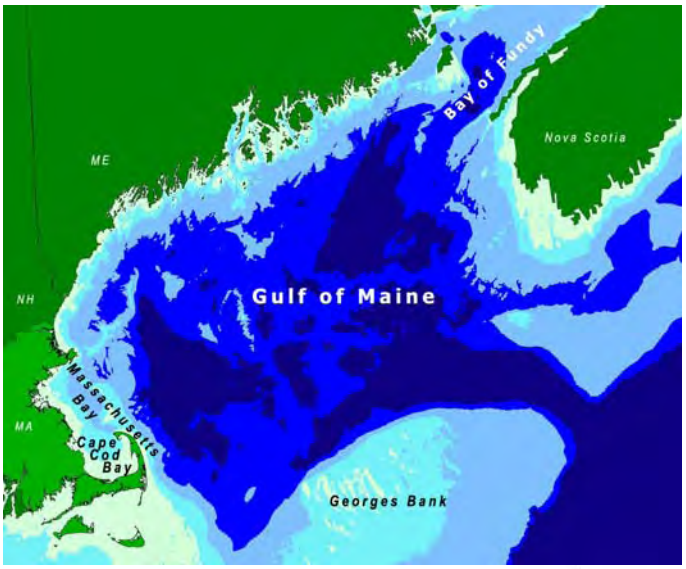
It would be a very tall order to simplify the complex interactions taking place within the Bays and their watersheds and give their health a report card grade. An A, B, C, D, or F could never adequately summarize the state of the Bays. However, by exploring specific elements of this coastal environment, we can learn about the challenges facing the Bays, clarify what we need to do to protect and preserve them, and begin a process to revisit this same question down the road to measure the progress made.

The *State of the Bays Report 2004* answers fourteen questions about Massachusetts and Cape Cod Bays and how they are faring under the demands of a rapidly growing human population and the associated impacts (including increased pollution, increased development, or loss of habitat) on the region's harbors, estuaries, and open waters. Before we can investigate specific issues, however, we need to familiarize ourselves with the many faces of, and threats to, this large water body.

An Introduction to the Bays

The Physical Landscape

The Massachusetts Bays region encompasses all of the coastal waters from the New Hampshire border to the tip of Cape Cod, an area of about 1,650 square miles bordered by a shoreline of more than 800 miles. The Bays are located at the southern end of the Gulf of Maine, a large coastal sea characterized by relatively cool water and large tidal ranges. The Bays' watershed (or the land area that drains water into the Bays) covers more than 7,000 square miles; half of this area is comprised of numerous watersheds within Massachusetts. The other half is the watershed of the Merrimack River in New Hampshire.



Understanding how water moves into and about the Bays is essential in predicting how human activities are likely to affect the marine environment. The Bays are influenced by the southward flowing coastal current of the Gulf of Maine. This counterclockwise current, combined with the large flow of fresh water from the Merrimack River, enters northern Massachusetts Bay between Cape Ann and the northern tip of Stellwagen Bank. The strength of this current varies with the season, running strongest during the spring when heavy rain and snowmelt flow from the Merrimack River and the Maine rivers to the north. Some of this water enters into Massachusetts Bay, mixes, and can flow into Cape Cod Bay where it lingers and eventually exits the system around the tip of Cape Cod.

The concept of *residence time* (defined here as the average length of time that water remains in a particular region before it "escapes") is valuable because it helps us to understand how long material added to the water (e.g. pollutants) will remain before being removed from the Bays. The residence time of surface water in the Bays region ranges from 20-45 days. In general, particles are flushed out of Massachusetts Bay more rapidly than either Cape Cod Bay or Stellwagen Basin. The result is that contamination in Cape Cod Bay and Stellwagen Basin can sometimes be more significant than in Massachusetts Bay because contaminants have more time to settle out from the water column into seafloor sediments. In addition, organisms inhabiting waters with greater residence time are potentially more exposed to contaminants and may accumulate them in their organs and tissues.

GoMOOS

Since 2001, the Gulf of Maine Ocean Observing System (GoMOOS) has brought hourly updated oceanographic data from the Gulf of Maine to all those who need it, from commercial mariners navigating through the Gulf to students in classooms. A series of offshore buoys record and report wind speed, wave activity, visibility, air temperature, water temperatures at various depths, water salinity, and more. You can even call the buoy directly to hear a computerized voice reading the latest data. For more information, visit the website at www.gomoos.org.

Habitats

The Bays teem with life. Despite a history of heavy use and, sometimes, neglect by humans, the rich tapestry of coastal and upland habitats continues to be the source of an extraordinary amount of biological production. Expanses of salt marsh, tidal flats, and eelgrass beds along the Bays coastline serve as nurseries for a variety of fish and invertebrates. The coast is also lined with beach and dune systems and rocky shores with exposed bedrock, while numerous lakes, ponds, and salt ponds dot the estuarine and inland landscape. From abundant and heavily utilized shellfish beds to commercially important lobsters to the endangered right whale, a tremendous number of species depend on the Bays' habitats for survival.

Key habitats in the Bays include:

Salt Marshes

Salt marshes are intertidal grasslands and are among the world's most productive ecosystems. Over the years, many salt marshes in Massachusetts, particularly in the Metro Boston area, have been destroyed or degraded by filling for urban development. Adoption of the Massachusetts Wetlands Protection Act and its regulations in the 1970s has been instrumental in slowing this trend, as indicated by recent estimates.

Currently, the major threats to salt marshes are not the widespread filling witnessed in the past, but rather, small incremental losses and degradation due to commercial development, legal filling (e.g., public works projects), illegal filling, and polluted stormwater runoff. Other threats include the aggressive invasive giant reed, *Phragmites australis*, which chokes out other native flora and fauna that are dependent on the marsh environment. Increased rates of sea level rise may also present future challenges to the health of the Bays' salt marshes.

Tidal Flats

Tidal flats provide habitat for a number of commercially important shellfish, and are major feeding areas for migratory shorebirds, including several threatened and endangered species, such as the Piping Plover and Roseate Tern. Tidal flats have been subjected to the same filling activities that have plagued salt marshes, and are also prone to high levels of pollutants because of their proximity to land-based sources, and because they tend to be areas of sediment accumulation.

Rocky Shores

Rocky shorelines offer dramatic coastal scenery, and are most prevalent in the North Shore region extending from Nahant through Cape Ann. Pollutants have less effect on both the rocky intertidal shore and submerged kelp forests than other coastal habitats because they are well flushed by wave action. Rocky shores may, however, be affected by invasions of non-native species transported into the Bays through pathways, such as ballast water from ships.

Eelgrass Meadows

Meadows of eelgrass, *Zostera marina*, are widely recognized as one of the world's greatest fish and shellfish nurseries. Eelgrass meadows provide protective cover and a source of food for a large number of marine species. Because these meadows are subtidal (i.e., beneath the water surface), estimating their current acreage and health is challenging.

Major threats to eelgrass are declines in water clarity, eutrophication, dredging, and boating activity. Intense coastal storms and a naturally occurring "wasting" disease (believed to be caused by a slime mold which can "thin" beds and make them vulnerable to storm damage or other environmental stresses), cause natural eelgrass population fluctuations.

Coastal Water

The nearshore coastal water of Massachusetts and Cape Cod Bays extends from the immediate shoreline to as deep as 100 meters in Stellwagen Basin. Much of this habitat is within the Commonwealth's Ocean Sanctuary Program or the Stellwagen Bank National Marine Sanctuary. A major management concern for this habitat is the protection of endangered species, such as whales and sea turtles, that visit the area. Other concerns include fisheries management and maintenance of water quality and habitat integrity in the presence of a number of wastewater outfalls and dredged material disposal sites.

Barrier Beaches and Coastal Dunes

Barrier beaches and coastal dunes are particularly important resting and feeding areas for migratory birds, and support a number of unique animals and plants, including various rare or endangered species that can tolerate the desert-like conditions.

Barrier beaches are the coastal habitat used most intensively by people, thus they present difficult management challenges. Conflicts commonly arise over balancing residential, commercial, and recreational interests with the preservation of the natural environment.

The Human Landscape

Population Pressure

The Massachusetts Bays' coast is among the most densely populated of any National Estuary Program, and the population continues to grow. As of the 2000 U.S. Census, over 1.7 million people, or more than a quarter of the population of Massachusetts, lived in the 50 Massachusetts Bays Program coastal communities. Increased development within the Massachusetts Bays region triggers increases in sewage effluent, stormwater runoff, and other nonpoint sources of pollution. These increases can lead to excessive inputs of nutrients, pathogens, and toxics that threaten fragile coastal habitats. More visible impacts of development include the loss of community character due to a rapid loss of open space, farmland, and historic sites. The "hardening" of the shore with structures such as seawalls, rip-rap, and groins to protect property from coastal storm damage can cause increased erosion of beaches and dunes.

Shipping, Boating, and Dredging

Boston is the major shipping port in the Massachusetts Bays region, generating $8 billion in annual revenue and supporting 9,000 jobs (Massport 2002 figures). In 2001, there were over 146,000 recreational boats registered within Massachusetts. To maintain this shipping and boating activity, Boston and other harbors require periodic dredging (the removal of sediment from the bottom of a water body). A major and ongoing management issue is the disposal of dredged material, especially those that are contaminated. There are various solutions that are the subject of long-term monitoring to determine their effectiveness, for example programs such as the recent Boston Harbor Navigation Improvement Project are pursuing creative new techniques. Other management issues associated with maritime activity are chronic oil spills and bacterial pollution from marine sanitation devices.

Tourism

Visitors to the coastal counties of Massachusetts spent nearly $8.8 billion in 2001 (Travel Industry of America, 2003). A major management issue associated with tourism is the conflicts that arise between recreational use and the protection of critical coastal resources, especially those on barrier beaches.

Whale-watching is one of the Bays' most popular tourist pastimes. Over one million passengers per year visit Stellwagen Bank and Jefferies Ledge during the summer and fall to view species such as humpback, fin, and right whales feeding in the Bays. Guidelines have been issued by the National Marine Fisheries Service (NMFS) to address concerns about the potential inadvertent harassment of whales by observation boats approaching too closely.

Fishing

Fishing has been an economic and cultural staple of coastal Massachusetts since Colonial times. For example, there were 1,046 commerical and 9,779 recreational shellfishing permits issued in 2002 within the Massachusetts Bays communities. The total amount of shellfish landed in the region in 1999 (the most recent year of full reporting) was over 7.7 million pounds.

Recreational and sport fishing are significant to the region's economy. NMFS estimated that in 1998 recreational marine fishers in Massachusetts spent nearly $847 million dollars.

Although overfishing is generally considered to be the primary cause of the current crisis in the fishing industry, pollution and habitat loss play a role as well, especially among fish that spawn nearshore or are anadromous (fish that migrate up rivers from the sea to breed in fresh water). Such fish have much greater exposure to polluted water and sediments than offshore species.

Conclusion

In the following pages we provide answers to fourteen questions regarding the current state of Massachusetts and Cape Cod Bays. There is still much to be learned about the Bays' ecosystem, so not every question will have a definitive answer. However, each answer provides background on the issues at hand, reviews current research, and explains how the Massachusetts Bays Program and our partners are responding to the needs of the Bays. As we will learn over the course of these fourteen questions, the problems facing the Bays are interrelated, just as the solutions depend on cooperation between all who live, work, and play in and along these priceless waters. Please join us as we continue to protect and restore the health and heritage of the Massachusetts Bays.

Question 1

Have conditions in Boston Harbor changed in the last ten years?

Background:

The amount of pollution entering Boston Harbor decreased with each new phase of the Massachusetts Water Resources Authority's (MWRA) Boston Harbor Project, which began in 1986. One of the first actions in the Boston Harbor Project was to improve disinfection of the effluent discharge. Later improvements in treatment, and the start-up of an outfall extending into Massachusetts Bay, dramatically decreased and finally ended the discharge of sewage solids, organic matter, toxic chemicals, and nutrients to Boston Harbor. Scientists have been tracking changes in the waters and sediments of the harbor since the beginning of the Boston Harbor Project.

Key Findings:

Bacteria

Enterococcus is the indicator used for monitoring the quality of marine recreational waters. As seen in Fig. 1-A, Boston Harbor as a whole was generally within swimming standardsfor the period of 1987-1998. There are elevated bacteria levels around the treatment plant outfalls, at the shoreline, and in the Inner Harbor.

For the period of 1998-2000 (Fig. 1-B), secondary treatment and better disinfection improved water quality in the North Harbor, and the closing of the Nut Island treatment plant improved water quality around the outfalls in the South Harbor. Almost all the Outer Harbor is within the swimming standard, but problems remain along the shoreline.

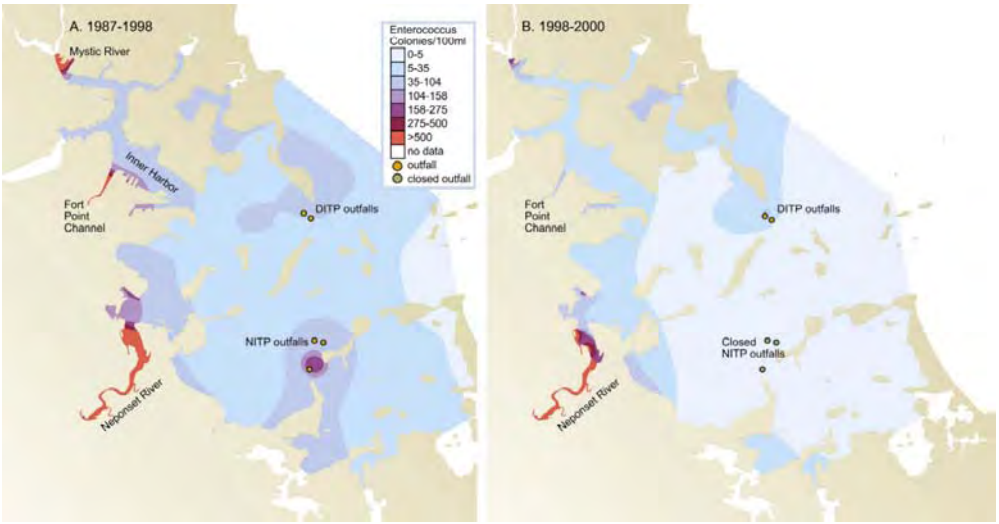


Figure 1-A: 1987-1998 Figure 1-B: 1998-2000

Solids Discharged

Pollutants such as toxic chemicals tend to stick to sewage solids, and go where the solids settle. The organic matter in sewage solids can degrade the ecosystem of the seafloor. The Harbor received about 160 tons of solids per day from MWRA treatment plants in 1988 and zero solids after 2000, when the bay outfall started being used.

Sediment Oxygenation

The Harbor's sediment community includes worms, snails, clams, and other animals and plants living at the bottom of the ocean. This important part of the marine ecosystem can be degraded if excess organic material from sewage solids settles to the ocean floor. As this material rots, it uses up oxygen that animals need to survive.

The photographs in Figures 1-C and 1-D are cross-sections of Boston Harbor sediments. Well-oxygenated sediments are light-colored and the black sediments have high levels of toxic sulfide and little oxygen.

Mostly dark sediments are seen in Fig. 1-C, and there is no visible life on the surface. Hydrogen sulfide produced by anaerobic bacteria feeds mats of sulfur bacteria that build up on the sediment surface.

Recovering sediments near the former sludge outfall in 1998 (sludge discharges ended in 1991) are shown in Fig. 1-D. The sediment is a healthy light gray, and tubes built by tiny marine arthropods oxygenate the sediment.

Figure 1-C: Unhealthy Sediments, 1990

Figure 1-D: Recovering Sediments, 1998

Water Column Nitrogen, Chorophyll, and Dissolved Oxygen

Even treated sewage contains large quantities of nutrients, which could cause eutrophication (over-enrichment of algae) in the Harbor. In September 2000, treatment plant discharges to the Harbor ended with the start-up of the new outfall. Since discharges to the Harbor have ended, total nitrogen has decreased by about 34%, and there was a 6% increase in mid-summer dissolved oxygen levels at the bottom of the Harbor. Chlorophyll (a measure of the amount of algae) decreased slightly the first year and increased slightly the second year in a limited area, showing that the relationship between nutrients and algal growth is affected by other factors.

Answer:

Yes, the waters and sediments of Boston Harbor, especially areas that were severely impacted by sewage pollution, have measurably improved and are more like a normal New England estuarine ecosystem.

Massachusetts Bays Program Role:

The MBP was originally funded through settlement fines from the suit filed by the U.S. Environmental Protection Agency and the City of Quincy against the Commonwealth of Massachusetts for violations of the Clean Water Act in Boston Harbor. While we now work throughout the larger Massachusetts and Cape Cod Bays region, we continue to monitor indicators of the Harbor's health and assist Boston Harbor communities in tackling urban runoff and other sources of pollution to the Harbor.

Massachusetts Bays Program Goal:

Now that wastewater discharges have been made cleaner and moved from Boston Harbor into Massachusetts Bay, combined sewer overflows and nonpoint sources of pollution have emerged as major inputs to the Harbor. The MBP will work with communities to address these pollution sources.

Question 2

Have there been any impacts from the MWRA discharge to Massachusetts and Cape Cod Bays?

Background:

The ocean outfall, which began operation in September 2000, is an important part of the Massachusetts Water Resources Authority (MWRA) program to minimize the effects of wastewater discharge on the marine environment. The outfall tunnel, bored through bedrock, terminates with a diffuser nine miles offshore and discharges at the sea floor in water 100 feet deep.

The effluent discharged into Massachusetts Bay is much better diluted and much cleaner than the discharge that historically entered Boston Harbor. Now, stringent regulation of industrial discharges to the sewer system prevents many pollutants from entering the wastewater, and the new Deer Island Treatment Plant provides greatly improved treatment before discharge.

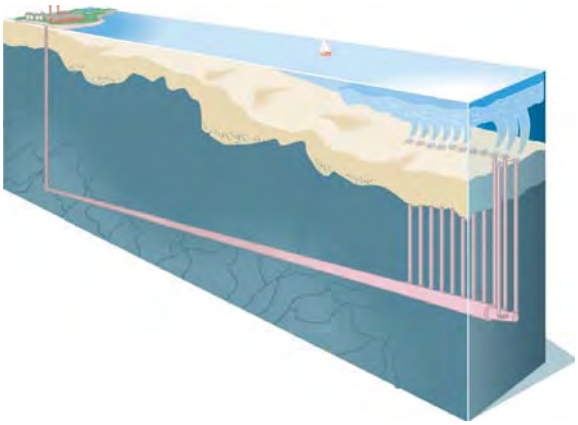


Figure 2-A: Deer Island Massachusetts Bay outfall schematic.

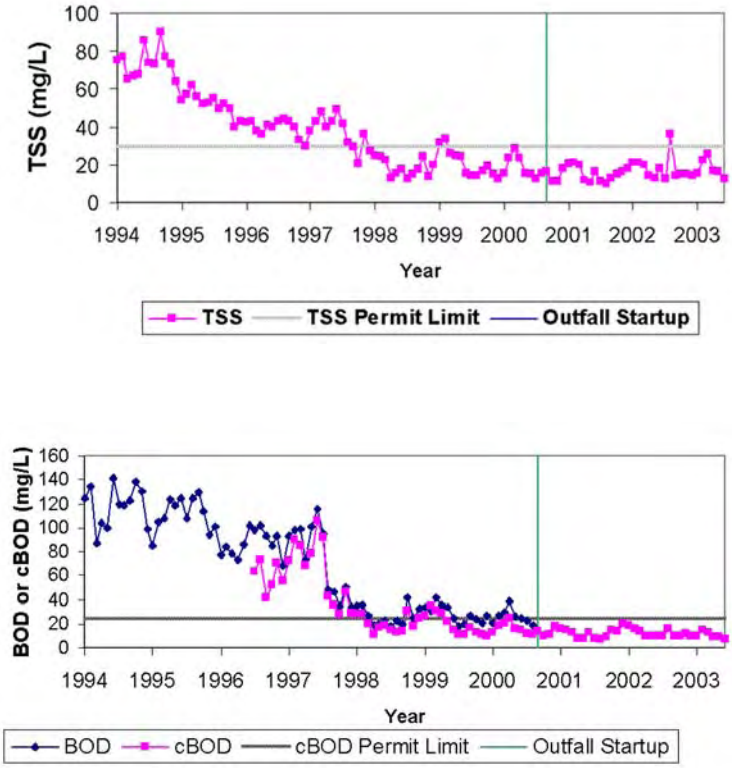


Figure 2-B: Monthly average solids (TSS, top) and oxygen-consuming material (BOD, measured as cBOD since 1997, above); Deer Island from 1994-2003.

The discharge permit for the outfall issued by the U.S. Environmental Protection Agency and the Massachusetts Department of Environmental Protection requires MWRA to monitor the effluent and the receiving waters in accordance with a monitoring plan. The monitoring program focuses on potential impacts of nutrients, organic material, toxic contaminants, pathogens, and solids from the effluent. To answer questions about the impacts of the outfall, environmental data gathered since the outfall began discharging in 2000 can be compared to baseline data collected by MWRA since 1992.

Wastewater Quality

The Deer Island Treatment Plant reliably meets its permit requirements. From the time that the permit became effective in August 2000 through the end of 2003, there have only been two violations of permit limits.

Water Quality

A dye study and ongoing monitoring show that the outfall provides adequate initial dilution to ensure that toxic chemical and microbial contaminants meet water quality standards. Most contaminants actually meet standards as the effluent leaves the treatment plant, even before dilution.

Because of the discharged effluent is rich in nitrogen, MWRA monitors key water quality indicators to learn if moving the discharge offshore might be causing nutrient-related ecosystem changes. Dissolved oxygen in bottom waters near the outfall and in deep Stellwagen Basin shows no change from conditions during the baseline period before the Bay outfall started up. Chlorophyll concentrations initially increased in Fall 2000, but this was due to a region-wide algal bloom and was unrelated to the outfall. No increase in red tide has been observed.

Fish & Shellfish

Mussels placed at the outfall site show increased levels of chlordane and PAH, but not other contaminants. The concentrations in the mussels are well below levels of concern to human health, and below levels that accumulate in Boston Harbor mussels. Flounder fillet and liver, and lobster meat and hepatopancreas collected at the outfall site show no contaminant increases. Flounder liver disease has been declining over many years in Boston Harbor, and remains low at the outfall site and elsewhere in Massachusetts and Cape Cod Bays.

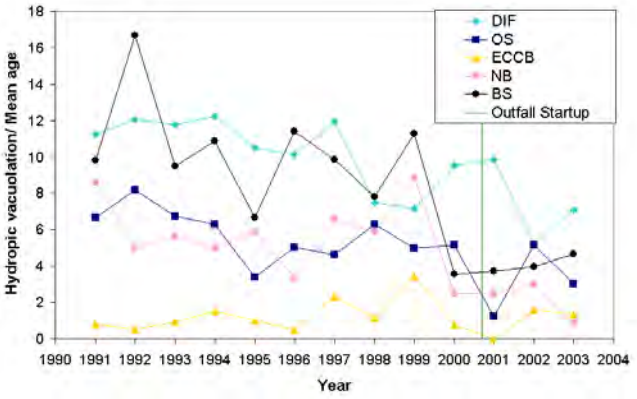


Figure 2-C: Prevalence of early-stage liver disease in flounder, normalized to age, in Massachusetts Bay stations: Deer Island Flats (DIF), Outfall Site (OS), Eastern Cape Cod Bay(ECCB), Nantasket Beach (NB) and Broad Sound (BS).

Sea Floor

Sediment contaminant concentrations have not increased beyond levels measured during baseline monitoring from 1992-2000. No change has been observed in the biodiversity of animals living in or on the sea floor, and oxygen penetrates the sediments as deeply as before.

Answer:

The new outfall was opened in 2000 and immediate water quality improvements were observed in Boston Harbor. To date, minimal impact from the new outfall has been observed in the Bays . The long-term effect on the greater Massachusetts Bays is the subject of ongoing monitoring.

Massachusetts Bays Program Role:

MBP staff tracks monitoring data produced by the MWRA and coordinates other marine monitoring programs within the Bays, such as the National Coastal Assessment and Gulfwatch, to ensure that the new outfall discharge is not negatively affecting the health of the Bays.

Massachusetts Bays Program Goal:

To continue to track the effects of the MWRA outfall on Massachusetts and Cape Cod Bays, to assist the MWRA in overseeing monitoring, and communicating the results.

Further Information

More detail on the initial effects of the outfall in Massachusetts Bay can be found in the MWRA's 2002 *Outfall Monitoring Overview* (Werme and Hunt, 2003).

Question 3

What are the levels of toxic contaminants in tissues of shellfish in Massachusetts and Cape Cod Bays?

Background:

Toxic contaminants are chemicals that have the potential to harm living organisms. These contaminants can enter the Massachusetts Bays through point sources of pollution, such as discharge pipes, or nonpoint sources of pollution, which include runoff from suburban lawns and city streets, as well as pollution that is deposited from the air.

Since 1991, the Gulfwatch program (administered by the Gulf of Maine Council for the Marine Environment) has given scientists and managers a better understanding of the status and trends of toxic contaminants in the Gulf of Maine. This monitoring program uses the blue mussel *(Mytilus edulis)* as an indicator for contamination. Blue mussels are ideal indicators because they remain in one place through their lifetime and can accumulate contaminants in their tissues. The mussels are collected from 12 intertidal sites within the Massachusetts Bays (over 50 sites throughout the Gulf of Maine) and their tissues are analyzed for metals, PCBs, PAHs, and chlorinated pesticides.

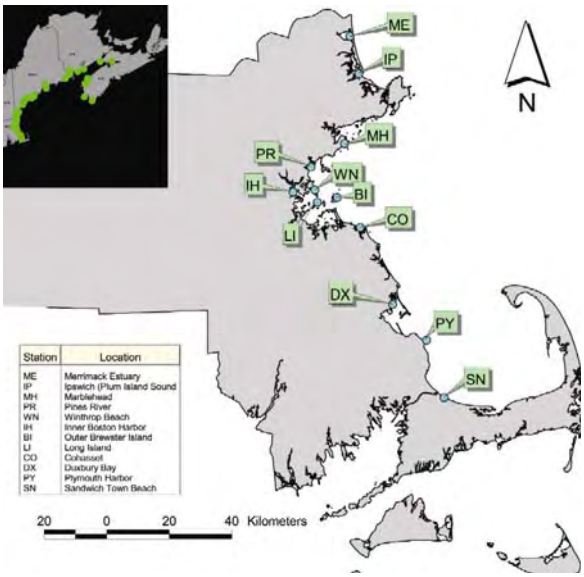


Figure 3-A: Gulfwatch Stations in Massachusetts

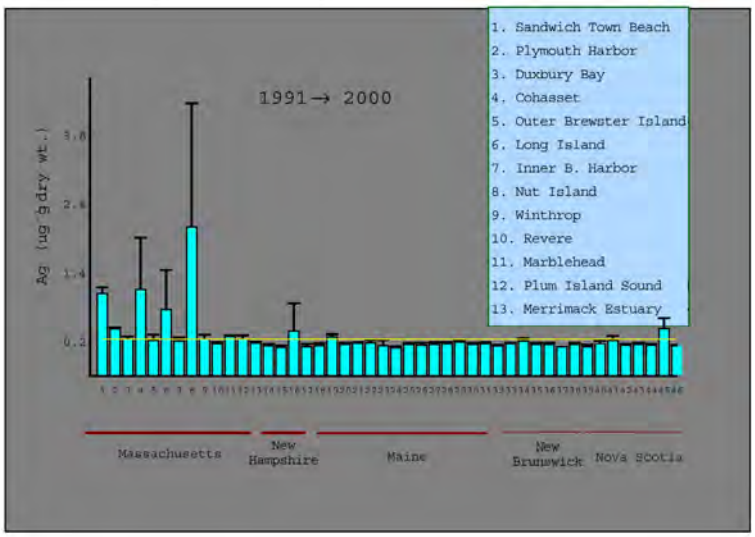


Figure 3-B: Distribution of silver concentrations in blue mussel tissue collected at all stations (Solid line = mean + 1 SD of all samples north of Massachusetts). Stations observed at or above this line are: Sandwich, Plymouth, Cohasset, Boston Harbor's Long Island and Nut Island.

Key Findings:

No organic contaminant in Gulf of Maine mussels exceeded the U.S. Food and Drug Administration's standards for human consumption. However, concentrations of organic contaminants tended to be higher in the southwestern Gulf of Maine (see figure 3-B), where coastal watersheds still bear the legacy of industrialization, and locally near the urbanized population centers of the Massachusetts Bays (see figure 3-C). Of all sites in the Gulf of Maine, Sandwich, Massachusetts has the greatest number of measured contaminants whose levels increased. While Sandwich was originally expected to represent a "clean" site, data shows that it appears to be receiving and accumulating contaminants from elsewhere in the Gulf of Maine. A site in Boston's inner harbor has shown the highest concentrations of many contaminants compared to all Gulf of Maine sites.

Answer:

Although analysis indicates that most of the sampling sites are seeing generally steady contaminant levels, localized contamination – especially at those sites influenced by industrialization – is apparent. To date we are unable to answer whether there have been increases in contamination in recent years. Continued Gulfwatch monitoring will provide insight into this important question.

Massachusetts Bays Program Role:

The Massachusetts Bays Program has been collecting blue mussels for the Gulfwatch program for a decade, and during the past five years has helped to coordinate the Massachusetts collection and analysis. The MBP has further committed itself by adding a priority action plan (Monitoring the Marine Environment) in the 2003 revision to the CCMP.

Massachusetts Bays Program Goal:

Continue to monitor and detect trends in toxic contaminants, provide information to environmental managers, and take remedial action where necessary.

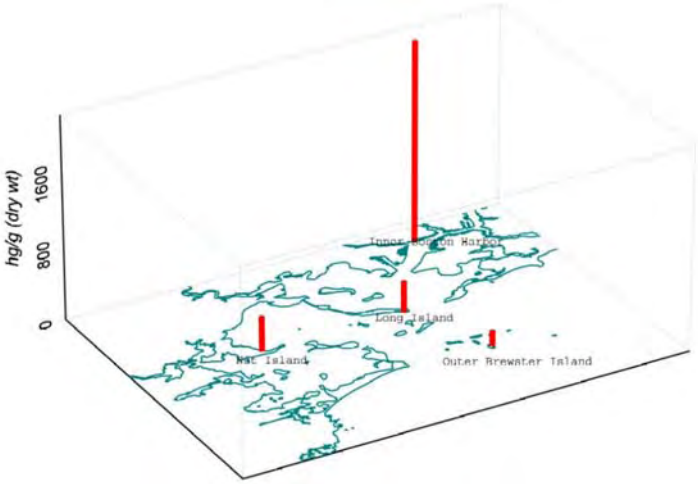


Figure 3-C: Polyaromatic hydrocarbons (PAHs) in mussel tissues from four sites in Boston Harbor averaged over 1993-2000. There appears to be a concentration gradient of PAH in mussels; from high values in the inner Harbor to lower values further out into the Harbor, where potential for mixing with Massachusetts Bays increases.

Figure 3-D: Close-up of blue mussels *(Mytilus edulis)*

Further Information:

Gulfwatch data from 1991-1997 are published in Chase *et al*. (2001). Electronic files that include site locations and chemical data are available on the Internet at: http://www.gulfofmaine.org/council/committees/eqmc/gulfwatch/default.asp or can be obtained by contacting Christian Krahforst at the Massachusetts Bays Program, christian.krahforst@state.ma.us.

In 1991 the MBP published an analysis entitled *Sources and Loading of Pollutants to the Massachusetts Bays* (MBP-91-01).

A Gulfwatch fact sheet is available at http://www.gulfofmaine.org/council/publications.gulfwatchfactsheet.pdf

Question 4

Has the amount of shellfish landings from Massachusetts and Cape Cod Bays changed over the past ten years?

Background:

Shellfish have historically been one of the most abundant and heavily utilized resources along the coast of the Massachusetts Bays. Even the casual explorer of the Bays' shallow coves, estuaries, salt marshes, and coastal ponds will usually find exposed shellfish or signs of shellfish buried in the mudflats. The inshore shellfishery of the Massachusetts Bays is an important part of the state's coastal heritage. A wide array of shellfish species in the Bays are harvested for human consumption, including soft-shell clams, quahogs, oysters, bay scallops, blue mussels, and razor clams.

The Massachusetts Division of Marine Fisheries (*MarineFisheries*) collects shellfish landings and permit data supplied by municipal shellfish constables and *MarineFisheries* shellfish biologists. The information collected is used to assist managers in the development of fisheries management plans and local regulatory decisions.

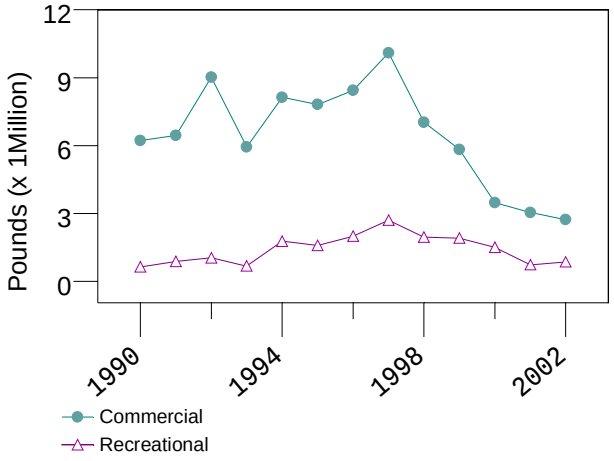


Figure 4-A: Landings for All Species for Shellfish from Massachusetts Bays

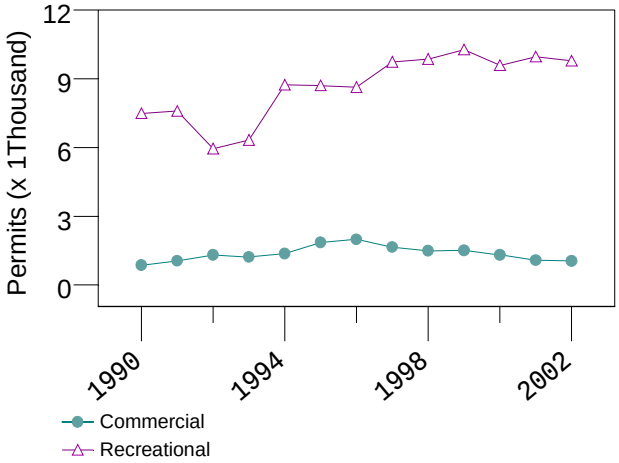


Figure 4-B: Shellfish Permits Issued by the Cities and Towns of Massachusetts Bays

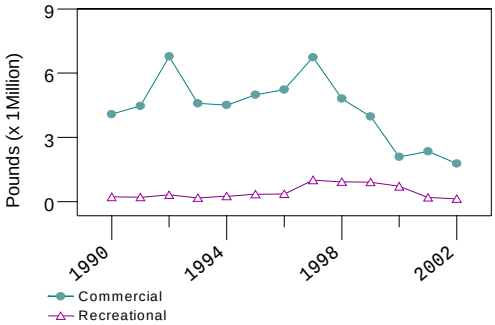


Figure 4-C: Landings of Soft-shell Clams by Massachusetts Bays Cities and Towns

Key Findings:

The graphs presented here portray the number and types of permits issued and the pounds landed in the shell of each species for each shellfishery type (commercial or recreational). The last year of full reporting for the Massachusetts Bays region was 1999. For 2000, 2001, and 2002, some of the municipalities have not yet submitted landing records.

Fifteen towns north of Boston Harbor report no landings since all of their waters are closed to shellfishing due to poor water quality. Six other towns (Boston, Hingham, Hull, Quincy, Weymouth and Winthrop) have landings of only soft-shell clams that are harvested for depuration (a process where bacteria and viruses that may be harmful for human consumption are removed) at the *MarineFisheries* Shellfish Purification Plant in Newburyport.

Answer:

Although there appears to be a downward trend in terms of number of pounds of shellfish landed, conducting a trend analysis of landings in the Massachusetts Bays is difficult for a number of reasons. The most important problem is the discrepancy in reporting systems between various shellfish constables within and between towns over time. Some constables produce estimates based on numbers of permits issued, available fishing days, and number and size of flats open to fishing. Others conduct actual daily catch observations and tallies. Some use a combination of both. Methods can change over time in a single town and with changes in personnel, making comparisons difficult.

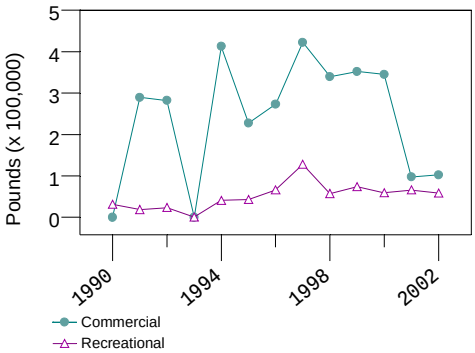


Figure 4-D: Landing of Oysters by Massachusetts Bays Cities and Towns

Massachusetts Bays Program Role:

One of the MBP's priority Action Plans from the CCMP is the protection and enhancement of shellfish resources. Working with numerous partners, including the Massachusetts Office of Coastal Zone Management (CZM), *MarineFisheries*, the Department of Environmental Protection, the Natural Resources Conservation Service, and County Conservation Districts, the MBP spearheaded a program in 1993 to restore and protect shellfish beds in the Bays called the Shellfish Clean Waters Initiative (SCWI). The program began to assess pollution sources at 12 different shellfish bed sites, initiated efforts to clean up the sites, and developed a monitoring program to ensure that reopened beds remained harvestable. In 1998, after five years of providing staff and funding to nurture the program, the MBP turned the SCWI program over to CZM.

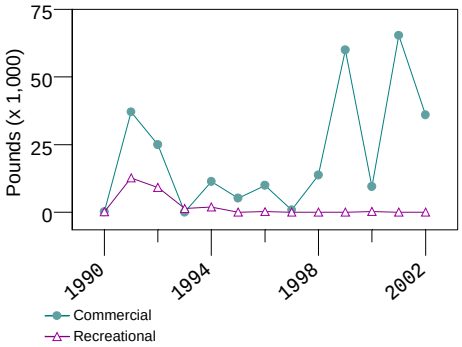


Figure 4-E: Landing of Bay Scallops by Massachusetts Bays Cities and Towns

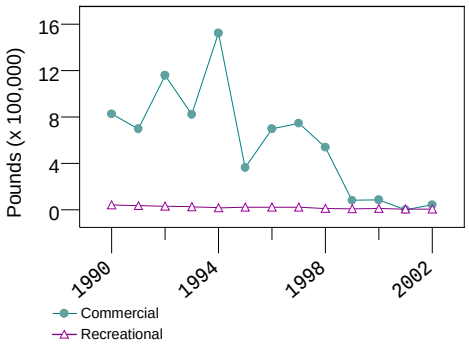


Figure 4-F: Landing of Mussels by Massachusetts Bays Cities and Towns

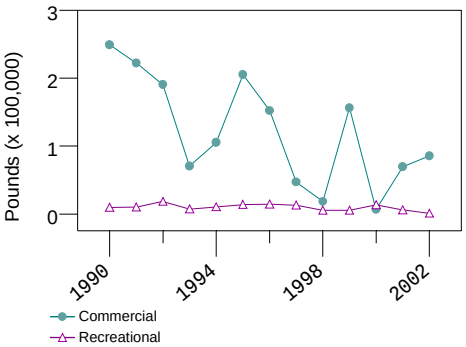


Figure 4-G: Landing of Razor Clams by Massachusetts Bays Cities and Towns

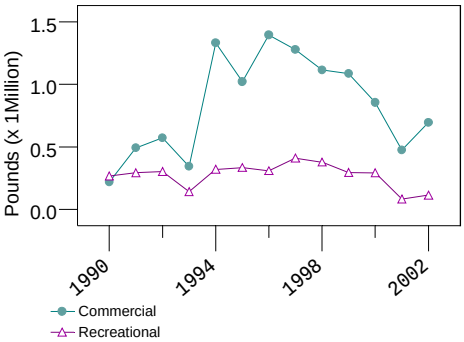


Figure 4-H: Landing of Quahogs in Pounds for Massachusetts Bays Cities and Towns

Massachusetts Bays Program Goal:

To promote sound management of the Bays' shellfish resources by restoring closed shellfish beds and improving monitoring efforts.

Question 5

Have restoration efforts resulted in improvements to coastal wetland areas?

Background:

Prior to the passage of state and federal wetlands protection regulations, countless acres of salt marsh and tidal flat habitat were filled, drained, and dredged to support the development and growth of urban and residential areas and agricultural lands. In addition, transportation infrastructure (such as roads and highways) and other types of land development have fragmented what were once connected expanses of coastal wetlands and restricted normal tidal flow. Tide-restricted salt marshes are wetlands where a crossing (road, dike, railroad, trail) has cut off a salt marsh from normal tidal flow, damaging the health of the salt marsh above the crossing (i.e.on the landward side). Starting in the mid-1990s, a network of partners has been actively working to restore destroyed and degraded coastal wetlands in Massachusetts.

Key Findings:

Significant progress has been made in the effort to restore degraded and former coastal wetlands in Massachusetts. Now administered by the Massachusetts Office of Coastal Zone Management (CZM), the Wetlands Restoration Program has completed over thirty-five projects, totaling over 450 acres of restored wetlands. The majority of restoration projects have focused on the re-establishment of tidal flow, with some accompanying removal of fill, re-grading of marsh topography, and construction of creeks and pools. In addition, regional plans or atlases have been developed that identify and inventory tidal-restricted coastal wetlands for about 85% of the Massachusetts coastline.

State and federal agency staff, academics, and trained volunteers are monitoring nearly all of the restoration projects to evaluate their progress. Short-term changes can be seen in tidal hydrology and in the area flooded by tides, resulting in new habitat available to salt marsh species, including fish, invertebrates, and birds. Some changes in plant communities can be seen within the first year or two following restoration, such as the die-off of freshwater plants and the colonization of specific salt marsh species like the glassworts (*Salicornia* spp.) and cord grass (*Spartina alterniflora*). Other restoration response, such as the suppression of the invasive common reed (*Phragmites australis*), is longer-term and can take as much as ten or fifteen years.

Figure 5-A: 2001 pre-restoration aerial photo of tide-restricted marsh (ponded with fresh water), Ipswich Little Neck Road

Answer:

Yes. Significant progress has been made in the last ten years, and it is anticipated that the next ten years will see even greater progress.

Massachusetts Bays Program Role:

The Massachusetts Bays Program has been a partner in many of the coastal wetland restoration projects. The MBP has also sponsored the development of the *Cape Cod Atlas of Tidal Restrictions* and the *South Shore Atlas of Tidal Restrictions*. The MBP has been an integral partner in the volunteer monitoring efforts with CZM and the Wetlands Restoration Program, Salem Sound Coastwatch, and The Association To Preserve Cape Cod.

Massachusetts Bays Program Goal:

Continue to work with CZM's Wetland Restoration Program and other partners to implement projects. Support and expand volunteer monitoring efforts.

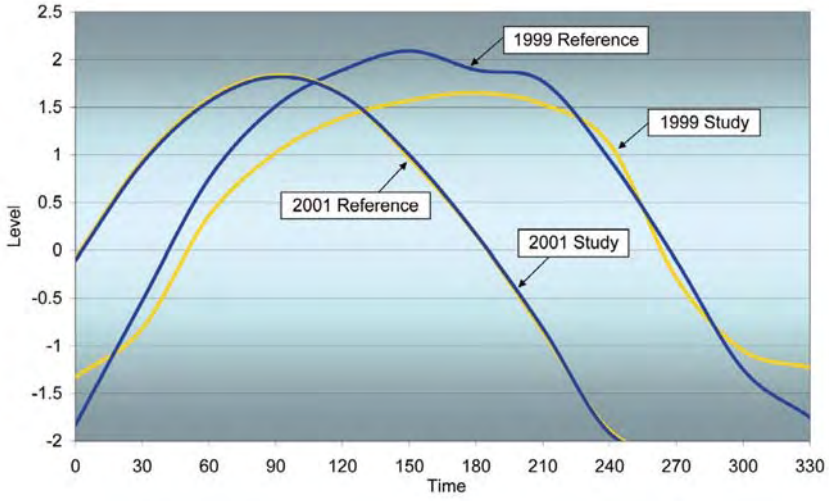


Figure 5-B: Before (1999) and after (2001) restoration tide level data for Ipswich Little Neck Road marsh. Note the restriction and time lag before and that the curves are nearly identical after restoration.

Regional Spotlight

Focus on Cape Cod - Tidally Restricted Salt Marsh Atlas

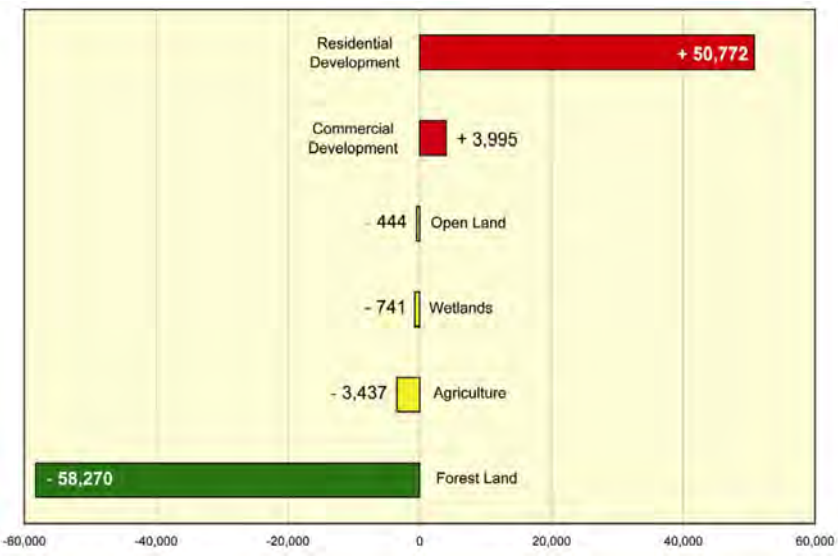
Massachusetts Bays Program staff, with support from the Executive Office of Environmental Affairs, the Cape Cod Commission, and CZM, inventoried tidally restricted salt marsh sites on Cape Cod. This project was a companion piece to atlases already completed for Buzzards Bay and several regions of the MBP. Local community groups use the Atlas to identify individual wetland restoration projects and local officials can identify restoration projects that can be coordinated with other planned municipal and state construction and maintenance activities. The Atlas has proven useful for other efforts as well, including assessing the condition of anadromous fish runs, identifying obstacles to fish passage, and prioritizing projects for state and federal grant funding. Since its completion in 2001, more than ten projects have been initiated, resulting in over 70 acres of wetland that has been improved or restored.

Question 6

What patterns of coastal development have taken place in the Massachusetts Bays region?

Background:

Over one quarter of the Massachusetts population (1.7 million people) lives within the 50 communities bordering Massachusetts and Cape Cod Bays. With the diverse environmental, economic, and cultural resources that the region has to offer, the number of residents in the Massachusetts Bays region continues to grow. However, as increases in population do not present a clear picture of how people may be impacting the Bays' natural resources, it is crucial to study how we are using the land that surrounds the Bays.



Key Findings:

Between 1971 and 1999, nearly 63,000 acres of undeveloped land (such as farm and forest land and open space) in the Massachusetts Bays region was developed for residential and commercial use. Most of this developed land was consumed for new housing, while over 58,000 acres of wildlife habitat, including wetlands and forest, were lost. Communities on the South Shore and Cape Cod have seen the most undeveloped acres consumed by development over the past 30 years.

Figure 6-A: Changes in Land Use, 1971-1999 (in acres). Source: MassGIS

While development is important for the survival and success of our communities, not all development is well executed. Many communities strive to balance development with environmental protection; however, Massachusetts state laws can sometimes restrict local efforts to guide growth through responsible planning.

For example, Massachusetts continues to be the only state that enables land to be subdivided along an existing road without being subject to subdivision review. As a result, sprawl along existing roads has become a dominant feature of the landscape, causing fragmentation of wildlife habitat, aesthetic damage, drainage problems, and safety hazards from poorly sited driveway entrances. The state's affordable housing law, Chapter 40B, was written to prevent communities from zoning in a way that excluded housing for people of lower incomes. Although the law has spurred the creation of a significant number of needed affordable housing units, it has become controversial because some contend that it is used to force towns to accept residential developments in densities greater than the land or community can assimilate.

Despite these challenges to guiding growth through responsible planning, communities are making progress using the tools that are available. Many Massachusetts Bays communities have: Community Development and/or Comprehensive Plans; adopted the Community Preservation Act (CPA); created Wetland Bylaws that are more protective than the state Wetland Protection Act; adopted water resources protection overlay zoning districts; completed Open Space and Recreation Plans; and adopted Open Space Residential Design or other cluster subdivision regulations.

Answer:

Large amounts of undeveloped land are being developed for residential and commercial uses, with the highest amount of newly developed land located in the South Shore and Cape Cod. State and local regulations need to be reviewed to ensure growth that balances development with environmental protection.

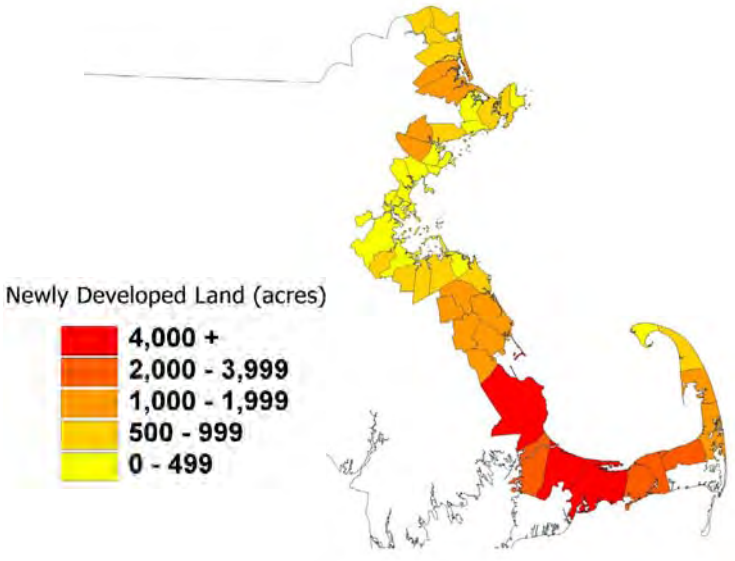


Figure 6-B: Number of acres of land converted from undeveloped to developed, 1971-1999. Source: MassGIS

Massachusetts Bays Program Role:

MBP regional staff provides essential hands-on assistance to local officials and non-profit organizations, including environmental landscape design pilot projects and local workshops for landowners, and workshops regarding Open Space Residential Design and the CPA. MBP's South Shore towns successfully passed the CPA at a rate nearly four times as great as the rest of the state, due, in large measure, to technical assistance provided by MBP regional staff.

Massachusetts Bays Program Goal:

To assist all Massachusetts Bays Program communities in adopting tools and techniques that balance development with environmental protection.

Regional Spotlight

Focus on the South Shore - Green Communities Speaker Series

In the fall of 2003, the Massachusetts Bays Program worked with regional partners on the South Shore to host a speaker series for local officials and coastal managers focused on balancing growth and coastal watershed protection. The four presentations in the series included conservation subdivision design, stormwater utilities, public participation, and regional open space planning. In total, 170 people from 35 communities in the state attended the series, and feedback from participants was overwhelmingly positive. We are working with communities to pursue grant opportunities that would allow us to implement some of the ideas that were generated by the discussions. Due to the success of the program, we are in the process of planning a Spring 2004 Green Communities Speaker Series. This new network of local officials, managers, and citizens has set a foundation for communities to creatively address the challenge of balancing development with environmental protection.

Question 7

How much of the Massachusetts Bays region is covered by impervious surfaces?

Background:

Impervious surfaces are surfaces that do not allow water to infiltrate the soil, such as rooftops, sidewalks, roads, and parking lots. During rainstorms or periods of snowmelt, these surfaces channel water down our streets and into storm drains. This stormwater often accumulates pollutants as it flows, carrying them into drains, rivers, and streams, and eventually to the Bays. Research has shown that as land is developed and the amount of impervious surface increases, water quality problems may increase. For example, studies in many regions of the country have found that watersheds with greater than 10 percent of their land area covered by impervious surface may suffer from degraded water quality, and greater than 10 percent imperviousness may cause significant deterioration[1].

Key Findings:

The Massachusetts Office of Coastal Zone Management recently refined a technique for estimating the amount of impervious surface based on different types of land use. Using this method, it is estimated that in 1999, nearly 20 percent (or 120,862 acres) of the land within the 50 Massachusetts Bays communities was covered by impervious surfaces. While estimates for the amount of impervious surface were made on a community (not watershed) basis, the fact that every Massachusetts Bays community exceeds the 10 percent impervious coverage threshold suggests that impervious surfaces in the region are harming the water quality of the Bays.

Reducing impervious surfaces and increasing groundwater recharge and infiltration must be addressed through better site development. For example, "Low Impact Development" (LID) is a site design strategy with a goal of reducing water quality impacts from residential and commercial development. The new techniques provided through LID can be utilized to protect natural resources if they are incorporated into local development rules and decision-making processes.

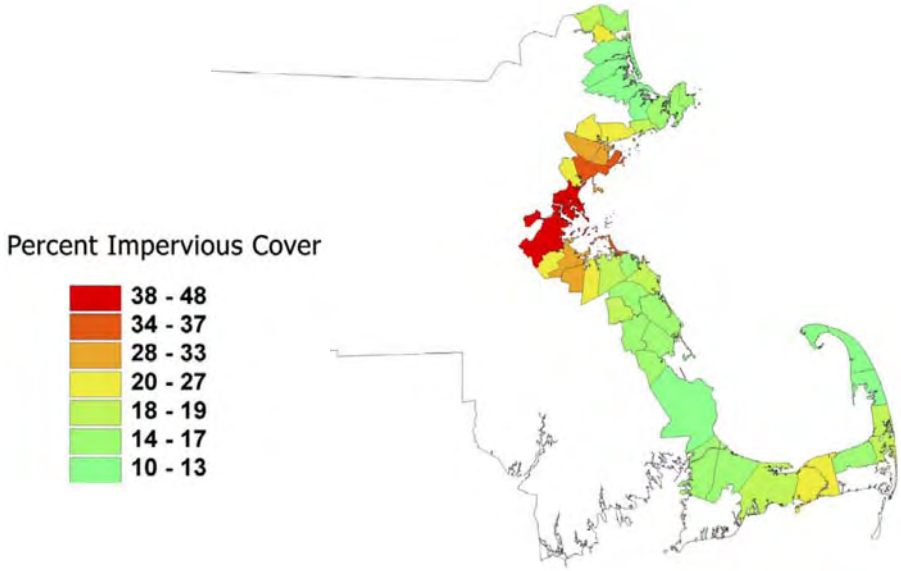


Figure 7-A: Percent of land covered by impervious surface, 1999.

[1] Center for Watershed Protection. 1998. Rapid Watershed Planning Handbook – A Comprehensive Guide for Managing Urban Watersheds. Ellicot City, MD. 51pp.

Answer:

It is estimated that nearly 20 percent, or 120,862 acres, of the Massachusetts Bays region is covered by impervious surfaces.

Massachusetts Bays Program Role:

The Massachusetts Bays Program is participating in a statewide working group to help local officials, engineers, developers, and landscape architects to incorporate LID principles into the local planning process. The MBP is also directly helping local officials learn the principles of LID and how to minimize water quality degradation by coordinating workshops, field trips, and case studies.

Massachusetts Bays Program Goal:

Minimize the amount of new impervious surfaces within the Massachusetts Bays region.

Figure 7-B: Storm drain

Question 8

How much of the Massachusetts Bays region is protected from development?

Background:

Development within the Massachusetts Bays region can place enormous pressure on fragile coastal habitats. For example, the Bays have lost close to 30 percent of their original coastal wetlands to development. Protecting open and recreational spaces, such as parks, farm and forest land, and historic sites, protects drinking water supplies and valuable wildlife habitat, and improves our quality of life.

Key Findings:

Total MBP Land Area: 621,773 acres
Permanently Protected Land: 152,225
Percent Permanently Protected: 24.5

All open space is not equal. Some land may have no permanent protection, such as a private golf course, or may only have a restriction on development for a limited amount of time. Permanently protected land is most valuable because it cannot be developed or converted for other uses in the future. MassGIS, a state agency that maintains environmental and geographic information, compiles data on how much protected and recreational open space exists in Massachusetts, how that space is protected, and where it is located. As of November 2003, MassGIS data revealed that just under 25 percent of the land located in the 50 Massachusetts Bays communities was permanently protected.

Protecting open space is becoming increasingly difficult in coastal Massachusetts as property values continue to soar, development pressures increase, and funding for acquisition is reduced in state and local budgets. Communities have become more resourceful in finding ways to protect their valuable open space, such as creating incentives for developers to set aside open space in their subdivisions. A successful way that communities have raised funds for open space is by adopting the Community Preservation Act and levying a surcharge on local property taxes.

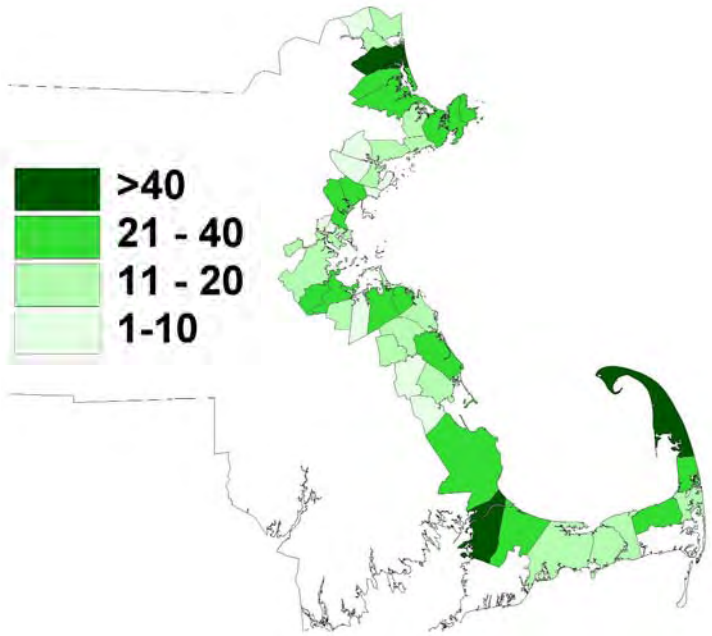


Figure 8-A: Percent of land permanently protected from development, 1999. Source: MassGIS

Answer:

Nearly 25 percent of the land within the 50 Massachusetts Bays Program communities is permanently protected from future development.

Massachusetts Bays Program Role:

The Massachusetts Bays Program will continue to assist communities to permanently protect open space through various programs and initiatives. For example, we have assisted communities to pass the Community Preservation Act, which enables municipalities to establish a local Community Preservation Fund dedicated to open space, historic preservation, and low and moderate income housing.

Massachusetts Bays Program Goal:

Increase the amount of permanently protected and recreational open space in the Massachusetts Bays region.

Figure 8-B: Coyote in salt marsh, Cape Cod

Regional Spotlight

Focus on Eight Towns and the Bay (Upper North Shore) - Green Landscaping

In 2003, the Massachusetts Bays Program spearheaded an environmental landscape design demonstration project with the Massachusetts Office of Coastal Zone Management, the Ipswich River Watershed Association, and the Town of Ipswich. A once-neglected property in Ipswich was transformed into low-income housing, and instead of traditional landscaping, only plants native to the local area were used. In turn, landscape at the redeveloped property will be water efficient, provide habitat for wildlife, require lower maintenance and fewer chemicals, and be aesthetically pleasing. The project was initiated through the Green Neighborhoods Alliance, a group of planners, environmentalists, state and municipal officials, lawyers, developers, and real estate agents working together to promote residential development that conserves open space. For more information, contact the Eight Towns and the Bay coalition (http://www.8TB.org).

Question 9

Has eelgrass habitat in Massachusetts and Cape Cod Bays changed over time?

Background:

Eelgrass, *Zostera marina*, is a type of flowering marine plant referred to as submerged rooted vegetation. A living habitat that moves and grows in search of suitable environmental conditions, eelgrass forms one of the most valuable shallow water habitats in New England. Meadows of eelgrass provide protective cover and a source of food for a large number of marine species, and affect chemical and physical processes in coastal waters. A diversity of environmental conditions support eelgrass growth, with sediment type, tidal current speed, water depth, and exposure dictating the character of eelgrass habitat. Human activities, such as degradation of water quality and physical disturbance (e.g., mooring fields and propeller scarring), also affect the quality of eelgrass habitat.

Figure 9-A: Eelgrass

Since 1993, the Massachusetts Department of Environmental Protection (DEP) Wetlands Conservancy Program has systematically mapped the statewide distribution of eelgrass. Maps were produced for Massachusetts and Cape Cod Bays in 1995 and provided the first Bays-wide assessment of eelgrass. These areas were re-mapped in 2002-2003 and results of this survey will provide the first quantitative assessment of statewide change in eelgrass habitat. Prior to the 1990s, sporadic scientific surveys and personal observations described trends in eelgrass abundance.

Monitoring programs, including those led by the U.S. Geological Survey/National Park Service partnership and the Massachusetts Office of Coastal Zone Management (CZM), are testing techniques to assess eelgrass habitat condition and determine causes of loss. These projects are providing small-scale, local assessments of eelgrass to complement the DEP maps.

Key Findings:

There is not enough data on eelgrass to quantify changes in its abundance within the Massachusetts Bays over time. The 1995 maps show the "baseline" distribution of eelgrass habitat, and relatively large beds were mapped in Salem Sound, Broad Sound, Plymouth Harbor, and the east side of Cape Cod Bay. Eelgrass in Salem Sound and Cape Cod Bay support the deepest growing beds in Massachusetts waters, which is indicative of healthy habitat.

An assessment of eelgrass abundance using historic accounts and anecdotal information demonstrates a substantial loss in eelgrass abundance through time. An outbreak of wasting disease in the 1930s decimated eelgrass populations throughout the northern Atlantic Ocean. Eelgrass generally recovered through the 1940s, but since the 1950s and 1960s eelgrass habitat has again been drastically reduced. However, the story is not all bad: from the 1990s until the present, eelgrass populations have been stable in the Massachusetts and Cape Cod Bays, and eelgrass is expected to recolonize Boston Harbor due to dramatic improvements to its water quality.

Figure 9-B: Eelgrass coverage in Massachusetts Bay north of Boston. Source MassGIS.

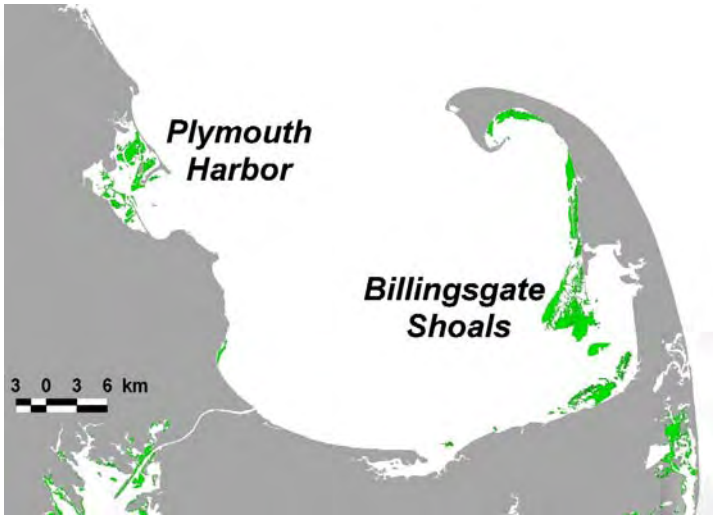


Figure 9-C: Eelgrass coverage south of Boston in Cape Cod Bay. Source MassGIS.

Answer:

Eelgrass habitat in the Massachusetts Bays has changed over time. Analyses of changes in the abundance and character of eelgrass habitat are few, but the information available, including targeted studies and anecdotal observations, confirm the loss of eelgrass habitat. Physical disturbance, such as mooring chain scarring and dredging, is the primary cause of eelgrass habitat loss in Massachusetts Bays, but changes in water quality warrant attention because of the sensitivity of eelgrass to the water column environment.

Massachusetts Bays Program Role:

The MBP is assisting the Massachusetts Office of Coastal Zone Management in developing an eelgrass health assessment index, similar to the current Wetlands Health Assessment Toolbox (WHAT) program, to help expand eelgrass monitoring efforts within the Massachusetts Bays.

Massachusetts Bays Program Goal:

Expand eelgrass monitoring efforts within the Massachusetts Bays.

Question 10

What marine invasive species are found in Massachusetts and Cape Cod Bays and are they increasing?

Background:

Marine invasive species are organisms that are introduced from areas outside their normal range by human activities. Species may be introduced through shipping (attached to hulls or in ballast water), seafood and fishing industries (including aquaculture, bait, and gear), recreational activities (boating, diving), pet and aquaria releases, public aquaria, research and education, and special cases (canals, oil rigs). Although economic damage from marine invasive species is poorly documented, over $130 million is spent nationwide to manage, control, or prevent damage from pests in terrestrial, freshwater, and marine ecosystems.

In August 2000 and 2003, taxonomic experts conducted rapid assessment surveys to identify native and non-native species found on floating docks and piers throughout coastal Massachusetts with the purpose of supporting management efforts to prevent, minimize, or manage marine invasive species (Fig. 10-A).

Figure 10-A: Rapid Assessment Survey sampling stations from August 2000 study. Hawthorne Marina, Rowes Wharf, Massachusetts Maritime Academy, US Coast Guard Station and Tripps Marina were surveyed in August 2003.

Figure 10-B: Scientists and students collecting algae and invertebrates from a floating dock.

On some of the docks that were sampled, introduced species covered large areas and were the most abundant species. Introduced species often foul aquaculture facilities where they may decrease flow through a pen or compete for food with shellfish on ropes. Some cause disease and others compete directly with native organisms.

Key Findings:

Over 260 species of plants and invertebrates were identified in the August 2000 survey. Twenty-eight were identified as "introduced" and thirty were identified as cryptogenic species (those whose origins are unknown and impossible to verify). Often they are small in size and many were first recorded during the 1800s. Some introduced species spread very quickly while others appear to disperse more slowly. An example of one that spread very quickly is the Asian shore crab (*Hemigrapsus sanguineus*), which spread from its point of introduction in Delaware and Cape May, New Jersey, southward to North Carolina and northward to Maine in only 12 years.

Figure 10-C: The Asian shore crab (*Hemigrapsus sanguineus*) feeds on algae and small mollusks and may have negative impacts on shellfishing in areas where it is found.

Both the 2000 and 2003 surveys found that of the total number of species identified, approximately 11 percent were introduced and 12 percent were cryptogenic. This percentage is lower than the percentage of introduced species in San Francisco Bay and Southern California, but about the same as those found in Washington. Since our 2003 survey, scientists have reported an introduced species (*Didemnum* sp.) offshore in Georges Bank where active scallop fishing occurs.

Figure 10-D: The Pacific tunicate (*Didemnum* sp.), seen here in dense colonies that can smother Georges Bank gravel sediments where scallop fishing occurs.

Answer:

Twenty-eight species were identified as being non-native in two surveys of floating docks within the Massachusetts Bays, and no new species were observed over a three-year period. However, some species are spreading and may cause economic damage to coastal shellfishing and offshore scalloping.

Massachusetts Bays Program Role:

MIT Sea Grant and the Massachusetts Bays Program led the two rapid assessment surveys and coordinated the involvement of National Estuary Programs in Maine, New Hampshire, Rhode Island, Connecticut, and New York. The MBP has also taken an active role in developing outreach materials for pet stores, including materials translated for non-English speakers. The MBP participates on the Massachusetts Aquatic Invasive Species Working Group to help develop and implement the state aquatic invasive species management plan.

Massachusetts Bays Program Goal:

Reduce the spread of marine invasive species in the Massachusetts Bays though continued monitoring and preparation for potential future invasions.

Question 11

Have endangered right whales shown signs of recovery?

Background:

With no more than 350 remaining individuals, the North Atlantic right whale is the most endangered large whale species in the world. Arriving late in the winter from southern and offshore waters, right whales enter Massachusetts and Cape Cod Bays to feed, to court, and to spawn before moving northward during the summer into the Bay of Fundy and the waters east of Nova Scotia. Right whale surveys have found that Cape Cod Bay, in particular, is an important feeding and socializing area for up to 95 individual whales annually, almost a third of the known population.

Key Findings:

Although they have been protected since 1935 from what was once heavy and consistent hunting, the right whale population has been slow to rebound with an average annual growth rate of 2.5 percent at best. Because the whales tend to move slowly and often rest at the surface, they are vulnerable to ship collisions and can become entangled in fishing gear. Between 1970 and 1999, the International Whaling Commission found that of 45 known right whale deaths, sixteen were due to ship collisions, three were due to fishing gear entanglement, thirteen occurred at birth, and thirteen were of unknown cause. According to the National Marine Fisheries Service (NMFS), right whale injuries and deaths attributed to human causes may be the principal reason why the population is recovering at such a slow rate. To begin to address the problem, NMFS and the U.S. Coast Guard implemented a Right Whale Mandatory Reporting System in 1999 that requires large shipping vessels within the Bays and other critical habitat areas to report information about their location, course, and speed. In return, the vessels receive information about right whale locations and recommendations on measures to avoid collisions with whales. The system is providing valuable information on patterns of vessel traffic in the Bays' critical habitat.

Figure 11-A: North Atlantic Right Whale

Answer:

The number of North Atlantic right whales is recovering at a very slow rate. Government agencies, researchers, fishermen, conservation groups, and mariners are working together to prevent human causes of whale mortality.

Massachusetts Bays Program Role:

The Massachusetts Bays Program is participating in the revision of the Stellwagen Bank National Marine Sanctuary Management Plan. Stellwagen Bank is partly located within the federal Cape Cod Bay Northern Right Whale Critical Habitat area.

Massachusetts Bays Program Goal:

To reduce the number of right whale injuries and deaths due to human causes.

Further Information:

Scientists from the Center for Coastal Studies and the New England Aquarium conduct winter and spring aerial surveys for right whales in Cape Cod Bay and adjacent waters. The work is primarily supported by the Massachusetts Division of Marine Fisheries, and reports can be found online at http://www.mass.gov/dfwele/dmf/.

Question 12

Have there been any observed changes in the fisheries in Massachusetts and Cape Cod Bays?

Background:

For many years, pollution, overfishing, the impacts of land use, and other environmental influences have strained the fisheries resources of Massachusetts and Cape Cod Bays. Populations of marine and estuarine organisms respond to these pressures with changes in their abundance and diversity. Since 1978, the Massachusetts Division of Marine Fisheries (*MarineFisheries*) has conducted a "bottom trawl survey" in which samples of finfish and other large invertebrates caught in the coastal waters of Massachusetts are sorted, weighed, and counted by species. This survey quantifies the populations of these finfish and larger invertebrates, and tracks their relative abundance over time to allow scientists and managers to evaluate the health of the stocks. The survey is conducted in May and September of each year, with each segment comprised of about 100 tows conducted throughout state waters at randomly selected locations.

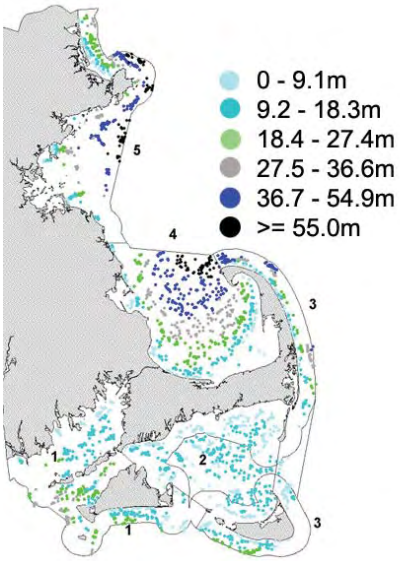
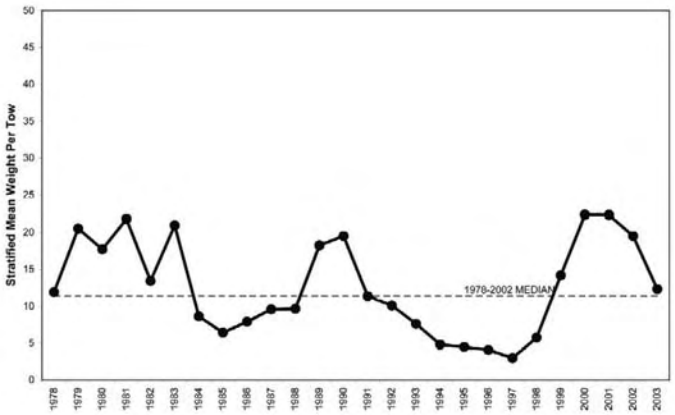


Figure 12-A: Location of survey tows conducted by *MarineFisheries*, 1978-2002.



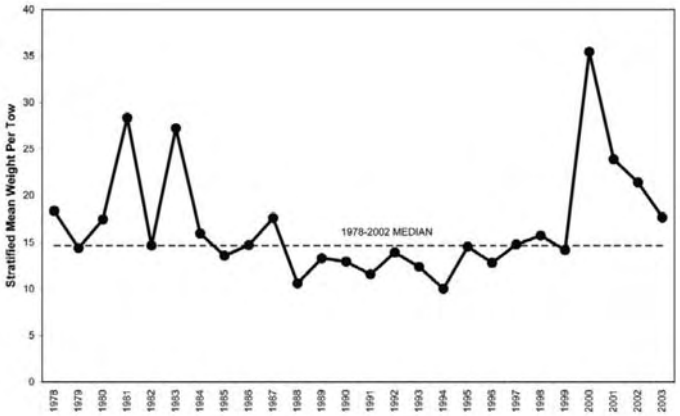
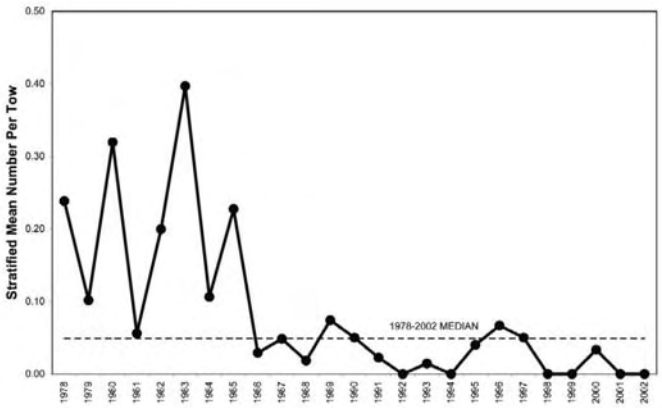


Figure 12-B: Catches of Atlantic cod from the *MarineFisheries* bottom trawl survey, 1978-2003 (above).

Figure 12-C: Catches of winter flounder from the *MarineFisheries* bottom trawl survey, 1978-2003 (above right).

Figure 12-D: Catches of Atlantic wolffish from the *MarineFisheries* bottom trawl survey, 1978-2003 (right).



Key Findings:

The trawl survey tracks the relative abundance of dozens of species of finfish and invertebrates in Massachusetts marine waters. A number of trends are seen within these species. Most of the commercially important finfish species within Massachusetts Bay showed population declines beginning in the 1980s and reaching into the mid-1990s (e.g., cod, winter flounder, wolffish). In recent years, most of these species have shown significant increases in their populations (cod, winter flounder), likely in response to restrictive fishery management rules, while some continue to remain at low levels (wolffish). Some species that are not fishery targets have shown an increase in population during the time period examined (longhorn sculpin). Overall, the fisheries resources are responding positively to increasingly restrictive management rules, although the response is different for each species.

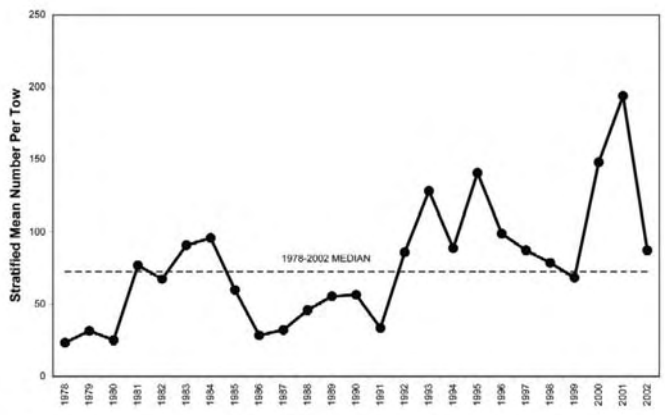


Figure 12-E: Catches of longhorn sculpin from the *MarineFisheries* bottom trawl survey, 1978-2003.

Figure 12-F: *MarineFisheries* staff processing a large catch during the bottom trawl survey.

Answer:

Yes, most species examined in the time series showed changes in abundance over time with increases in abundance seen for most species over the last few years.

Massachusetts Bays Program Role:

The MBP actively initiates and participates in coastal wetland restoration efforts. Coastal wetlands are vital to the health of fisheries since they provide spawning habitat, nursery habitat, and food production, and improve water quality. Healthy coastal wetlands result in increased fisheries species diversity, richness, and numbers.

Massachusetts Bays Program Goal:

To continue to support coastal wetlands restoration to provide nursery grounds for fisheries.

Question 13

Is it safer to swim at area beaches than it was ten years ago?

Background:

Exposure to disease-causing organisms, called pathogens, associated with fecal contamination is one of the major health threats facing people who swim in the coastal waters of the Massachusetts Bays. One of the main sources of pathogens in our coastal waters is storm water, which is often discharged near swimming beaches. People who swim or recreate in fecal contaminated waters are at increased risk of contracting diseases, such as cholera, gastroenteritis, hepatitis, giardiasis, and dysentery. Bacteria that are associated with fecal matter, such as *Enterococcus* and *Escherichia Coli.*, are used as indicators to test for the presence of the more difficult to detect pathogenic organisms.

Figure 13-A: Juniper Beach, Salem

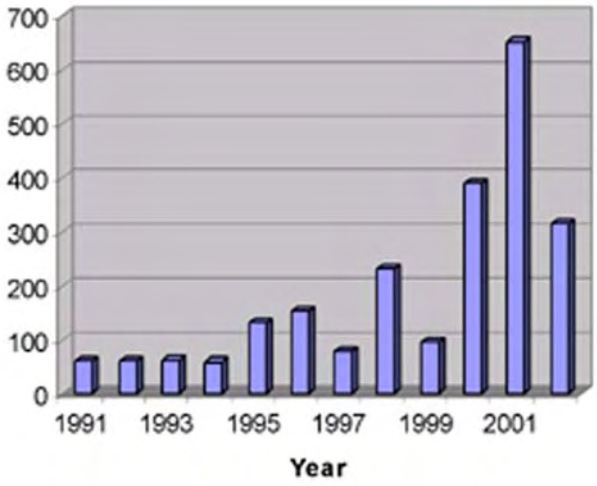


Figure 13-B: Number of beach closings or public advisories issued at Massachusetts beaches, 1991-2002 (Source: National Resources Defense Council)

In August of 2000, Massachusetts enacted regulations (M.G.L. C. 111, § 5S) requiring communities to monitor bacteria levels at public and semi-public bathing beaches during the beach season (June through September). At beaches where bacteria levels exceed acceptable levels, communities are required to post notices at access points stating that the water is unsuitable for swimming. These acceptable levels have been set in accordance with new, stricter U.S. Environmental Protection Agency standards for limits on indicator bacteria used to detect the presence of fecal contamination in recreational waters. As a result of increased monitoring and improvements in the quality of monitoring, the number of beach postings and closings has actually increased since the law went into effect (Fig. 13-B).

Key Findings:

For most of the region's beaches, there are not enough historical data to determine whether bacteria levels have changed significantly in the past ten years. Thus far, it is not yet possible to determine if the beaches are actually "cleaner" than ten years ago. MWRA has collected bacterial data on Boston Harbor beaches since at least 1987. No clear trends can be seen in bacteria levels at these beaches during that period (Fig. 13-C). While it is not possible to determine if the beaches are actually cleaner than they were ten years ago, since 2001 beaches have been posted as being unfit for swimming if bacteria levels are unacceptably high, and people generally do not enter the water.

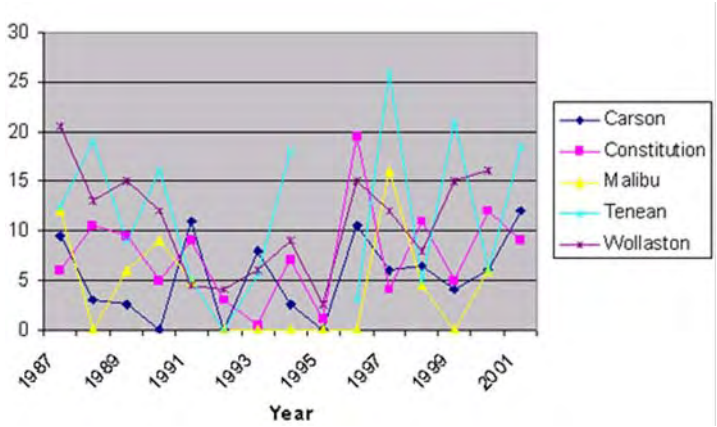


Figure 13-C: Percent of Boston Harbor beach monitoring samples failing water quality standards for bacteria, 1987-2001 (Source: Massachusetts Department of Conservation and Recreation)

Answer:

It is not clear. While changes in indicator bacteria are inconclusive, as a result of beach monitoring and posting regulations, today people are forwewarned when a beach may be contaminated.

Massachusetts Bays Program Role:

Stormwater can carry bacteria and viruses as it is collected from the streets and channeled into a network of underground pipes. Often it is discharged near swimming beaches. MBP staff members have worked on numerous projects to reduce the impact of stormwater on the Bays and their beaches. For example, Salem Sound Coastwatch's Clean Beaches & Streams Program identified a number of sites of contaminated discharge and successfully worked with municipal officials and other regional partners to develop solutions and notify the public of associated risks.

Massachusetts Bays Program Goal:

To continue to make beaches along the Massachusetts Bays safer for swimming.

Question 14

What are the long-term trends in permitted pollution discharges and their flows into Massachusetts and Cape Cod Bays?

Background:

Pollutants that enter the Massachusetts Bays from a specific source, such as an outfall from a wastewater treatment facility, are called point source pollutants. The federal Clean Water Act in 1972 began regulating these sources of pollution by requiring that parties dumping pollutants into navigable waters of the United States obtain a permit from the U.S. Environmental Protection Agency (EPA) through the National Pollutant Discharge Elimination System program (NPDES). The Act also funded the construction of sewage treatment plants, and with revisions in 1981, improved the capabilities of treatment plants built under the program. The Clean Water Act required all publicly owned treatment works (POTWs) to achieve secondary treatment (advanced removal of pollutants) by July 1, 1977; however, POTWs could apply for a waiver from this requirement. In 1987, the federal government enacted the State Water Pollution Control Revolving Fund, more commonly known as the Clean Water State Revolving Fund. This new funding strategy provided low-interest loans to construct water quality protection projects. The goal of all of these legislative milestones has been to reduce and eventually eliminate pollutants discharged to the nation's surface waters.

In 1991, the Massachusetts Bays Program published a document entitled *Sources and Loadings of Pollutants to the Massachusetts Bays*. In this publication, the authors listed all EPA-permitted discharges to the Massachusetts Bays and tabulated the types and amounts of pollutants flowing into the Bays. So what, if any, trends in wastewater flow can be seen since the 1991 report?

Figure 14-A: NPDES discharges map and legend

Key Findings:

As of 2004, the Massachusetts Bays have 30 permitted NPDES outfalls that federal and state regulators consider "major" discharges (permitted for greater than 1 million gallons per day [mgd] flow). In actuality, only 24 of these outfalls discharge more than 1 mgd on average. The total average daily flow from 29 of these facilities (Lucent Technologies had no discharge) is 2.82 billion gallons of effluent per day. An average of 2.19 billion gallons per day (78%) is taken in and discharged by the seven power plants along the coast of Massachusetts Bay. The eighteen municipal or regional wastewater treatment facilities discharge a combined average of 550 mgd (20%), while three industrial facilities discharge a combined average of 80 mgd (2%).

In 1991 the total maximum flow from the 33 major NPDES dischargers to Massachusetts Bay was 2.17 billion gallons per day. The seven power plants accounted for 1.37 billion gallons per day (63% of the total discharge to Massachusetts Bay), wastewater facilities accounted for 678 mgd (31%), and industry accounted for 130 mgd (6%). Even though the 1991 flow value is a measure of the **maximum** flow from all facilities, this value is 23% less than the 2004 **average** flow estimate of 2.82 billion gallons per day.

Since the 1991 Massachusetts Bays Program report, the overall number of permitted major discharges decreased from 33 to 30. Three sewage discharges were closed and their waste streams consolidated with more modern treatment facilities. Two new wastewater collection

systems and treatment facilities were built (Scituate and Cohasset) to replace failed or inadequate on-site residential treatment systems. In addition, two new wastewater facilities were built (Plymouth and MWRA) to replace inadequate existing facilities. The town of Provincetown also constructed a new sewage collection system and wastewater treatment facility but its discharge is to groundwater, not to Cape Cod Bay, and is therefore not included in this analysis. The number of facilities discharging to Massachusetts Bay under permit waivers (i.e. the facility does not have to achieve secondary treatment) has remained at only one -- Gloucester.

Details on changes are listed below:

Discharges Discontinued or Downgraded

- Discharges from the Exxon facility on the Merrimack River (NPDES # MA0002225) have been discontinued.
- Swampscott wastewater facility (NPDES # MA0101907) was closed and the wastewater is now sent to Lynn Water and Sewer Commission.
- Bostik (NPDES # MA0001180) was downgraded to a minor discharge (it discharges about 2,000-22,000 gallons per day).
- Monsanto Everett (NPDES # MA0000809) was closed and discharges have been discontinued.
- MWRA outfalls associated with NPDES # MA0102351 and MA0102352 (Deer Island and Nut Island, respectively) were closed.

New Discharges (since 1991)

- Cohasset has a new Waste Water Treatment Plant (WWTP) and associated discharge (NPDES # MA0100285).
- Scituate has a new WWTP and associated discharge (NPDES # MA0102695).
- MWRA now has a new outfall 9.5 miles offshore (NPDES # MA0103284).
- Gillette Company's discharge (NPDES # MA0003832) to Fort Point Channel in Boston's Inner Harbor was not on the 1991 list.

Answer:

The overall number of permitted discharges has decreased in the last 14 years. However, there has been an increase in discharge flow between 1991 and 2004 due to an increase in flow from cooling water use by power plants (possibly due to increased power demand). While the two data sets are not directly comparable, wastewater flow has been reduced due to local water conservation programs and infiltration control efforts. Industrial flows have decreased due to both conservation measures and plant closings.

Massachusetts Bays Program Role:

The Massachusetts Bays Program monitors NPDES-permitted discharges to the Bays.

Massachusetts Bays Program Goal:

Reduce point source pollutants to the Massachusetts Bays through the NPDES program.

Focus Study

The Boston Harbor Project Story

Figure FS-1: Aerial view of the Deer Island Treatment Plant

"Harbor of Shame" — that was the 1988 *Boston Herald* headline, referring to a study showing that Harbor sediments were some of the most contaminated in the country. By that time, public concern about pollution from the region's outdated sewage treatment system had resulted in state and federal court cases and the formation of a new agency. The Massachusetts Water Resources Authority (MWRA) was formed in 1985 by an act of the Massachusetts Legislature to take over metro Boston's water and sewer service. The new agency had two powerful weapons in its effort to bring the sewer system into compliance with Clean Water Act standards: it was independent of state appropriations — instead funded by water and sewer assessments on its 60 member communities — and it was under court order to get the job done.

The region's residents formerly low water rates increased rapidly in the 1980s to over $1,000 per year per household in some communities, in order to fund construction of a new sewage treatment plant and other system improvements. The decisions where to site the sewage treatment plant and how to handle sewage solids (sludge) resulting from treatment were also highly controversial.

Construction of the plant on Deer Island in Boston Harbor posed several engineering and logistical challenges. Since the only land access was via narrow residential streets, all construction materials and most workers were transported via water. A sewage treatment plant capable of providing primary and secondary treatment to over 1,000 million gallons per day required all the space available on the island. MWRA removed a prison to make room for the new primary treatment plant, which separates out most of the pollutants by gravity settling of solids. Then, MWRA tore down the old, undersized primary plant and built a new, innovative secondary treatment plant in its place. The secondary plant uses microorganisms to further treat the sewage. Solids are broken down in space-saving egg-shaped digesters, then barged to a new plant in Quincy where the sludge is converted into fertilizer. Finally, all of the construction had to take place without interrupting the continuous wastewater treatment process.

In spite of these challenges, the parts of the project that provide improved treatment and pumping were completed on schedule and under budget. MWRA halted the dumping of sewage sludge into the harbor in 1991; finished construction of the new primary treatment plant in 1995; and completed the secondary treatment plant in three stages, in 1997, 1998, and 2001.

To replace the near-shore outfalls from the Deer Island and Nut Island treatment plants, an outfall and diffuser system was constructed to discharge treated wastewater into the deeper water of Massachusetts Bay, nine miles from shore. MWRA and the regulatory agencies chose the site based on the results of field and modeling studies of likely effects of discharges at several locations in western Massachusetts Bay. Since the effluent is better diluted in deeper water, the outfall was sited as far offshore as was feasible. Still, construction of the outfall was beset by difficulties and was not completed until the late summer of 2000, five years behind schedule. Therefore, the outfall never carried primary-treated effluent; by the time of outfall completion, secondary treatment was available.

Modeling and field studies indicated that even without improved treatment, the new outfall would have less impact on Massachusetts Bay than did the old harbor outfalls. Nevertheless, there was public concern that the Massachusetts Bay ecosystem could be more sensitive to the nutrients in treated wastewater. In particular, because of concern about the highly endangered North Atlantic right whale, MWRA agreed to conduct additional monitoring of outfall effects on the Bay.

MWRA has a very extensive monitoring program of its effluent and of effects in Massachusetts Bay. The monitoring is required in its discharge permit, and is overseen by an independent Outfall Monitoring Science Advisory Panel (OMSAP). MWRA began baseline studies in 1992. Since the outfall did not begin operation until late 2000, there are nearly nine years of pre-discharge data, which helps scientists understand the natural variability in Massachusetts Bay. Post-discharge monitoring by MWRA began when the outfall was turned on in September 2000. During 2003 and 2004, MWRA and OMSAP conducted a review of the monitoring program and refocused it on longer-term effects because the first few years of post-discharge monitoring showed minimal effects.

The completion of the new treatment plant and outfall has led to measurable improvements in Boston Harbor's water quality. Improvements were seen in stages, as MWRA stopped sludge dumping, improved pumping to the sewage treatment plant, and completed primary and secondary treatment facilities before finally moving the discharge offshore. Improved pumping, as well as construction of larger sewers and combined sewage treatment facilities, has greatly reduced the amount of raw sewage entering the harbor during rainstorms. Remaining challenges include completing the combined sewer overflow control program and, unlike in the past, investing in maintenance to keep the sewer system and the treatment plant in good repair. Meeting these challenges will keep Boston Harbor a place we can be proud of.

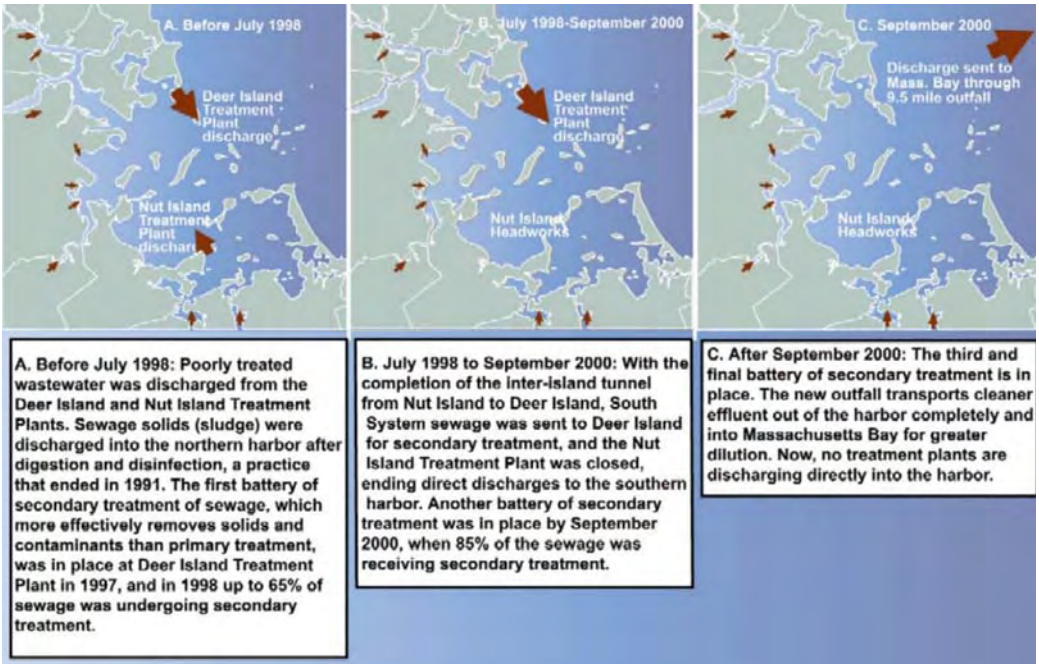


Figure FS-2: Sources of sewage in Boston Harbor

Focus Study

Wetlands Restoration Program

Environmental restoration is an invaluable tool for returning damaged ecosystems to as close to their original, healthier state as possible. Over the past decade, environmental restoration has received increased attention and resources as scientists and managers have recognized its value in achieving the goal of a healthier environment. During this period, federal and state government agencies have developed restoration programs and offered numerous grant opportunities, new organizations have emerged with restoration at the center of their activities, and thousands of restoration projects have been completed.

Wetlands have been particularly vulnerable to destruction and degradation from human activities. The United States has lost over 50% of the 220 million acres of wetlands that existed on the continent 200 years ago. Many of the remaining wetlands have been degraded through indirect impacts that diminish their functions and values. While wetland regulations help to preserve existing habitat, restoration is the only way to recover lost and degraded wetland systems.

Founded in 1994, the Wetlands Restoration Program (WRP) supports voluntary restoration of degraded or former wetlands. To fulfill its mission, WRP works with a broad network of partners to develop regional restoration plans, identify and evaluate specific restoration opportunities, assess project feasibility, prepare engineering design plans, obtain permits, complete construction, monitor restoration progress, and deliver outreach and educational resources. In July 2003, the Wetlands Restoration Program was transferred to the Massachusetts Office of Coastal Zone Management (CZM) from its former host, the Department of Environmental Protection. The purpose of the relocation was to improve coordination with related programs and initiatives, such as the Massachusetts Bays Program, and to reduce administrative costs. Now integrated within CZM, the program is focusing its efforts on wetlands restoration in coastal watersheds.

Since 1994, about 35 projects have been completed, totaling over 450 acres of restored wetlands. During this period, the program has leveraged over $12.5 million in non-state funds, including $9.5 million in federal funds and nearly $1 million in private sector financial and technical service donations. To better understand two critical components of the program, the following will focus on a planning project and the implementation of a restoration project.

Great Marsh Aquatic Habitat Restoration Plan:

The Great Marsh coastal region stretches from Amesbury to Rockport along the north shore of Massachusetts and contains a tremendous wealth of aquatic habitats, many of which are renowned for their ecological significance and immeasurable social values. The coastal communities of the Great Marsh region derive tremendous economic, social, and cultural benefits from the “services” provided by the region’s aquatic habitats. Historic and current human activities have degraded (and continue to degrade) these habitats in numerous ways—the most significant include filling and destruction of salt marshes and other tidelands, restriction of normal tidal flows, chronic pollution of coastal waters, obstruction of fish passages, channelization of coastal streams, and degradation of natural buffers. These stressors reduce the ability of aquatic habitats to support native plants and animals; increase their vulnerability to invasion by foreign species; reduce their capacity to buffer storm damage; impede their ability to filter pollutants; and decrease their value for human use and enjoyment.

Figure FS-3: Aerial view of the Great Marsh (Plum Island to the east)

Although many impacts are, in practical terms, permanent (e.g., buildings located on filled tidelands), numerous opportunities exist to undo past damages and restore habitats to a healthier condition. The goal of this project is to develop a restoration plan that will be used by area communities, state and federal agencies, and other organizations and individuals to identify and restore degraded coastal aquatic habitats within the Great Marsh region. Using regional and site-specific maps, photos, and characterizations for all sites, the Great Marsh Aquatic Habitat Restoration Plan will identify tidally restricted and filled (or otherwise physically impaired) coastal wetland sites within the nine study area communities: Amesbury, Essex, Gloucester, Ipswich, Newbury, Newburyport, Rockport, Rowley, and Salisbury. The plan will also identify wetlands that are subject to stormwater discharges, wetlands that have significantly degraded buffers, and wetlands that are associated with impediments to anadromous fish passage. Finally, the plan will offer highlights of selected priority sites, providing greater detail on conditions, restoration options, conceptual restoration designs, and recommendations for next steps.

In developing the plan, WRP will rely on input and participation from the nine coastal communities within the study area, as well as various agencies and regional organizations including the Massachusetts Bays Program; Eight Towns and the Bay; Massachusetts Audubon Society; Great Marsh Coalition; Parker River National Wildlife Refuge; The Trustees of Reservations; Ipswich and Parker River Watershed Associations; *MarineFisheries*; Massachusetts Area of Critical Environmental Concern Program; Massachusetts River Restore Program; and Massachusetts Executive Office of Transportation and Construction. The plan, however, is only the first step toward project implementation. Follow-through by area communities and restoration partners is critical to restoration success. The post-plan vision is one of a long-term effort that is driven by communities and organizations that, with the support of state and federal resources, pursue restoration projects through to completion. WRP will work with the communities and other restoration partners to help make that vision a reality for the Great Marsh region.

Damde Meadows:

Figure FS-4: Installing the box culvert at Damde Meadows, Hingham

At The Trustees of Reservations Worlds End Reservation in Hingham there is a salt marsh that has a long history of human stress: it has been diked and dammed, farmed for salt meadow grass, converted to a freshwater hayfield, and flooded as an open water pond. In May 2003, this marsh received a significant push towards restoration with the removal of the historical tide restrictions and the installation of new culverts.

A diverse array of local, state, federal, and private partners carried the project through the restoration process: pre-restoration monitoring, site evaluation, project design, permitting, and construction. The $185,500 project includes the installation of two concrete box culverts that were sized to allow unrestricted, natural tidal flow to the 18-acre site and complete drainage at low tide. The higher tides will reach deep into the marsh, eventually killing off much of the invasive *Phragmites australis* (common reed). Areas now dominated by *Phragmites* are expected to gradually develop into a high marsh plant community, dominated by salt hay grass (*Spartina patens*) and spike grass (*Distichlis spicata*).

This project serves as an excellent example of the power of partnerships and collaboration. Secretary of Environmental Affairs Ellen Roy Herzfelder praised this work during the dedication, stating, "Caring for our wetlands is critical to the environmental and economic health of the coastal communities that all New Englanders treasure. By joining forces with our many public and private partners, as we have done for the Damde Meadows Salt Marsh Restoration Project, we can restore a significant part of our wetland heritage and maintain it for future generations."

Focus Study

Massachusetts Partnership in the National Coastal Assessment (COASTAL 2000) Project

The U.S. Environmental Protection Agency (EPA) has partnered with the Commonwealth of Massachusetts to conduct one of the most comprehensive assessments ever developed of the State's coastal sediments, waters, and living organisms. The nationwide EPA Coastal 2000 Monitoring effort (also known as the National Coastal Assessment or NCA) is a partnership of the Massachusetts Office of Coastal Zone Management (CZM), the Massachusetts Bays Program, and the University of Massachusetts to monitor and analyze samples collected in our nearshore coastal waters. The program was initiated as the Massachusetts Ecosystem Assessment Project (MEAP), whose primary objective is to collect and analyze sediment, waters, and fish tissue samples from selected stations to evaluate the health and conditions of Massachusetts' estuaries and coastal waters. During the 2000-2001 sampling season (July-September), samples of surface sediments from 91 stations were collected so scientists could analyze "contaminants of environmental concern," which include both inorganic (metals) and organic (PAHs, PCBs, and pesticides) contaminants. Water column samples were collected at each sediment site providing a "snapshot" of the water column's characteristics. Fish sampling was performed by the Massachusetts Division of Marine Fisheries (*MarineFisheries*) during its annual fall trawl surveys.

Sampling & Parameters:

Water column, sediment, and fish sampling were conducted as described in the Coastal 2000 Field Sampling Manual (EPA/620/R-00/002, April 2000) and in accordance with EPA's Coastal 2000 Quality Assurance Project Plan (or QAPP, August, 2000). These documents can be found at: (http://www.epa.gov/emap/nca/). Variables determined for each site included:

Station Variables

- Location (GPS)
- Depth
- Weather: Current conditions as well as those 3 days prior to sampling
- Tidal stage
- Submerged aquatic vegetation/macroalgae (presence or absence)
- Secchi depth (water clarity)

Water Quality

- Nutrients (NO_3+NO_2, NH_3, o-phosphate, and silicate)
- Total Suspended Solids (TSS)
- Chlorophyll *a*

Local environmental Parameters

- Conductivity
- Temperature
- Oxygen
- Chl *a* Fluorescence
- pH
- Light attenuation

Sediment Variables

- Grain size
- Organic carbon
- Inorganic and organic contaminants
- Toxicity
- Community structure (macrobenthos)

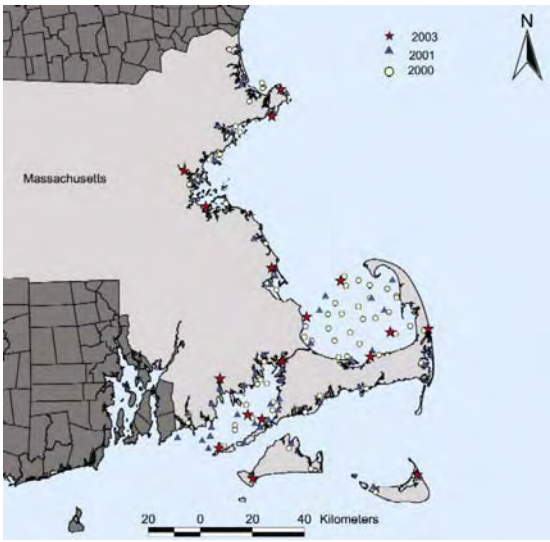


Figure FS-5: Sampling stations surveyed as part of the National Coastal Assessment Partnership (for Massachusetts, this partnership is called the Massachusetts Ecosystem Assessment Program) for the years 2000, 2001, and 2003. Note: Samples were collected in the Massachusetts portion of Mt. Hope Bay (upper Narragansett Bay) by the Rhode Island partners and are not shown here.

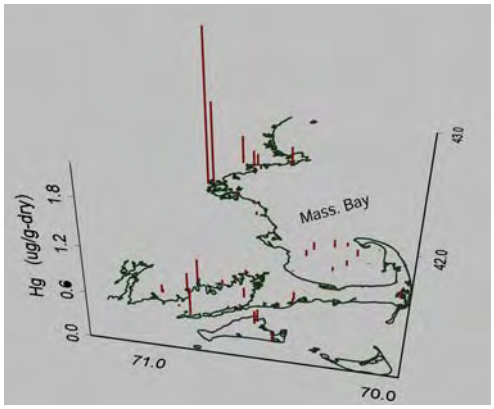


Figure FS-6: Spatial distribution of mercury (Hg) concentration in surface sediments from samples collected in Massachusetts near coastal waters during 2000 and 2001.

Statewide Distribution of Chemical Concentrations:

While the National Coastal Assessment Program is designed to describe the condition of estuaries at the **national** level, an increasing number of sampling stations covering an expanding portion of the U.S. coastline is providing researchers with the opportunity to conduct preliminary **state**-level analyses. Supplementing NCA data with similar types of samples (for instance samples of sea floor sediment taken in or around the time of NCA sampling) can strengthen the confidence in our analysis and allows scientists and managers to determine problem areas within the coastal zone. As an example, NCA data for mercury (Hg) in surface sediments is shown in Fig. FS-6. Mercury is a naturally occurring element. However, when it enters the water it transforms into a highly toxic form that can accumulate in fish that are consumed by humans, causing a health risk. In the Massachusetts Bays region, significantly high levels of Hg are observed from sediments taken from Gloucester, Salem, and Boston Harbor.

Next Steps:

Data collected for the NCA program is streaming in nationwide and is being managed by the EPA. The data from 2000 and 2001 has been checked for quality and, at the time of this writing, the EPA has drafted an ecological assessment for the Northeast region based on data collected from Delaware through Maine. State partners and the EPA are discussing the development of more state- and regional-level assessments using NCA data as well as other comparative data sets. For 2004 and 2005, sampling for the parameters described above will continue, with approximately 15 new stations in Massachusetts added each year. A total of 136 stations will be sampled in Massachusetts nearshore coastal waters between 2000-2005. Beginning in 2003, selected stations will be revisited every three years to provide coastal scientists with data that will improve their ability to monitor future changes in the condition of our coastal waters. The Massachusetts Bays Program will continue to serve as a state coordinator for the National Coastal Assessment and develop the Massachusetts annual monitoring plan for this rapidly expanding national program.

For additional information on this program, contact the Massachusetts Bays program, through e-mail: christian.krahforst@state.ma.us, or visit http://www.epa.gov/emap/nca/.

Project Fiscal Information

This project is funded, in part, by the U.S. Environmental Protection Agency through the National Coastal Assessment Program. Additional in-kind support is provided by the University of Massachusetts, Massachusetts Bays Program, and the Massachusetts Division of Marine Fisheries.

Focus Study

Seafloor Mapping of the Bays

Stretching nearly 30 miles under the surface of Massachusetts Bay, the recently constructed HubLine transports significant volumes of natural gas to electric generating facilities, industrial customers, and gas distribution markets in the northeastern United States. The 30-inch diameter pipeline, which required the excavation of a 35 mile-long trench, begins in Beverly on the North Shore of Massachusetts and travels to Weymouth on the South Shore.

The HubLine project, sponsored by Duke Energy and subsidiary Algonquin Gas Transmission Company, represents one segment of a pipeline that will stretch from the natural gas reserves of Sable Island, Canada, to the Gulf of Mexico. While the final project worked to address numerous concerns raised by federal and state agencies regarding impacts to coastal wetlands and navigation hazards, the long-term impacts to habitat in the Massachusetts Bays are not entirely clear. Monitoring the condition of the Bays' habitats in the vicinity of the pipeline will be crucial in the coming decade.

The Algonquin Gas Transmission Company and Maritime and Northeast Pipeline LLC provided funding to produce high-resolution seafloor geologic maps of three locations within Massachusetts Bays (Boston Harbor, the South Essex Ocean Sanctuary, and the Southern Merrimack embayment) as partial mitigation for the environmental impacts resulting from pipeline construction. The Massachusetts Office of Coastal Zone Management has entered into a Cooperative Funding Agreement with the U.S. Geological Survey Seafloor Mapping Group to produce these maps that will include bathymetry, shaded relief, and interpretations of the seafloor geology and habitat. The seafloor geology and habitat maps will be used to aid resource management planning and to review the impacts of development projects on the seafloor. The maps will also provide scientists with a framework for future research, such as studying the relationships between seafloor habitats and the organisms that use them. Once completed, the maps will complement existing seafloor maps of Stellwagen Bank and portions of Massachusetts Bay.

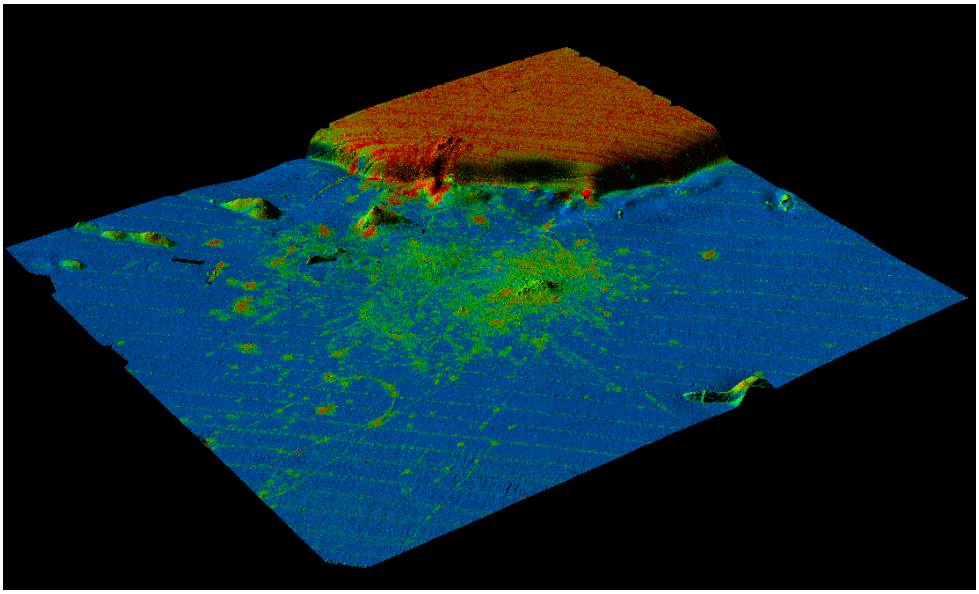


Figure FS-7: Through the seafloor mapping initiative, digital maps, like this one of the Massachusetts Bays Disposal Site, can be produced. Since the 1940s, the disposal site, located 17 nautical miles east of the entrance to Boston Harbor and adjacent to the Stellwagen Bank National Marine Sanctuary, has been used as a repository for dredged material, rock debris, sunken vessels, munitions, construction debris, and industrial and low-level radioactive waste. Green represents moderate backscatter deposits of dredged material. The green mound in the middle of the image is located at the present disposal point. Blue represents low backscatter mud of Stellwagen Basin, and orange represents high backscatter gravelly sand and cobbles and boulders of Stellwagen Bank. Red represents very high backscatter deposits of rock debris from the excavation of the Ted Williams Tunnel beneath Boston Harbor.

Focus Study

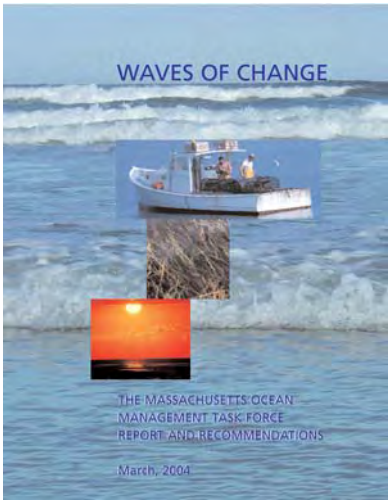
Massachusetts Ocean Management Initiative

Coastal and ocean waters have played a significant role in the history of Massachusetts, for fishing, shipbuilding, trade, recreation, and scientific research. Efforts to manage ocean resources are not new and began with the need to regulate fishing activities and designate shipping lanes. In the twentieth century, mooring fields, special use areas, and other types of ocean zoning became more common, as local, state, and federal government agencies sought to manage increasing fishing and navigational uses. Until recently, the relatively informal management of ocean resources responded to existing needs.

In recognition of the range of existing and proposed ocean uses in the Commonwealth and the many questions being raised on managing ocean resources and the uses of them, Governor Mitt Romney and Secretary of Environmental Affairs Ellen Roy Herzfelder announced an Ocean Management Initiative in March of 2003. A 23-member Ocean Management Task Force, representing both the private and public sectors, was appointed in June to examine the current trends and issues, identifying data and information gaps, reviewing existing ocean governance mechanisms, and drafting recommendations for administrative, regulatory, and statutory changes, if deemed necessary. State waters, which generally extend three miles offshore, are owned by the Commonwealth and are held in trust for its citizens.

In March of 2004, the Ocean Management Task Force released a Task Force Report and Recommendations, and a companion Technical Report. The Task Force Report describes the theme areas (e.g. governance, management tools, scientific understanding, and public outreach) that the Task Force has addressed, six Principles for ocean management, and sixteen Recommendations with justification and implementation plans.

The Task Force's recommendations were made available for public comment until April 2004, after which the Secretary of Environmental Affairs will submit her recommendations to the Governor. The work of the Task Force is on the leading edge of state ocean management as it tries to plan ahead for how the Commonwealth intends to use and protect its ocean resources.



Further Information:

The Ocean Management Task Force reports can be downloaded from the Massachusetts Office of Coastal Zone Management's website at: http://www.mass.gov/czm/oceanmgtinitiative.htm

Focus Study

Volunteers

Figure FS-8: Citizen volunteers monitoring a salt marsh

Volunteers have the ability to contribute significantly to the measurement of environmental conditions. For government agencies, watershed associations, and non-profit organizations, there are many advantages to tapping the pool of citizen volunteers, the most important of which, perhaps, is to educate citizens about environmental problems and to promote their personal sense of community responsibility. Citizens often have intimate knowledge about their local resources, and their knowledge can help identify potential environmental problems. Many environmental protection efforts require assessments, management, and planning at the local level, and the stronger citizens understand these issues, the better they can advocate for the solutions at all levels of government. For government agencies with increasingly limited resources, citizens with proper training can extend knowledge with environmental data.

The goals of citizen monitoring programs are generally to: 1) educate and promote environmental stewardship, 2) tap into local knowledge and interest for local problems, 3) advance scientific knowledge and management practices, and 4) support and enhance agency efforts. The biggest challenges in involving volunteers include recruiting dedicated individuals and providing them with adequate training, and supervising their efforts to ensure the quality of the information that they collect.

Citizen volunteers are active in all of the sub-regions of Massachusetts Bay. Salem Sound Coastwatch (SSCW), a non-profit group based in Salem and a local partner of the Massachusetts Bays Program, provides an excellent case study for the profound role that volunteers can contribute to coastal protection. SSCW was founded on the premise that volunteers could be trained and could contribute to important environmental initiatives. For more than a decade, SSCW has trained and worked with volunteers on a variety of projects and issues related to the protection of Salem Sound, the body of water surrounded by six communities on the North Shore of Massachusetts.

Figure FS-9: Volunteers learning to identify invasive species

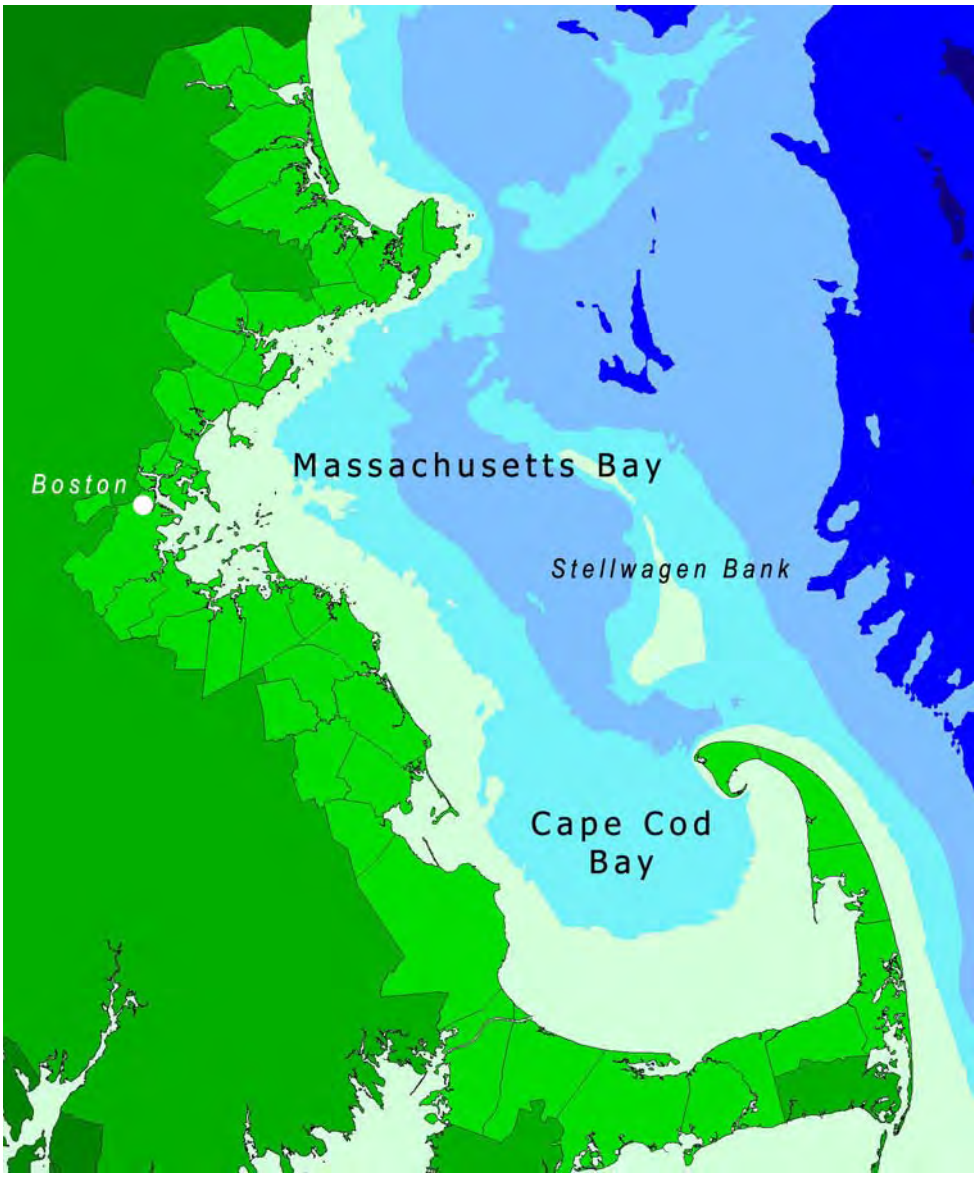
The first project undertaken by SSCW was a shoreline survey to document all pipes and other non-natural discharges into coastal waters. Citizens were trained in documentation techniques and then walked the shoreline to record all of the discharges and identify all potential pollution sources that could impact the water quality of Salem Sound, including its shellfish beds. Next, a series of samples was collected and analyzed for bacteria by a certified laboratory. This information was critical to the identification of impacts to shellfish beds and other resources. More recently, this program has evolved into the "Clean Beaches and Streams" program, where volunteers track and sample discharges onto swimming beaches in order to identify public health threats. Working with the local communities, SSCW has then helped to correct several unknown public health threats, such as previously unidentified leaking sewer pipes. SSCW's volunteers made a significant contribution, helping to fill the gap left by inadequate local resources for monitoring.

Figure FS-10: A young volunteer participates in a fish count

Another volunteer training program conducted by SSCW has been the Wetlands Health Assessment Toolbox (or WHAT project), developed by the Massachusetts Bays Program and the Massachusetts Office of Coastal Zone Management. WHAT has trained volunteers to collect biological and water quality data to document impacts to coastal wetlands from various human activities, including blockages to tidal flows and stormwater discharges. Remediation of these human activities occurred in several locations and volunteer-collected data contributed to documenting the success of these efforts. Such data provide critical assistance in illustrating the environmental benefits of restoration efforts. Restoration success often reveals itself only after several years, and long-term monitoring by government agencies is seldom affordable. Therefore, local citizens with a special interest in "their" wetlands are helping to fill this gap.

Most recently SSCW has embarked on a program to train volunteers to monitor tide pools. This effort aims to not only increase volunteer knowledge about the marine life that lives in these pools but also to train volunteers to spot newly arrived invasive species, one of the emerging scourges affecting our natural areas. Citizens are learning how the tide pools change through the seasons, as well as about impacts caused by non-native invasive species on our ecosystem. This particular citizen role has been critical in detecting the distribution of invasive species since citizen volunteers and school groups have often been first to document several new range expansions of these unwelcome species.

The Massachusetts Bays Program will continue to support Salem Sound Coastwatch, and all of our regional partners, in their efforts to train and involve citizens in volunteer efforts. We recognize the educational and scientific values of these efforts. For more information about volunteer efforts at Salem Sound Coastwatch, visit their web site at www.salemsound.org.


Boston
Massachusetts Bay
Stellwagen Bank
Cape Cod
Bay

FIVE THINGS YOU CAN DO TO SAVE THE BAYS

1) TAKE ACTION IN YOUR HOME. Reduce your use of chemicals, detergents, fertilizers, and pesticides—it will make a difference.

2) PROTECT THE COAST IN YOUR COMMUNITY. The MBP has representatives from every coastal community working to protect the coast. Contact the MBP to see how you can help.

3) PARTICIPATE IN THE ANNUAL COASTSWEEP CELEBRATION. COASTSWEEP is a great way to lend a hand, pick up some trash, and restore our coast. Watch the MBP Web site (www.massbays.org) and the Coastal Zone Management newsletter or web site (www.mass.gov/czm) for more information.

4) SUPPORT FUNDING AND PROTECTIVE LEGISLATION FOR THE MASSACHUSETTS BAYS. State and federal legislators need to hear from you, their constituents. For alerts on issues that need you support, contact the MBP or the Association of National Estuary Programs, a Washington, D.C.-based nonprofit organization that supports the 28 National Estuary Programs (202-354-6455, info@anep-usa.org).

5) ENJOY AND PROMOTE THE BAYS' RESOURCES. Whether you paddle, swim, hike, fish, or boat...whether the Bays provide you with recreation or your livelihood, communicate your interest in their protection to elected officials, educators, peers, and your children. Support your local watershed group. Volunteer your time to a local board. Speak up at Town Meeting. Write a letter to your local newspaper. Contact the MBP for more information.

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