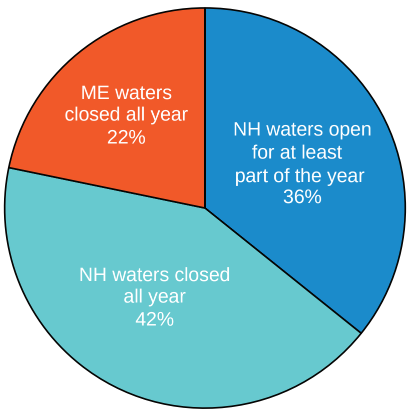
In 2011, the most recent year with data, 64% of the shellfish growing areas were closed to harvesting on a year-round basis.

FIGURE 9.1 Shellfish harvest classifications for Piscataqua Region estuaries, 2011



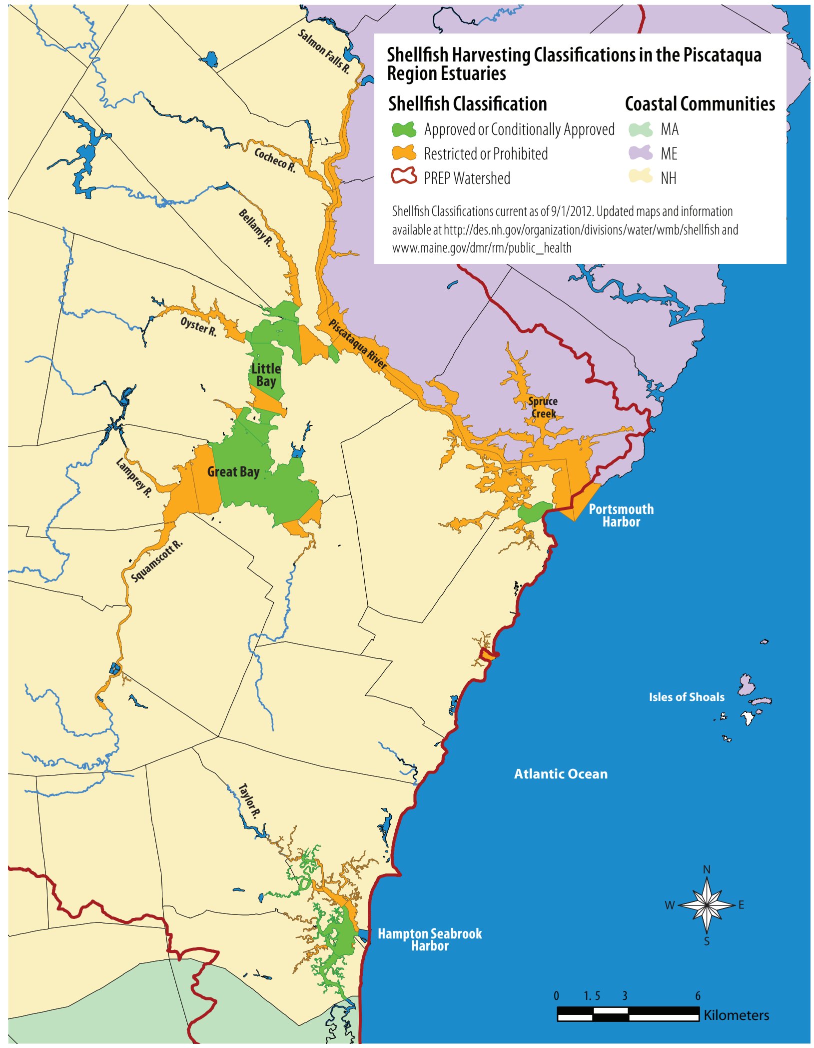
ME waters open for at least part of the year 0%

Data Source: NH Dept. of Environmental Services and Maine Dept. of Marine Resources

Success Story

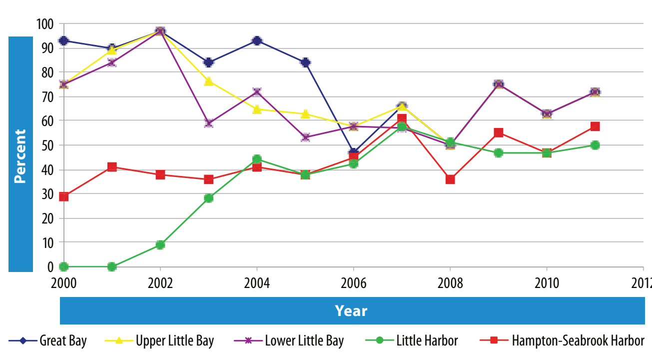
Will Carey of Little Bay Oyster Company Oysters are a model for the importance of a healthy ecosystem that in turn supports a healthy economy. Will Carey of The Little Bay Oyster Company grows oysters in his "underwater vineyard" off of Fox Point in Newington, NH. Enterprises like the Little Bay Oyster Co. represent an opportunity to reintroduce a natural resource as part of local business and stimulate the NH economy. Today Little Bay Oyster Company is now one of about six commercial growers and part of a growing movement of local economies based on a healthy ecosystem, valuable natural resources and clean water.

FIGURE 9.2 Shellfish Harvesting Classifications in the Piscataqua Region Estuaries



Data Source: NH Dept. of Environmental Services and Maine Dept. of Marine Resources

FIGURE 9.3 Shellfish harvesting opportunities in open areas as a percent of the maximum possible per year



Data Source: NH Dept. of Environmental Services

Beach Closures

How often are tidal bathing beaches closed due to bacteria pollution and how has it changed over time?

Hampton Beach on a crowded Summer day. Photo by C. Keeley

Poor water quality prompted advisories extremely rarely in 2011. There are no apparent trends.

EXPLANATION Tidal beaches in the Piscataqua Region are mostly located along the Atlantic coast, not in the estuaries (Figure 10.1). At these beaches, between 1 and 11 advisories have been issued per year between 2003 and 2011 (Figure 10.2). The advisories have resulted in very few beach closures as a percent of the total beach days in the summer. The greatest number of advisories occurred in 2009 (11 advisories affecting 6 beaches for a total of 23 days or 1.2% of the total beach-days for that summer). In 2011, there were four advisories affecting three beaches for a total of nine days (or 0.5% of total beach-days for that summer). Therefore, the PREP goal of having minimal (i.e., <1%) advisories at tidal beaches is currently being met. The beaches with the most advisories are the New Castle Town Beach (9), the North Hampton State Beach (7), and Fort Foster in Maine (5).

Jenness Beach, Rye, NH. Photo by J. Carroll

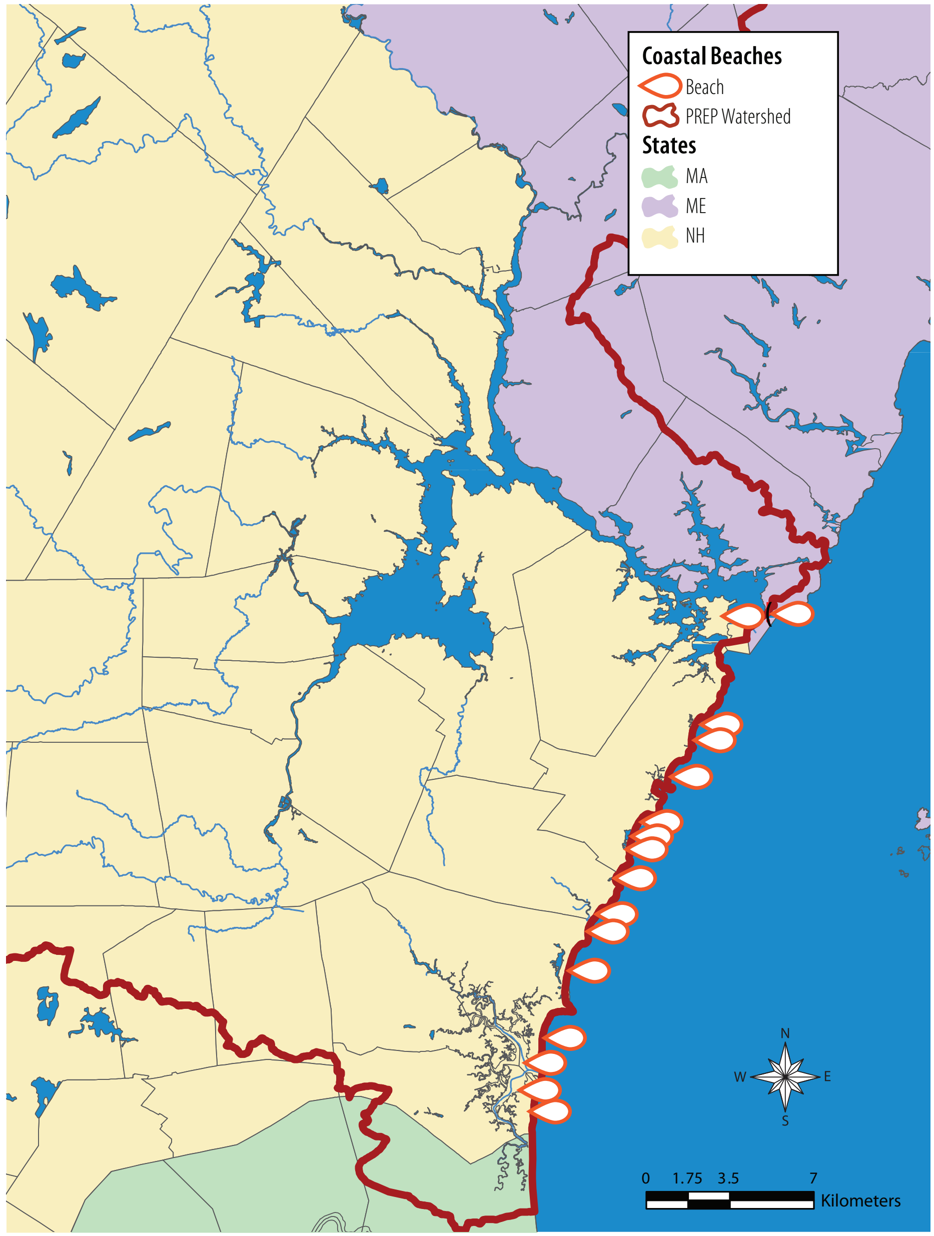
Why This Matters

If the concentrations of bacteria in the water at a beach do not meet state standards for swimming, the state agencies may recommend that an advisory be posted at the beach. Therefore, the number of postings at tidal beaches is a good indicator of bacteria pollution at important recreational areas. Recreational beach visitors supply tourist dollars for our region's economy giving local businesses like hotels, restaurants and beachfront shops a boost.

PREP GOAL **Less than 1% of summer beach days over the summer season affected by closures due to bacteria pollution.**

The beaches with the most advisories are the New Castle Town Beach, the North Hampton State Beach, and Fort Foster in Maine.

FIGURE 10.1 Coastal Beaches



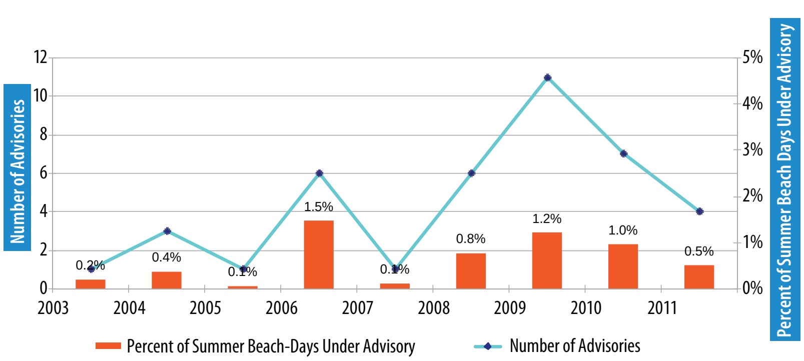
Data Source: NH Dept. of Environmental Services and Maine Dept. of Environmental Protection

Success Story

New Hampshire's 5 Star Beaches

The Natural Resource Defense Council publishes an annual guide to water quality for US beaches. Two of New Hampshire's beaches were once again rated as "5-Star," standing out from over 200 beaches rated from across the country. Hampton Beach State Park and Wallis Sands in Rye were recognized for exceptionally low violation rates and strong testing and safety practices.

FIGURE 10.2 Advisories at tidal beaches in the Piscataqua Region, 2003-2011



Data Source: NH Dept. of Environmental Services and Maine Dept. of Environmental Protection

Toxic Contaminants

How much toxic contamination is in shellfish tissue and how has it changed over time?

Wrack on the shore in New Castle, NH. Photo by D. Kellam

The vast majority of shellfish tissue samples do not contain toxic contaminant concentrations greater than FDA guidance values. The concentrations of contaminants are mostly declining or not changing.

EXPLANATION Shellfish collect toxic contaminants in their flesh when they feed by filtering water. The Gulf of Maine Council's Gulfwatch Program uses blue mussels (*Mytilus edulis*) for measuring the accumulation of toxic contaminants in their flesh. Between 1993 and 2011, 20 stations in the Great Bay Estuary and Hampton-Seabrook Harbor have been tested at least once for toxic contaminants in blue mussel tissue. The concentrations of toxic contaminants in mussel tissue have been less than U.S. Food and Drug Administration guidelines at all of the sites except for South Mill Pond in Portsmouth and shellfish harvesting is not permitted in this area. The acceptable levels of contaminants in these creatures suggest that the amount of toxic contaminants in estuarine waters are of minimal concern in most of the estuary.

Samples of mussel flesh from three locations (Portsmouth Harbor, Hampton-Seabrook Harbor, and Dover Point as shown in Figure 11.1) have been tested repeatedly between 1993 and 2011 to detect trends. The trends for toxic contaminants were decreasing (Figures 11.2, 11.3, 11.4) or remaining stable in these locations. These trends reflect that people are using less of the products containing these contaminants due to product bans and pollution prevention programs. While declining trends are a good sign, the amount of some toxic contaminants are still elevated. Research by Sunderland et. al. (2012) reported that the amount of mercury in the muddy bottom of the Piscataqua Region estuaries was similar to Boston Harbor and other estuaries located close to cities.

Frog photo by PREP

Why This Matters

Mussels, clams, and oysters accumulate toxic contaminants from polluted water in their flesh. In addition to being a public health risk, the contaminant level in shellfish flesh is a long-term indicator of how clean the water is in the estuaries. If toxic pollution does not appear in the flesh of the mussels, then the amount of toxic pollution in the water is likely very low.

PREP GOAL **Zero percent of sampling stations in the estuary to have mean shellfish tissue concentrations greater than FDA guidance values and no increasing trends for any contaminants.**

FIGURE 11.1 Gulfwatch Program Sampling Stations

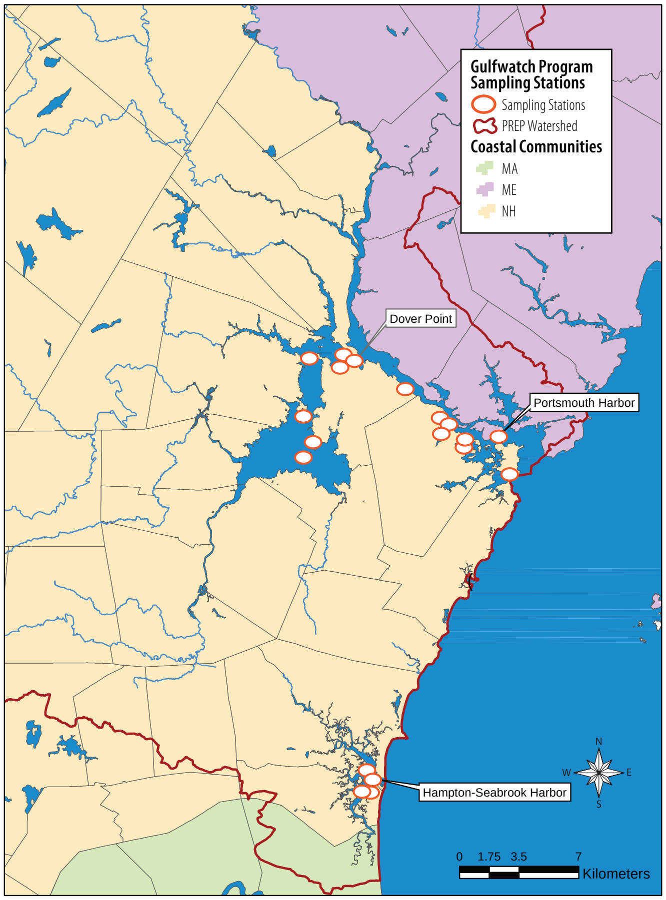
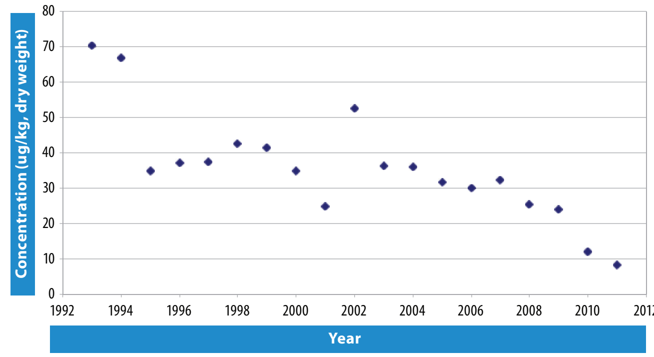
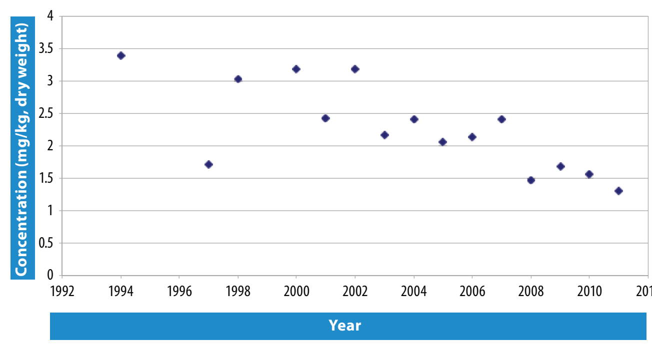


FIGURE 11.2 Total PCBs in Mussel Tissue in Portsmouth Harbor



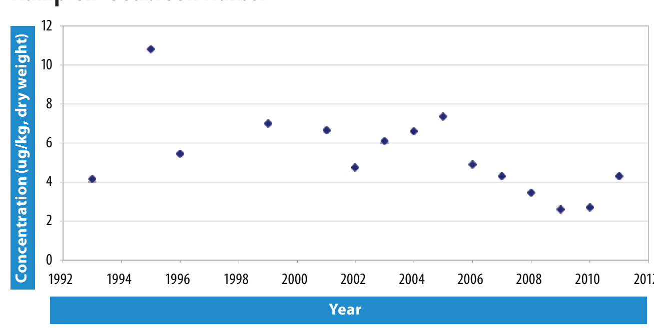
Data Source: NH Gulfwatch Program

FIGURE 11.3 Lead in Mussel Tissue at Dover Point



Data Source: NH Gulfwatch Program

FIGURE 11.4 Total DDT Pesticides in Mussel Tissue in Hampton-Seabrook Harbor



Data Source: NH Gulfwatch Program

Newt photo by NH Fish & Game

Digging Deeper

PCBs (Polychlorinated Biphenyls) belong to a broad family of man-made organic chemicals known as chlorinated hydrocarbons. PCBs were domestically manufactured from 1929 until their manufacture was banned by the US EPA in 1979. They were used in hundreds of industrial and commercial applications. Since being banned in 1979 the presence of PCBs in the environment has dramatically dropped.

In 1972 after the publication of Rachel Carson's *Silent Spring* the use of the pesticide DDT (dichloro-diphenyl-trichloroethane) was also banned. Although it is no longer used or produced in the United States, we continue to find DDT in our environment. Other parts of the world continue to use DDT in agricultural practices and in disease-control programs. Therefore, atmospheric deposition is the current source of new DDT contamination in soils, fish & shellfish.

PAHs are Polycyclic Aromatic Hydrocarbons. PAHs are created when products like coal, oil, gas, and garbage are burned but the burning process is not complete.

Source: US EPA

Oysters

How many oysters are in the Great Bay Estuary and how has it changed over time?

Oyster spat, or seed, set on an oyster shell. Photo by R. Grizzle

The number of adult oysters decreased from over 25 million in 1993 to 1.2 million in 2000. The population has increased slowly since 2000 to 2.2 million adult oysters in 2011 (22% of goal).

EXPLANATION The New Hampshire Fish and Game Department monitors the oyster populations in the six major reefs in the Great Bay Estuary (Figure 12.1).

Data from 1993 to 2011 show that the oysters in Great Bay have been declining considerably (Figure 12.2). There was a steep fall from over 25 million adult oysters in 1993 to 1.2 million in 2000. The major cause of this decline is thought to be the diseases MSX and Dermo which have caused similar declines in oysters in the Chesapeake and other mid-Atlantic estuaries. Since 2000, the number of adult oysters has grown slightly to 2.2 million. The 2011 number of adult oysters is approximately 22% of the PREP goal of 10 million adult oysters. Biologists hoped for a large increase in oysters when the 2006 oyster seed, called spat, reached maturity in 2009. A small amount of mature oysters (>60 mm) did appear in 2009 but they did not grow to the typical adult size (>80 mm). Overall, the average amount of adult and mature oysters in the major beds is 58% and 45% lower than 1997 levels, respectively.

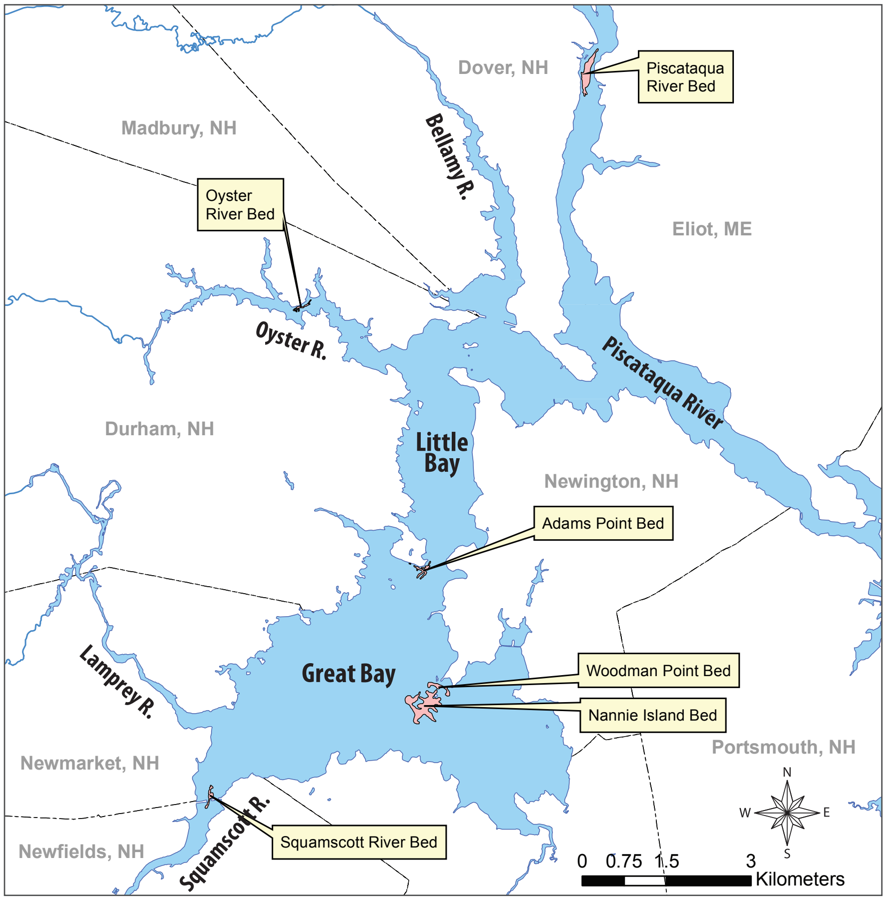
The New Hampshire Fish and Game Department has monitored the prevalence of the diseases MSX and Dermo in oysters from the Great Bay every year since 1995 (Figure 12.3). There has been no apparent trend in MSX infection rates since the disease was first detected. Approximately 21% of the oysters in Great Bay were infected with MSX at some level in 2011. However, starting in 2002, the prevalence of Dermo infections has increased from zero to greater than 90%. The increase in Dermo may be the result of warming water temperatures or adjustment of the parasite to local conditions. These two diseases, in combination with other factors, limit the survival of oysters into adult size. Recreational harvest of oysters has been declining for 30 years and is not thought to be affecting the size of the population.

Why This Matters

Oysters are filter feeders that take in the water around them, filter out some of the pollutants and sediment, and then release cleaner water. Harvesting and aquaculture farming of oysters provide economic benefits to local communities and businesses. Oyster shell reefs also create important habitat for other creatures in the estuary.

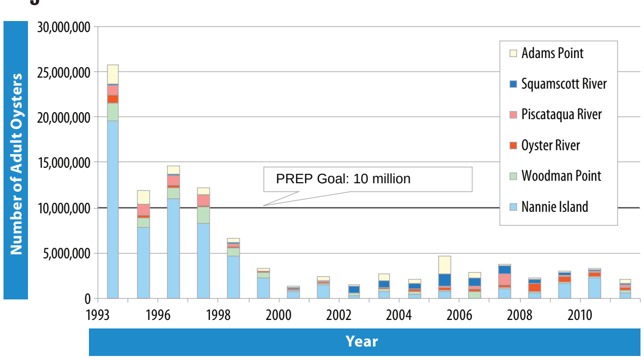
PREP GOAL **Increase the abundance of adult oysters at the six documented beds in the Great Bay Estuary to 10 million oysters by 2020.**

FIGURE 12.1 Major oyster beds in the Great Bay Estuary



Data Source: NH Dept. of Environmental Services

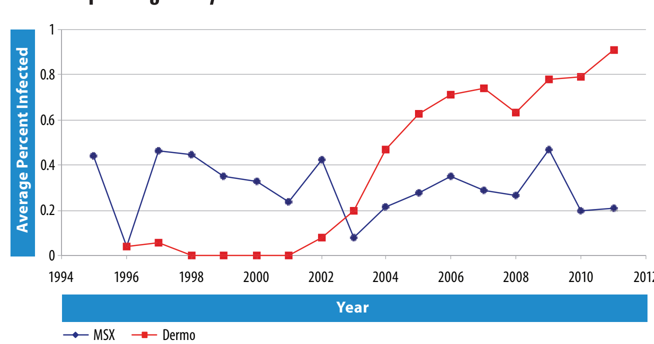
FIGURE 12.2 Number of adult oysters* in major Piscataqua Region beds



* Shell height greater than 80 mm

Data Source: NH Fish and Game Department

FIGURE 12.3 Average MSX and Dermo infection prevalence in Piscataqua Region oysters from all beds



Data Source: NH Fish and Game Department

Success Story

Oyster Conservationists Homeowners are helping Ray Konisky of the Nature Conservancy rebuild oyster reefs at the mouths of the tributary rivers of Great Bay. Through the Oyster Conservationist program, people with waterfront property can take care of baby oysters until they are ready to join the big oysters at the restoration sites around the Bay. In the 2011 season, 39 families helped grow oysters for restoration. More oyster parents are always needed, contact Kara McKeton (kmcketon@tnc.org) if you're ready to help raise baby oysters!

OYSTERS

Clams

How many clams are in Hampton-Seabrook Harbor and how has it changed over time?

Digging for clams in Hampton Harbor. Photo by PREP

The number of clams in Hampton-Seabrook Harbor is 43% of the recent historical average. Large spat or seed sets may indicate increasing populations in the future.

EXPLANATION The largest clam flats in the Piscataqua Region estuaries are in Hampton-Seabrook Harbor (Figure 13.1). The number of adult clams in these flats has been monitored by NextEra Energy/Seabrook Station over the past 41 years (Figure 13.2). The number of adult clams has undergone several cycles of growth and decline. Peak clam numbers of approximately 18 million and 27 million occurred in 1983 and 1997, respectively. Between the peaks, there have been crashes in 1978 and 1987, with the number of adult clams totalling less than 1 million. From 1997 to 2004, the number of adult clams dropped to 1.9 million. By 2006 the population had rebounded to 5.1 million (93% of the goal). However, in the last five years, the population has declined to 2.4 million (43% of the goal).

"Clam spatfall" refers to the event when clam larvae fall out of the water and settle onto the muddy bottom. It is critical to have good spatfalls on a clam flat in order to recruit new clams which can then grow into adults. Figure 13.3 illustrates that clam spatfall in recent years has been higher than historical averages, which may mean more adult clams in the future.

Father and daughter clamming. Photo by PREP

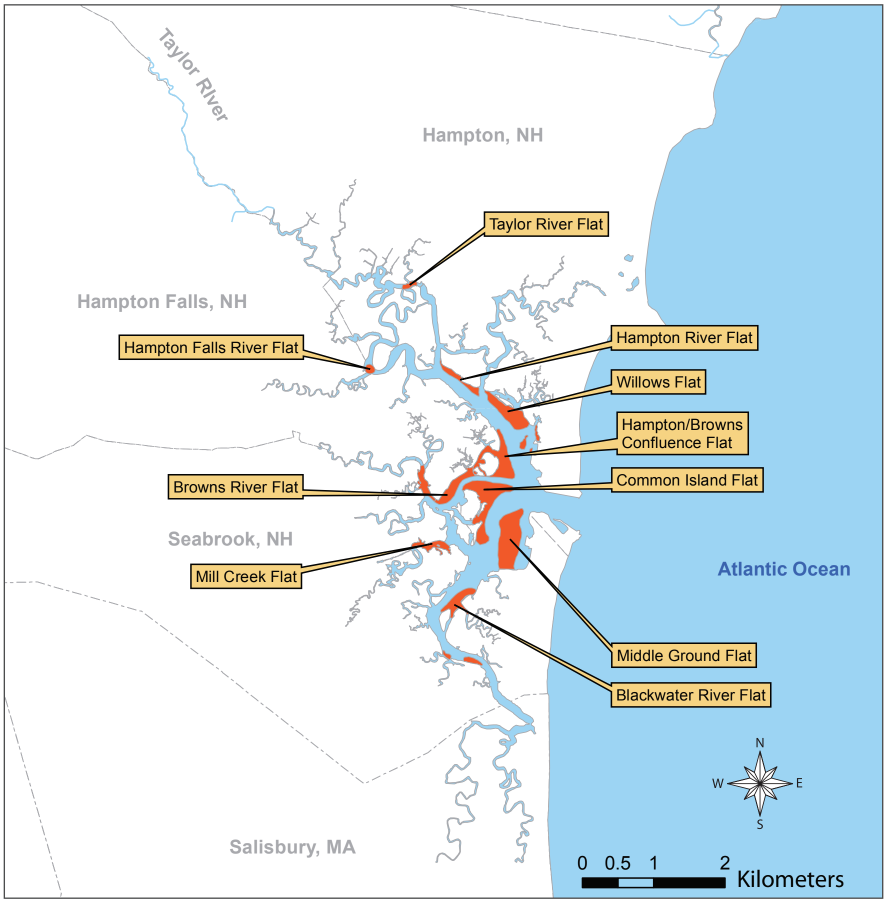
Why This Matters

Soft shell clams are an important economic, recreational, cultural, and natural resource for the Seacoast region. Recreational shellfishing in Hampton-Seabrook Harbor is estimated to contribute more than $3 million a year to the New Hampshire economy.

PREP GOAL **Increase the number of adult clams in the Hampton-Seabrook Estuary to 5.5 million clams by 2020.**

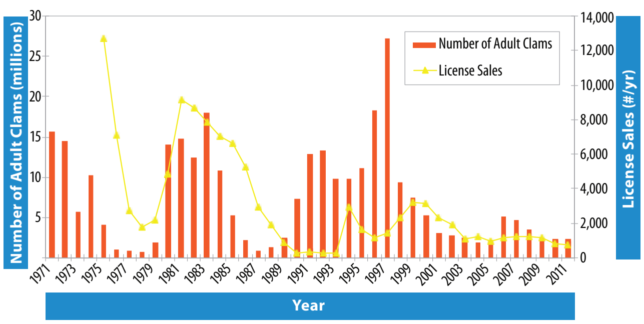
In the last five years, the population of clams has declined to 2.4 million (43% of the goal).

FIGURE 13.1 Major clam flats in the Hampton-Seabrook Estuary



Data Source: NH Dept. of Environmental Services

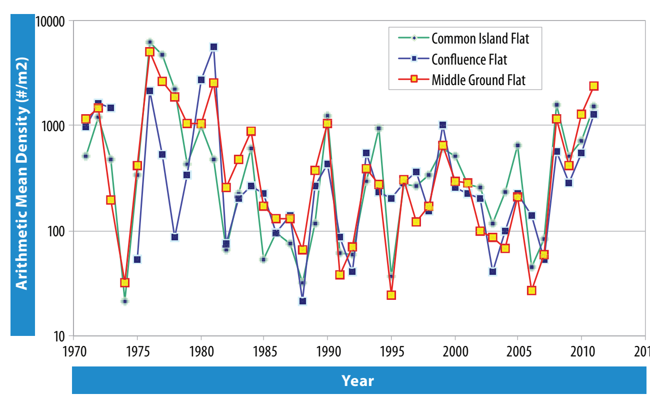
FIGURE 13.2 Number of adult clams* in Hampton-Seabrook Harbor and recreational clam harvest license sales



*Shell length greater than 50 mm

Data Source: NextEra Energy Seabrook Station and NH Fish and Game Department

FIGURE 13.3 Average clam spat* density in Hampton-Seabrook Harbor



*Young clams with shell length between 1-25mm

Data Source: NextEra Energy Seabrook Station

Success Story

The New Hampshire Shellfish Program

The New Hampshire Department of Environmental Services (NHDES) Shellfish Program ensures that shellfish harvested from the state's tidal waters are safe to eat. In order to provide this service, the program regularly monitors bacteria levels in seawater from over 75 locations in New Hampshire's tidal waters and evaluates weekly samples of mussels to ensure that shellfish are not contaminated with Paralytic Shellfish Poison (PSP) toxin from "red tide" events.

Migratory Fish

How have migratory fish returns to the Piscataqua Region changed over time?

Fish ladder on the Lamprey River, Newmarket, NH. Photo by PREP

Migratory river herring returns to the Great Bay Estuary generally increased during the 1970-1992 period, remained relatively stable in 1993-2004, and then decreased in recent years.

EXPLANATION Major rivers of the Piscataqua Region historically had very large populations of migratory fish including Atlantic salmon, river herring, American shad, and American eels. Today, only river herring and American eels still return regularly in substantial numbers to the rivers and are the focus of current migratory fish restoration efforts.

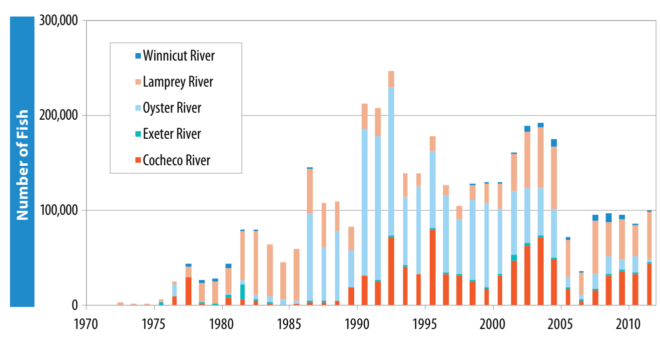
River herring returns to the major rivers of the Great Bay Estuary have been combined in Figure 14.1. This figure illustrates that river herring returns to the Great Bay estuary generally increased during the 1970-1992 period, remained relatively stable 1993-2004, then decreased in recent years. This decline is likely due to a combination of losses while the herring are in the sea-going portions of their lifecycle, limited freshwater habitat quantity/quality, difficulty getting up fish ladders that are installed over dams, safe downstream passage over dams, possible over-fishing in some river systems, water pollution, and flood events during upstream migrations. The Taylor River, in Hampton-Seabrook Harbor, has had the highest recorded returns of herring (Figure 14.2). However, this population has declined dramatically. The decline is most likely due to poor water quality in the Taylor River reservoir upstream of the dam.

Why This Matters

River herring are migratory fish, which means they travel from the ocean upstream to freshwater streams, marshes, and ponds to reproduce. Herring are eaten by other species and therefore sustain important commercial and recreational fisheries and other wildlife.

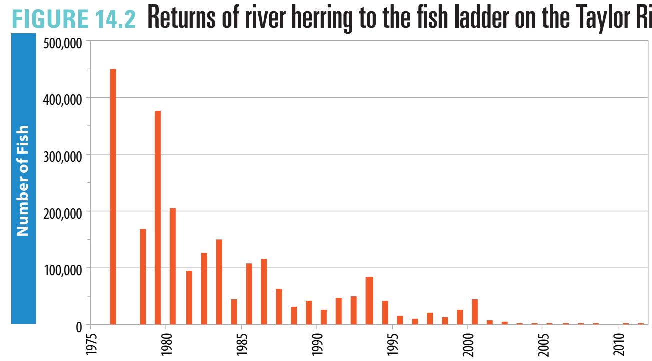
PREP GOAL No goal.

FIGURE 14.1 Returns of river herring to fish ladders in the Great Bay Estuary



Data Source: NH Fish and Game Department

FIGURE 14.2 Returns of river herring to the fish ladder on the Taylor River



Data Source: NH Fish and Game Department

Salt Marsh Restoration

How much salt marsh restoration has been done?

Pickering Brook, Greenland, NH. Photo by D. Kellam

280.5 acres of salt marsh have been restored since 2000 and 30.6 acres of salt marsh have been enhanced since 2009, which is moderate overall progress towards PREP's goals.

EXPLANATION Salt marshes are coastal wetlands connected to the ebb and flow of the tides. Salt marshes serve as a critical base of the food web in the estuary, provide essential breeding, feeding, and rearing places for birds, fish, and other wildlife, filter pollutants, and protect our communities from coastal flooding. Historically, many salt marshes were filled for development, blocked off from the tides for hay fields, or impacted with ditches to try to drain them. Restoration of salt marshes involves undoing these past harmful alterations, while enhancement usually involves removing invasive plants and re-establishing native plant communities.

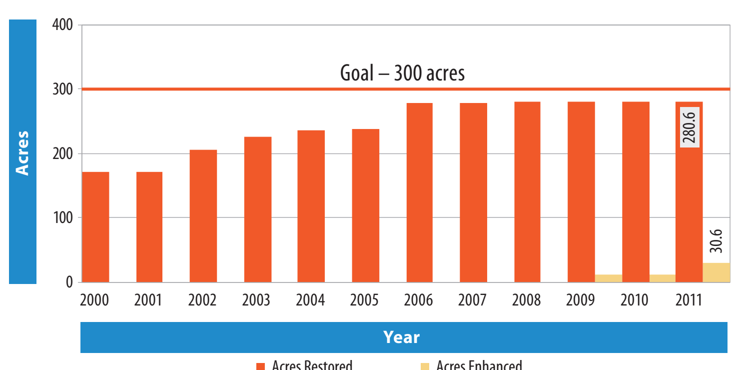
PREP has two complementary goals for salt marsh restoration: to restore 300 acres of salt marsh and to enhance an additional 300 acres of salt marsh by 2020. Tracking of enhancement acres is a new indicator and began in 2009. There has been significant progress toward the goal of restoring 300 acres of salt marsh (Figure 15.1), with 280.5 acres restored (93% of goal).

Limited progress has been made toward the goal of enhancing 300 acres of salt marsh. There has been 30.6 acres of marsh enhancement work completed since 2009, representing 10% of the goal.

Why This Matters

Salt marshes are among the most productive ecosystems in the world.[18] In the past few centuries, many of the salt marshes in the Piscataqua Region watershed have been degraded or lost over time. Restoration efforts attempt to restore the function of these critical habitats.

FIGURE 15.1 **Cumulative acres of salt marsh restoration and enhancement projects, 2000-2011**



PREP GOAL **Restore 300 acres of salt marsh and enhance an additional 300 acres of salt marsh by 2020.**

Conservation Land (General)

How much of the Piscataqua Region is permanently conserved in its natural state?

Evans Mountain Overlooking Bow Lake, Strafford, NH. Photo by D. Sperduto

At the end of 2011, 88,747 acres in the Piscataqua Region watershed were conserved which amounted to 13.5% of the land area. At this pace, the goal of conserving 20% of the watershed by 2020 is likely to be reached.

EXPLANATION By the end of 2011 there were 88,747 acres of conserved, protected land in the watershed (Figure 16.1). This amount is equivalent to 13.5% of the land area, which is below the PREP goal of 20% by 2020. Eighty-six percent of the conservation lands have permanent protection status. The remaining lands are "unofficial" conservation lands, water supply lands, or recreational parks and fields. The rate of growth of conservation lands in the Piscataqua Region Watershed has been approximately 7,000 acres per year. If this pace is maintained, the PREP goal to conserve 20% of the entire Piscataqua Region watershed by 2020 will be achieved.

The percentage of land area that is protected in each town is shown in Figure 16.2. This map illustrates that significant progress has been made in the towns around Great Bay, near the coast, in the vicinity of the Bear Brook and Pawtuckaway State Parks, and in the Mt. Agamenticus to the Sea area. In contrast, there is a lower percentage of protected land in the Salmon Falls River and Cocheco River watershed areas.

Photo by C. Keeley

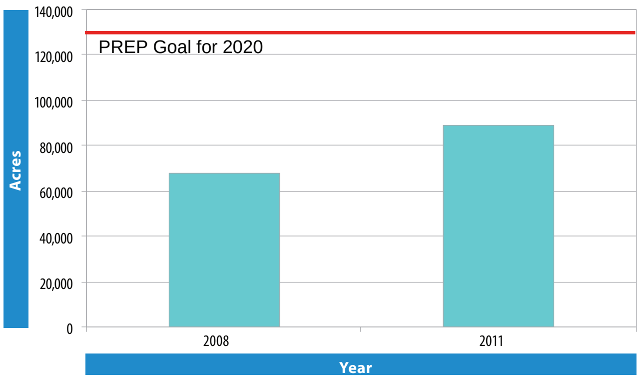
Why This Matters

Our region is under pressure from rapid population growth and land development. Conserving a network of undeveloped natural lands in our region is critical in order to maintain clean water, support healthy wildlife populations, minimize flood damages, and provide quality recreational opportunities.

PREP GOAL Conserve 20% of the watershed by 2020.

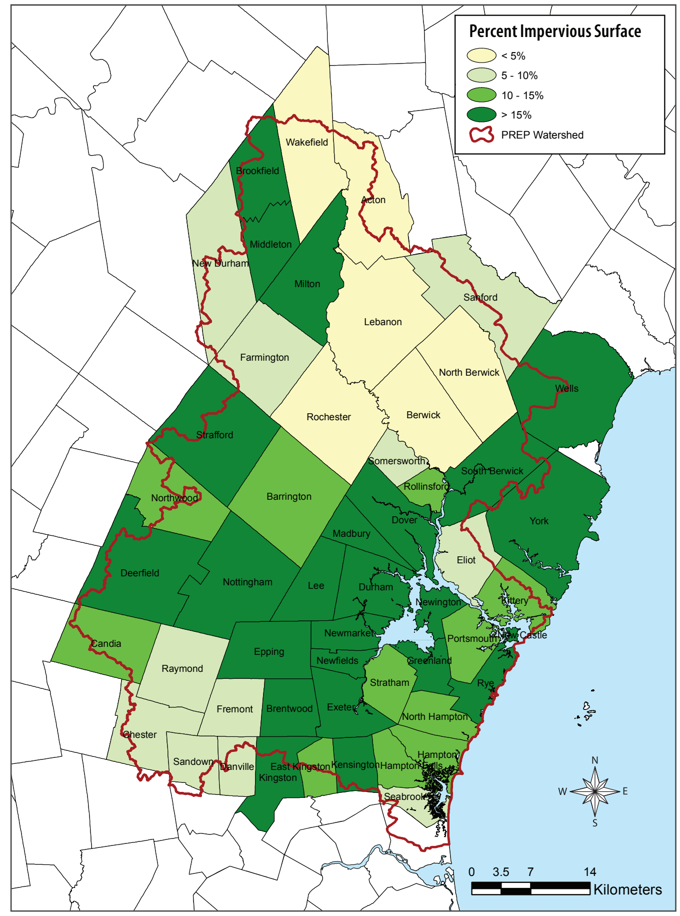
By the end of 2011 there were 88,747 acres conserved that is 13.5% of the land area of the Piscataqua Region.

FIGURE 16.1 Conservation lands in the Piscataqua Region watershed



Data Source NH GRANIT & Wells National Estuarine Research Reserve

FIGURE 16.2 Percent Conservation Lands

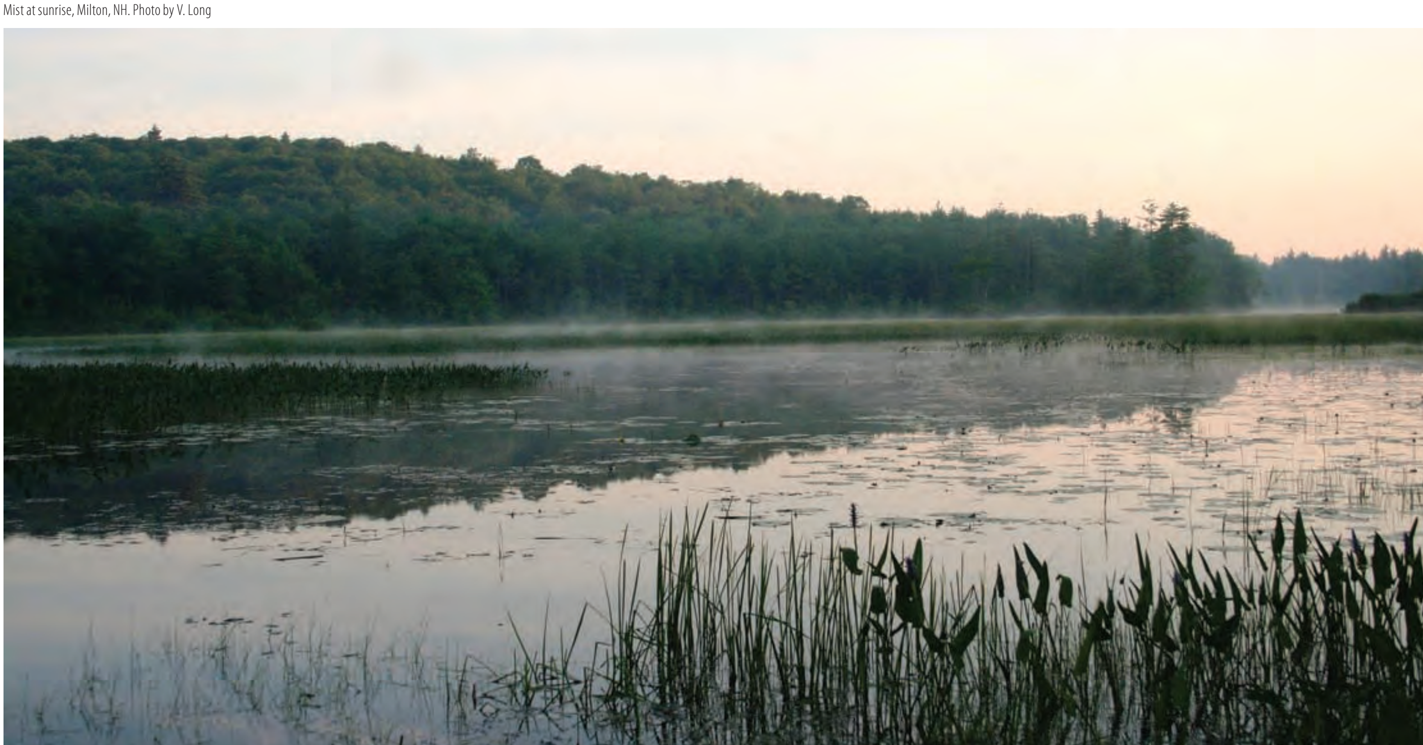


Data Source NH GRANIT & Wells National Estuarine Research Reserve

Success Story

Protecting A Mountain Where A Coastal River Begins In 2011, the local land trust Bear-Paw Regional Greenways permanently protected 1,015 acres on Evans Mountain, an area in the Town of Strafford from which the Isinglass and Cocheco Rivers begin their journey to the Great Bay Estuary. This project conserves clean streams, highest quality wildlife habitats, and large forestlands perfect for outdoor recreation and educational opportunities such as hiking, hunting, and snowmobiling.

Mist at sunrise, Milton, NH. Photo by V. Long



Conservation Land (Priority)

How much of the top priority areas in the Piscataqua Region are permanently conserved in their natural state?

Spruce Swamp, a Conservation Focus Area in Fremont, NH. From the Fremont Prime Wetland Designation Study by West Environmental

In 2011, 28% of the core priority areas in New Hampshire and Maine were conserved. At this pace, the goal of conserving 75% of these lands by 2025 is unlikely to be reached.

EXPLANATION *The Land Conservation Plan for New Hampshire's Coastal Watersheds* and *The Land Conservation Plan For Maine's Piscataqua Region Watershed*s are two key science-based regional conservation plans that identified 90 Conservation Focus Areas in the Piscataqua Region watershed. These areas represent the highest priority lands to conserve in order to protect clean water and highest quality wildlife habitat. PREP has established a goal of permanently protecting 75% of the lands in these focus areas by 2025. Of the 88,747 acres of existing conservation lands, more than half (45,869 acres) fall within the high-priority conservation focus areas. Overall, 28% of the focus areas have been conserved. This statistic demonstrates that the conservation focus areas have been a priority for land protection efforts but that the majority of these areas are still unprotected.

In recent years, less than one-in-five of the new conservation lands have been in high priority focus areas. The goal to conserve 75% of the focus areas will not be met unless the pace of conservation in these special areas increases.

Why This Matters

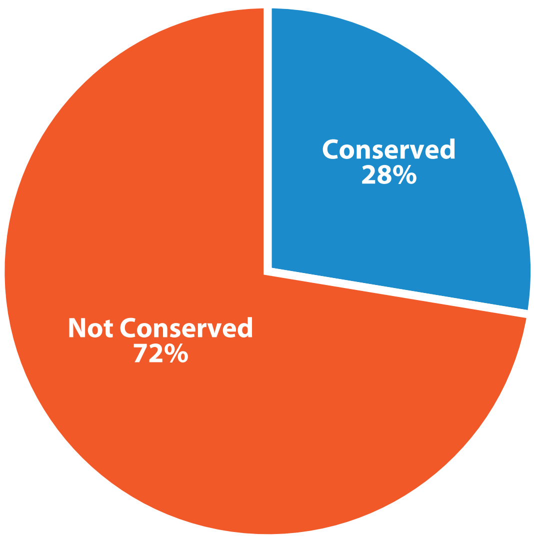
Our region still contains exceptional unfragmented natural areas that support critical wildlife populations and maintain high water quality. There is a small window of time to protect these areas in order to ensure these benefits remain for future generations.

PREP GOAL **Conserve 75% of lands identified as Conservation Focus Areas by 2025.**

Goose in Marsh. Photo by C. Keeley

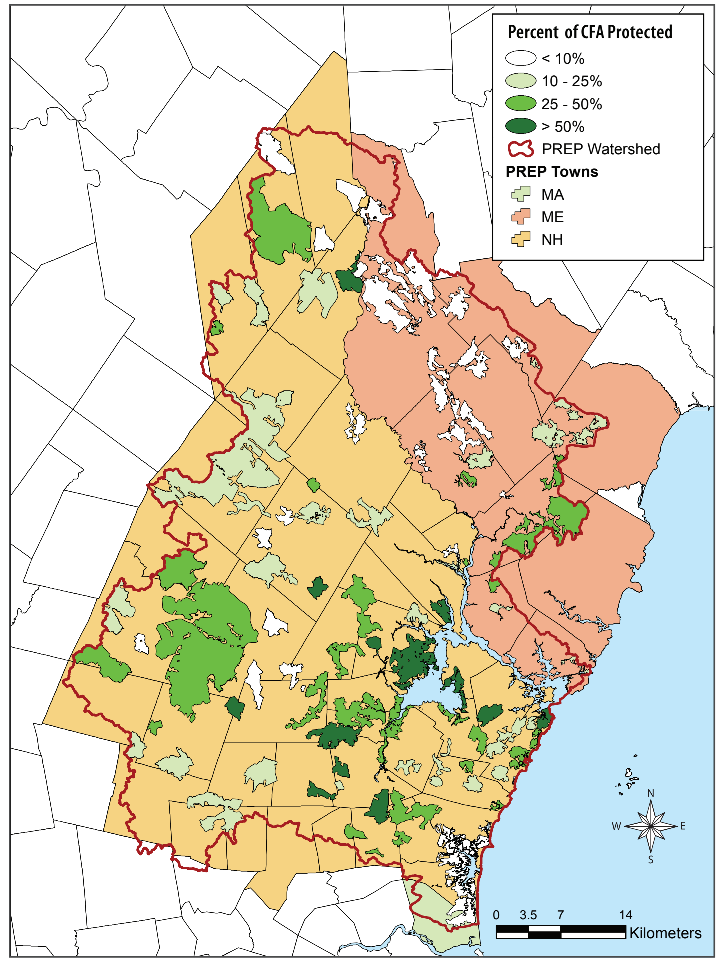
Of the 88,747 acres of existing conservation lands, more than half (45,869 acres) fall within the high-priority conservation focus areas.

FIGURE 17.1 Percent of core priority areas in the Piscataqua Region that are conserved in their natural state



Data Source: NH GRANIT and Wells National Estuarine Research Reserve

FIGURE 17.2 Percent of each Core Priority Area in the Piscataqua Region that is conserved in its natural state



NH GRANIT & Wells National Estuarine Research Reserve

Isinglass River, Strafford, NH. Photo by D. Sowers

Success Story

Conserving Top Priority Conservation Land and Building a Town Forest The Town of Fremont, NH is working to add 76 more precious acres to their existing 313 acre Glen Oakes Town Forest while permanently protecting the Spruce Swamp Conservation Focus Area. This area contains highest quality wildlife habitat in the state and exceptional trails for public access. Protection of this special natural area will ensure that the wetlands there continue to provide clean water to both the Lamprey and Exeter Rivers that flow to the Great Bay Estuary.

Oyster Restoration

How much oyster restoration has been done?

Imported clam shell is deposited to settle on the bottom and make a reef for new oysters to grow on at the mouth of the Oyster River. Photo by D. Kellam

A total of 12.3 acres of oyster beds have been created in the Great Bay Estuary, which is 61% of the goal. Mortality due to oyster diseases is a major impediment to oyster restoration.

EXPLANATION Nine oyster restoration projects have been completed in the Piscataqua Region watershed since January 1, 2000. As a result of these projects, a total of 12.3 acres of oyster bed has been restored, representing 61% of the goal of 20 acres (Figure 18.1). Restoration projects start by the setting of disease-resistant oyster seed called spat then planting the settled spat to an artificial reef on the estuary floor. High mortality was reported for some of the restoration sites. However, the restoration work still created an oyster reef structure by installing cultch or other materials on which spat could settle. Additional information about oyster restoration in New Hampshire is available from www.oyster.unh.edu. A major impediment to oyster restoration efforts in the Great Bay Estuary is the ongoing oyster mortality due to MSX and Dermo infections in native oysters. Inconsistent year spatfall is another limiting factor.

This indicator tracks restoration effort in terms of acres for which restoration was attempted. The area of successful, functioning habitat created by restoration projects may be lower.

Why This Matters

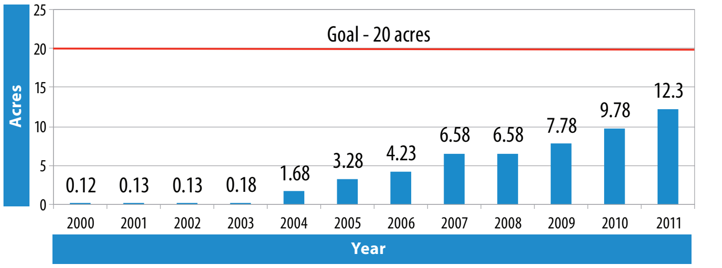
Oysters grow in concentrated groups, called beds, in areas with hard bottom. Historic data has documented that the amount and size of oyster beds in the Piscataqua Region watershed have been decreasing or lost over time. Restoration efforts attempt to restore the abundance and function of these critical habitats.

PREP GOAL **Restore 20 acres of oyster reef habitat by 2020.**

Success Story

Oyster Shell Recycling The Coastal Conservation Association of NH works with eight area restaurants to help restore oysters to Great Bay. Weekly, CCA volunteers pickup discarded oyster shells after they've been happily slurped by customers. Shells are then recycled back to the bottom of Great Bay to give growing oyster spat or seed a place to grow at restoration sites.

FIGURE 18.1 Cumulative acres of oyster restoration projects, 2000-2011



Eelgrass Restoration

How much eelgrass restoration has been done?

Measuring eelgrass height at a restoration site in Great Bay. Photo by J. Carroll

A total of 8.5 acres of eelgrass beds have been restored which is only 17% of the goal. Poor water quality is often the limiting factor for eelgrass transplant survival.

EXPLANATION Several eelgrass planting projects have been completed since January 1, 2000. A small, community-based project was attempted in North Mill Pond in 2000. Eelgrass was transplanted in over twenty wooden planting frames. The total area covered by the project was 0.5 acres. None of the transplants survived due to the water not being clean enough. In 2001, an eelgrass replacement project for the US Army Corps of Engineers was completed in Little Harbor. Eelgrass was transplanted and covered 5.5 acres. The restoration was monitored for one year following the transplant and found to be successful. However, because the purpose of this project was to replace eelgrass beds that were destroyed, it was not counted toward the PREP goal. In 2005, eelgrass was transplanted to locations in the Bellamy River (1 ac.) and Portsmouth Harbor (0.25 ac.). In 2006-2008, a total of 6.8 acres of eelgrass was restored in the Bellamy River. The project was funded by the Natural Resource Conservation Service. Therefore, since 2000, 8.5 acres of eelgrass restoration projects have been completed (16% of the goal) (Figure 19.1). Prior to 2005, no state or federal money was available for eelgrass restoration.

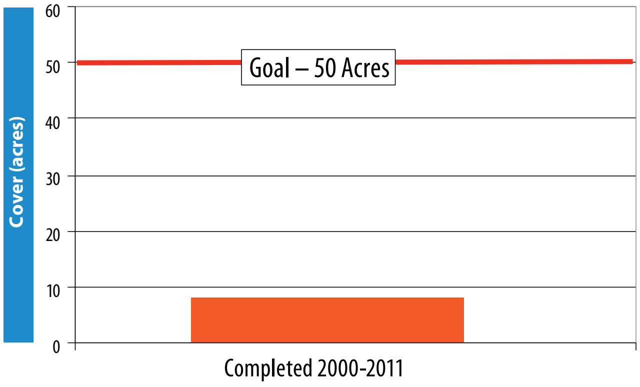
This indicator tracks restoration effort in terms of acres for which restoration was attempted. The area of successful, functioning habitat created by restoration projects may be lower.

Why This Matters

Eelgrass grows in meadows on the floor of the estuary and provides important habitat for young fish, lobsters and mussels. Historic data suggests that eelgrass meadows in the Piscataqua Region watershed have been thinning or lost over time. Restoration efforts attempt to restore the coverage and function of this critical habitat.

PREP GOAL **Restore 50 acres of eelgrass habitat by 2020.**

FIGURE 19.1 **Cumulative acres of eelgrass restoration 2000-2011**



Migratory Fish Restoration

How much river restoration for migratory fish has been done?

Alewife photo by: B. Gratwicke www.dcnature.com

River herring access has been restored to 42% of their historical distribution within the mainstems of the major rivers in the Piscataqua Region. This represents substantial progress in meeting PREP's goal of restoring 50% of the historical distribution of river herring by 2020.

EXPLANATION Major efforts are underway to restore river herring access to their historical freshwater streams and ponds in order to support recovery of their populations. Figure 20.1 shows the miles of freshwater in the main branch of each major river that was historically accessible to herring, and how many miles of that habitat are currently accessible. There is 100% access to main-stem sections of the Winnicut, Exeter, and Cocheco Rivers but less than 30% access in all other rivers. Overall, river herring access has been restored to 42% of their historical distribution within the main stems of the region's major rivers (Figure 20.2). This represents substantial progress in meeting PREP's goal of restoring 50% of the historical distribution of river herring by 2020.

Winnicut River Fish Passage, Greenland, NH. Photo by: C. Lentz.

Why This Matters

Dams and road crossings of streams often block migratory fish from swimming upstream to reproduce and safely downstream to grow in the estuary and ocean, limiting their populations.

PREP GOAL **Restore native diadromous fish access to 50 percent of their historical mainstem river distribution range by 2020.**

There is 100% access to main-stem sections of the Winnicut, Exeter, and Cocheco Rivers but less than 30% access in all other rivers.

FIGURE 20.1 Mainstem stream miles accessible to river herring in major rivers of the Piscataqua Region

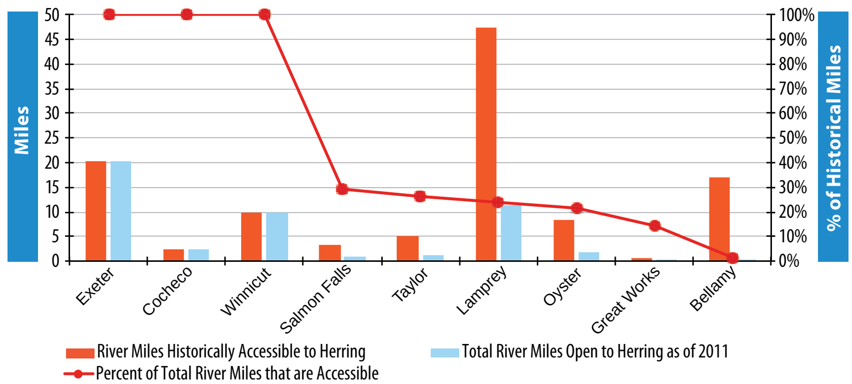
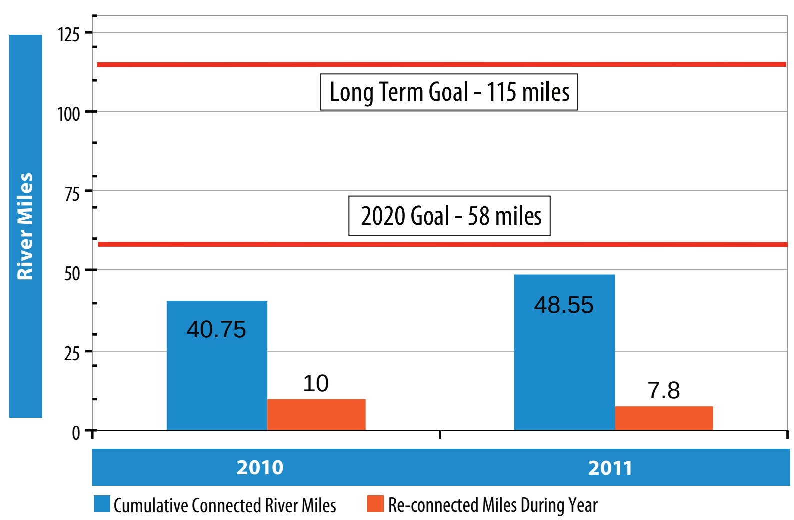


FIGURE 20.2 Upstream river miles re-connected for migratory herring on the mainstems of major rivers



Newly installed Wiswall Fish Ladder on the Lamprey River, Durham, NH. Photo by D. Cedarholm

Success Story

Returning Fish after 200 Years

Thanks to leadership from the Town of Durham, the USDA Natural Resource Conservation Service, and the New Hampshire Fish and Game Department, migratory fish from the Great Bay Estuary are now swimming upstream to habitat in the Lamprey River that they have been blocked from reaching for over 200 years. Access to at least 7.8 miles of the Lamprey River was restored by constructing a fish passage ladder over the Wiswall Dam in Durham, with initial estimates of 14,000-26,000 fish getting past the ladder in the first year.

EMERGING ISSUES & CHANGING CONDITIONS

Autumn Marsh. Photo by C. Keeley

Estuaries are complex and responsive to factors both within, and outside of, our control. By definition, an environmental indicators report is not intended to determine cause and effect. The causes of some environmental changes can be numerous, and directed research is sometimes required to better understand how the estuaries respond to stresses like pollution and losses of key habitats.

This report provides a summary of results from an extensive suite of environmental monitoring data collected and analyzed by PREP and its partner organizations. However, PREP also recognizes that there are emerging issues not fully described in this report or reflected in our current indicators that are likely to impose additional challenges to the health of our estuaries. This section of the report acknowledges some of these pressing emerging issues that are likely to need more research, monitoring, and analysis attention in the near future.

Weather and Climate

The most influential emerging issue is the fact that New England's climate is changing, and the best available scientific information indicates that climate change impacts such as sea level rise, temperature increases, and more frequent severe storm events are highly likely to continue to increase throughout the next century. These major changes to climate and weather events will substantially affect water quality, wildlife habitat, and human communities in unprecedented ways. One of the implications is that more erratic and extreme weather is to be expected and that assessing the health of our estuaries based on assumptions of historical weather and climate patterns can be misleading. Climate change impacts are likely to contribute additional stress to coastal habitats that we are working to conserve and restore. For instance, increased rainfall can transport additional contaminants such as sediments and nutrients into our estuaries. Climate change is also likely to substantially change the temperature, saltiness, and acidity in our estuaries and thereby modify many of the natural chemical and biological processes in the bays. Exactly how these changes will affect coastal habitats, shellfish, water quality, and human health is uncertain – but it is certain that they will have an important influence over the future State of Our Estuaries. To learn more about these issues refer to the 2011 report "Climate Change in the Piscataqua/Great Bay Region: Past, Present, and Future" (www.carbonsolutionsne.org).

Macroalgae

Recent major research efforts have been completed to inventory the types of macroalgae present in the Great Bay estuary, assess their abundance, and map their coverage in the bay. These efforts have led to recognition that a substantial increase in the abundance of nuisance macroalgae is an emerging problem for the bay and that increased monitoring and research effort is needed to better understand this issue.

Aquaculture

There is substantial interest in the region about the potential to responsibly develop shellfish and algae aquaculture within or adjacent to our estuaries as a way to help remove excess nutrients from the water column while also producing valuable commodities. The environmental, social, and economic costs and benefits of aquaculture scenarios is a topic of current and ongoing research interest.

Pharmaceuticals and Personal Care Products

Thousands of chemicals from pharmaceuticals and personal care products used by humans (such as prescription drugs and cosmetics) end up in sewage waste, are insufficiently removed by conventional treatment systems, and inevitably enter our nation's waterways. These chemicals have been documented in many waterways that have been studied, and some research suggests that certain chemicals may cause ecological harm. Potential negative impacts on our region's waterways are largely unknown at this time.

Did You Know

The US Drug Enforcement Administration has hosted five successful National Drug Take-Back Days over the last two years. The most recent event in September 2012 resulted in 244 tons of prescription medication being safely disposed. Citizens are able to return unused or expired prescription drugs to their local police station or other location to be sure they are disposed of properly keeping them out of our environment.

Visit www.deadiversion.usdoj.gov/drug_disposal/takeback to find out when the next take-back day is scheduled.

LOOKING AHEAD: DATA, MONITORING, AND RESEARCH NEEDS

Both prior to and during the development of this report, one theme that emerged was the critical need for more data collection and research on critical topics. As we work closely with our municipal, state, private, and university partners on collecting and analyzing data, it is well understood that more data is needed to help inform some of the critical questions that are being asked about our estuaries today. PREP has worked hard since the program began in 1995 to develop and implement a diverse Monitoring Plan that synthesizes and analyzes data about our estuaries. PREP is committed to working with our partners on securing resources to address data and research gaps in an effort to provide researchers, managers and the public with accurate scientific information needed to make management decisions pertaining to the health of our estuaries.

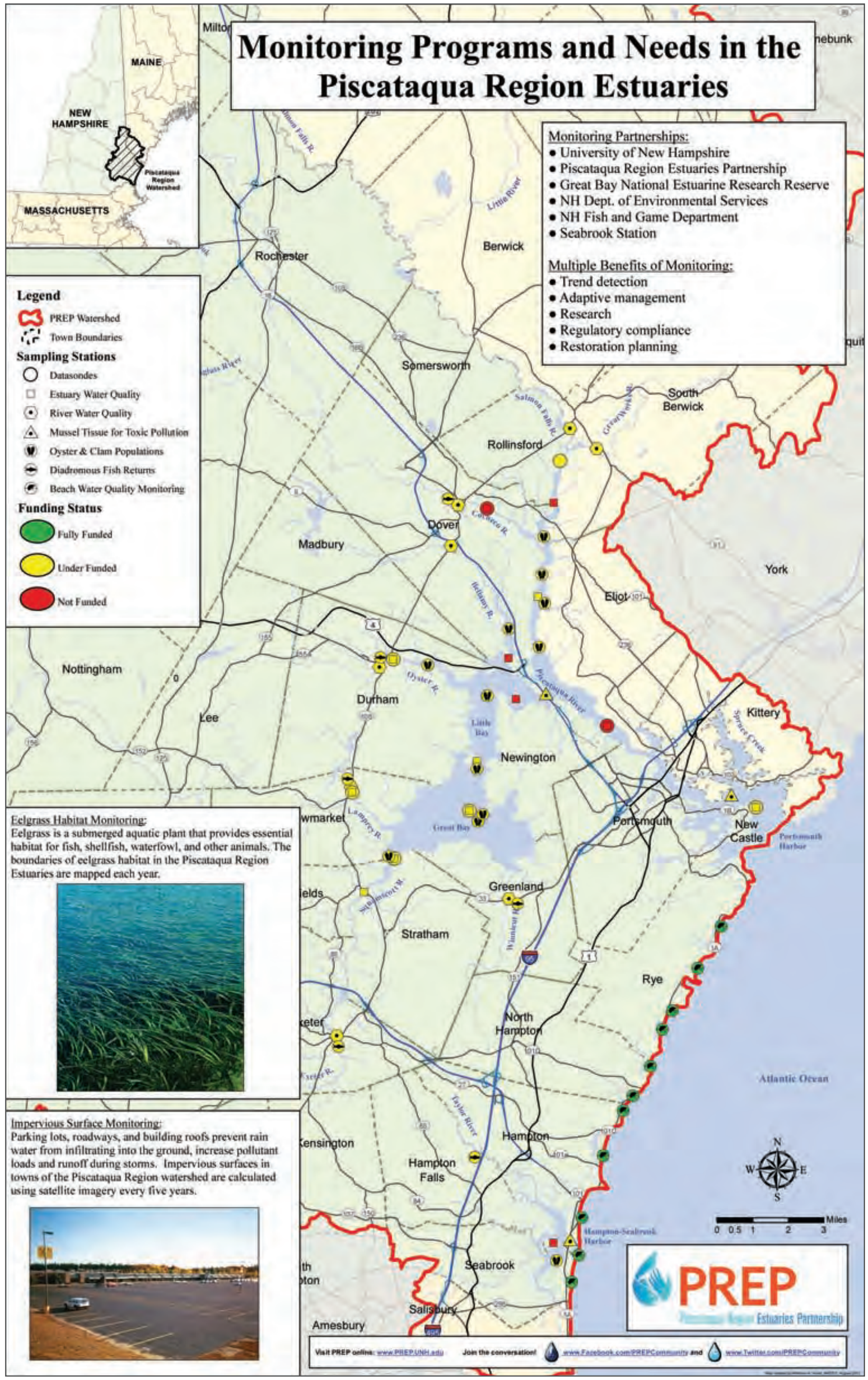
Monitoring Needs (Data Collection)

The Piscataqua Region estuaries have been monitored by the University of New Hampshire researchers, government programs, and volunteers for decades. However, at this crucial juncture the programs that monitor the health of the estuaries need to be upgraded to answer new questions and help inform management decisions. The current system of monitoring is a mosaic of programs with shrinking funds from different federal and state sources. There is an immediate need to add stations in a number of areas throughout the system.

Research Priority Themes

Over the next three to seven years there are a number of high priority research areas needing additional work. Given how a number of indicators interrelate with one another, themes that have been identified as priority include:

- **Oyster restoration and other economically beneficial, nutrient extractive technologies**
- **Integration and expansion of stormwater management strategies**
- **Macroalgae, including its extent, new invasive species, and relationship to nutrient-uptake**
- **Nutrient and other pollutant loads and concentration variations throughout the system**



- **Changes in climatic conditions and storm events, and their impact on pollutant loading, species shifts, marsh migration, coastal resiliency, and flooding**
- **Impacts of dams and other factors on anadromous fish**
- **Sediment concentrations, sources, transport and resuspension, and ecosystem impacts**
- **Ecosystem services within and surrounding the estuaries**
- **Emerging bacterial pathogens and toxin-producing microorganisms**

A commitment to, and the required support for, increased data collection and focused research will be critical to our collective success in answering important questions about the challenges in our estuaries.

CREDITS & ACKNOWLEDGEMENTS

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END NOTES

1. See CBP (2000), Cloern (2001), Bricker et al. (2007), Burkholder et al. (2007), and CENR (2010)
2. See Bricker et al. (2007) and Diaz and Rosenberg (2008)
3. See Bricker et al. (2007), Diaz and Rosenberg (2008), and Nixon et al. (2005)
4. See Cloern (2001), Bricker et al. (2007), CERN (2010), Mathieson (2012), Valiela et al. (1997), Hauxwell et al. (2001), and McGlathery (2001)
5. See Fox et al. (2008) and Pedersen and Borum (1996)
6. See Chock and Mathieson (1983) and Hardwick-Witman and Mathieson (1983)
7. See Nettleton et al. (2011)
8. See Nettleton et al. (2011), page 82
9. See Pe'eri et al (2008)
10. See NRC (2000), Cloern (2001), Bricker et al. (2007), EPA (2001), Diaz and Rosenberg (2008)
11. See Diaz and Rosenberg (2008), Cloern (2001), and Bricker et al. (2007)
12. See Pennock (2005)
13. See HydroQual (2012)
14. See Short and Short (1984)
15. See Duarte (2001) and Heck et al. (2003)
16. See Morrison et al. (2008)
17. See Burkholder et al. (2007)

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A short guide for municipal leaders and legislators that provides a short list of priority policy options for consideration and model efforts from our own communities.

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