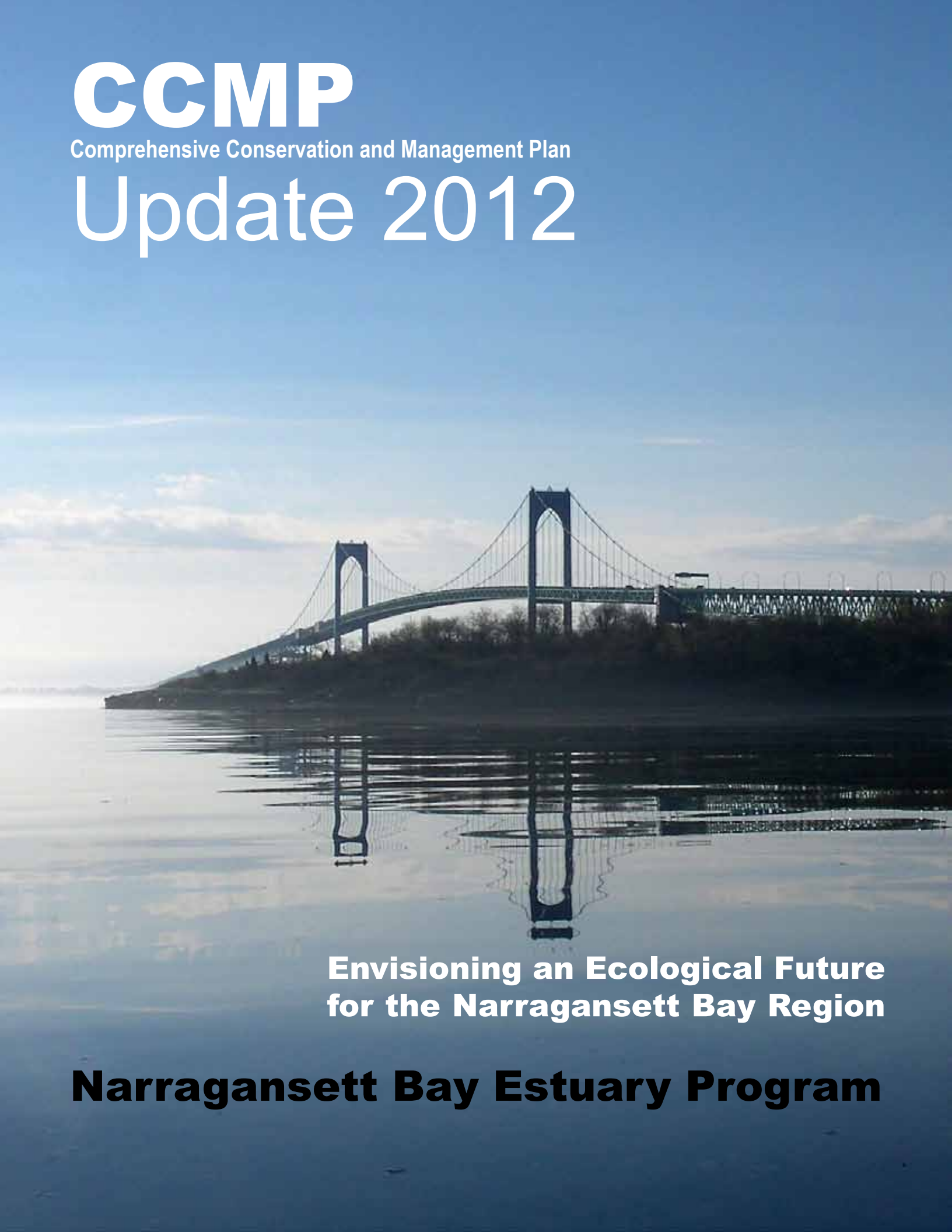
CCMP

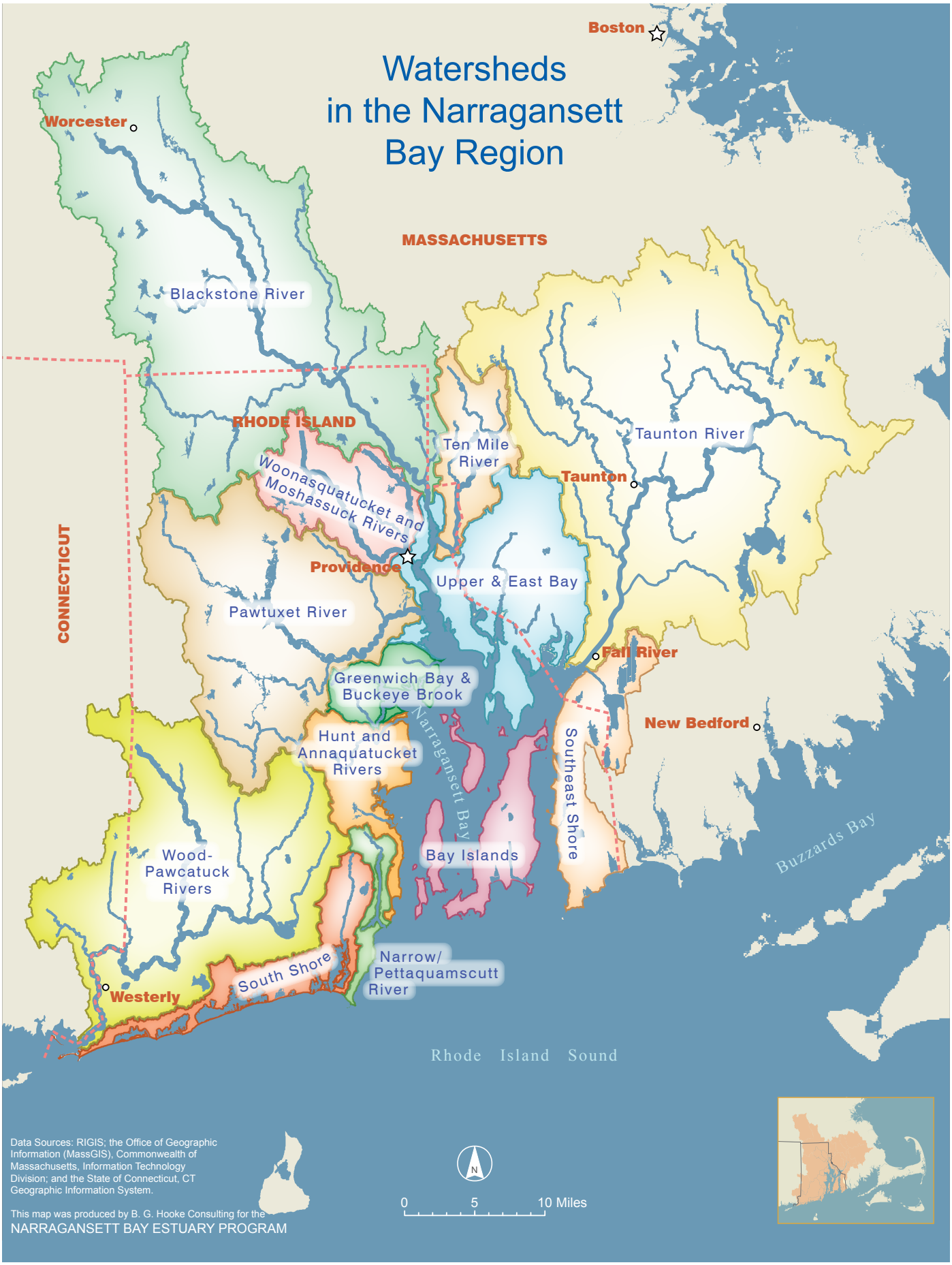
Comprehensive Conservation and Management Plan

Update 2012



Envisioning an Ecological Future for the Narragansett Bay Region

Narragansett Bay Estuary Program


Watersheds in the Narragansett Bay Region
Boston
Worcester
MASSACHUSETTS
Blackstone River
RHODE ISLAND
Ten Mile River
Taunton River
Taunton
Woonasquatucket and Moshassuck Rivers
CONNECTICUT
Providence
Upper & East Bay
Pawtuxet River
Fall River
Greenwich Bay & Buckeye Brook
New Bedford
Hunt and Annaquatucket Rivers
Narragansett Bay
Southeast Shore
Buzzards Bay
Wood-Pawcatuck Rivers
Bay Islands
Narrow/ Pettaquamscutt River
South Shore
Westerly
Rhode Island Sound
Data Sources: RIGIS; the Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division; and the State of Connecticut, CT Geographic Information System.
This map was produced by B. G. Hooke Consulting for the
NARRAGANSETT BAY ESTUARY PROGRAM
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CCMP

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Update 2012

Envisioning an Ecological Future for the Narragansett Bay Region

Narragansett Bay Estuary Program

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CCMP

Comprehensive Conservation and Management Plan

Update 2012

Envisioning an Ecological Future for the Narragansett Bay Region

NARRAGANSETT BAY ESTUARY PROGRAM

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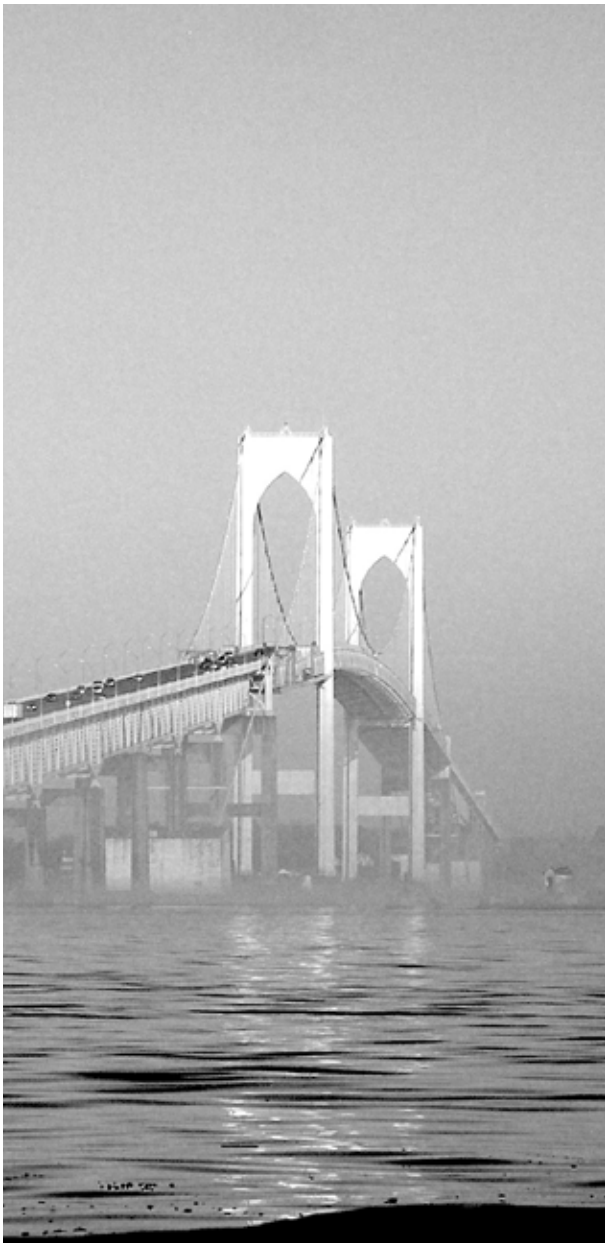
NARRAGANSETT BAY
ESTUARY PROGRAM



CCMP
Comprehensive Conservation and Management Plan
Update 2012

PREFACE

In the early 1990s, the original Comprehensive Conservation and Management Plan (CCMP) for the Narragansett Bay watershed was developed under the federal Clean Water Act's National Estuary Program. That stakeholder-driven document contained over 500 recommended actions to protect and restore watershed resources while supporting key human uses. Many of the actions in that plan have been implemented over time by state and local governments and nongovernmental organizations, but environmental problems persist and new issues have emerged. The Narragansett Bay Estuary Program (NBEP) set out to work with partners and stakeholders to update the estuary management plan. This update includes stakeholder-identified policies and strategic actions that have regional implications and so is framed using a geographic scope that includes not only the watershed segments in Massachusetts and Rhode Island but also the Rhode Island portion of the Wood-Pawcatuck watershed as well as Rhode Island's coastal salt ponds watersheds; the term Narragansett Bay Region is used to reflect the broader geographic scope of the action plan. Many of the actions recommended in this plan, for example, habitat restoration, will occur on a regional scale. By also including the Wood-Pawcatuck and salt ponds watersheds, this plan captures most of Rhode Island's political "ecosystem"—the legal, social and political structure which governs Bay management. The bi-state regional framework for the plan also captures much of Narragansett Bay's "user-shed," communities which use and value the Bay and its resources for work, recreation, and amenity value.

This document recognizes the major efforts of governments and watershed groups that have made a real difference in protecting and restoring the Bay and its watersheds through planning and action. There have been important successes that provide lessons learned on how we can continue to make progress toward goals as well as how to avoid obstacles that can impede action. *CCMP Update 2012* synthesizes action recommendations from many existing state and local plans and adds new recommendations developed through extensive consultation with agencies, nongovernmental organizations, watershed groups and resource users. It also supports and promotes the use of a collaborative watershed approach in managing watershed and bay resources. The recommended actions in this update respond to ecosystem needs identified by stakeholders. The plan is intended to provide not only a consistent record of the consensus reached on common priority goals and objectives but also identify specific actions on which we can work together to advance these goals.

Our intention is that the concerted effort that went into this document will result in a useful and dynamic plan—one that will be updated with new information, revised with new techniques and adjusted as priorities change over time. We hope that you will read the material and—whether a government official, a nonprofit practitioner or an interested citizen—will let us know what you think about how best to meet the goals within this document. It is only through the involvement and cooperative effort of all bay and watershed stakeholders that we will be able to achieve the goal of a healthy and sustainable watershed region that will continue to provide benefits to all who live within its boundaries.

—Richard Ribb
Director, Narragansett Bay Estuary Program
www.nbep.org

ACKNOWLEDGEMENTS

Thanks to the many people from across the Narragansett Bay Region who contributed comments, participated in small and large group work sessions and provided sound advice as the NBEP developed this updated estuary management plan.

We appreciated the assistance and guidance from key partners and contributors including representatives of state agencies and programs from Rhode Island Department of Environmental Management, Massachusetts Executive Office of Energy and Environmental Affairs – Divisions of Environmental Protection and Fish & Game, R.I. Coastal Resources Management Council, the Massachusetts Coastal Zone Management Program, the University of Rhode Island's Coastal Institute and Graduate School of Oceanography, the Narragansett Bay Estuarine Research Reserve, and the R.I. Bays, Rivers & Watersheds Coordination Team. Also thanks to nongovernmental partners including the Blackstone River Coalition, the Taunton River Watershed Alliance, and the R.I.'s watershed councils. We also received help and comments from our federal partners at U.S. EPA's Region 1 and the Atlantic Ecology Division, R.I. Natural Resources Conservation Service and the U.S. Fish & Wildlife Service.

Special thanks go to people who devoted a great deal of time and energy to the planning process. The members of the NBEP Executive Committee were especially helpful; Jane Austin, Judith Swift, Susan Kiernan, Jan Reitsma, David Gregg, Mel Cote and Margherita Pryor served as a steering workgroup for completion of the *CCMP Update 2012*. Thanks also to the NBEP Management Committee for its guidance to the NBEP on program workplans and directions and its several reviews of the document drafts.

Thanks also to Mark Amaral of Lighthouse Consulting Group for helping us work through a challenging plan development process and to Bill Napolitano, Ernie Panciera, Nancy Hess, Ames Colt and Jared Rhodes who helped in the early stages of plan development. Brian Jones, of Brian Jones Design, brought his creative skills to this effort, creating an attractive, usable document design and providing insights on using design to enhance communication.

Thanks to Senators Sheldon Whitehouse and Jack Reed, Congressmen James Langevin, David Ciccilline and Patrick Kennedy all of whom have strongly supported and encouraged the NBEP and the national network of NEPs to which it belongs. R.I.'s Governor Lincoln Chafee also deserves thanks for his support of the National Estuary Program and the NBEP dating from his time as Mayor of Warwick, R.I. through his tenure in the U.S. Senate and in his current position.

PLAN ORIGIN AND DEVELOPMENT

In the 1980s, the U.S. Congress determined that key estuaries across the United States were threatened by land development, increasing populations, water pollution, species decline and habitat loss and degradation. The late Senator John H. Chafee and other leaders in Congress drafted a visionary piece of legislation that was included in the 1987 Amendments to the federal Clean Water Act. This legislation created the National Estuary Program and was designed to focus attention and resources on the problems of our threatened estuaries; Narragansett Bay was one of the first four estuaries to be included in the program. The signature aspect of the law was to create a stakeholder-driven planning and implementation process in each estuarine watershed designated by Congress as of national significance. Narragansett Bay was one of the original estuaries in the program; currently, there are 28 locally-based National Estuary Programs in the U.S. It required that each of these stakeholder committees prepare a management plan for estuaries that uses an ecosystem perspective that transcends political boundaries. The initial estuary plan for Narragansett Bay was signed by Rhode Island's governor and the EPA Administration in January 1993 and has long needed the updating that this document represents. In the development of this plan update, it became clear that what was needed was more of a strategic plan with priorities identified; the plan still, however, provides a watershed and regional ecosystem perspective that is necessary to ensure we recognize the interconnectivity of the ecosystem and the human actions that affect it.

Many of the actions recommended in the earlier plan have been completed and we have made headway against some of the problems identified. Toxic metal discharges from industrial sources have been reduced by over 90%, wastewater discharged to the bay and rivers is much cleaner than it was earlier, the states and wastewater treatment authorities are addressing combined sewer overflow issues, watershed lands have been protected (NBEP, 2009), voters have approved bond issues to fund wastewater improvements and land acquisition, people are more educated about the environment, and many nongovernmental organizations have grown and built capacity to be important partners in restoring and protecting ecosystem resources. However, as the NBEP 2009 *Narragansett Bay and Watershed Status and Trends Report* documented, we still have many challenges ahead of us.

The NBEP has developed this estuary plan update as part of its Clean Water Act charge and has worked with and been assisted by many partners in bringing the update to completion. The development process started with an NBEP analysis and synthesis of goals, objectives and actions drawn from dozens of local, state and federal plans that affect the Narragansett Bay watershed. Similar plans from other watersheds were reviewed to help develop a plan format that was readable and easy to use. A series of watershed stakeholder meetings were held on each topic area of the plan where people provided comments, suggestions, action items and other guidance on what the update should address. NBEP staff interviewed key officials from state agencies and NGOs in both states and extensively consulted with state agency staff on plan content to ensure that state priorities were effectively captured. The plan appendices (page 59) contain lists of the people and organizations that were consulted in the development of the plan.

NBEP work on this plan was also informed by the extensive watershed stakeholder and technical work carried out by the program including:

Watershed Counts—a bi-state watershed effort to identify and define measurable indicators that can be used to assess condition

Land & Water Conservation Summits—a collaborative training and information summit for watershed stakeholders and activists that covers a full range of watershed management activities. The 2012 Summit marked the NBEP's tenth year of organizing and supporting this effort in collaboration with the Land & Water Conservation Partnership.

Narragansett Bay and Watershed Status and Trends Report—a comprehensive report produced by the NBEP on a 5-year cycle to communicate the condition of the region's watersheds. The latest report was issued in 2009.

This plan recommends a series of implementation actions for each of four key topic areas. These emerged as priorities at the end of an intensive planning process to identify actions that respond to needs expressed by stakeholders, and were distilled down to those that should be implemented in the near term.

PURPOSE AND USES OF CCMP UPDATE 2012

The *CCMP Update 2012* presents a realistic, consensus-based plan for achieving a sustainable future for the Narragansett Bay Region. The plan is guided by a comprehensive set of shared goals, objectives and priority actions to promote collective efforts towards that future, and provides a suite of meaningful indicators to communicate progress in meeting those goals. Note that *CCMP Update 2012* is built upon and strongly connected to existing plans and strategies previously developed by government and nongovernmental organizations in both Rhode Island and Massachusetts; goals and objectives from those efforts are the foundation for this update along with a series of new recommended actions that were identified by a wide range of regional stakeholders. The plan was organized and developed by the NBEP using a variety of methods to gather and synthesize input from stakeholders and experts in Rhode Island and Massachusetts. In bringing together state, federal and municipal agencies, nongovernmental and grassroots organizations; businesses, academic institutions, and individuals, *CCMP Update 2012* outlines a collaborative framework to apply ecosystem-based management principles for planning and action, increasing the effectiveness of our efforts to collectively manage, protect and restore ecosystem resources.

The vision and goals presented in *CCMP Update 2012* will be translated into action in several ways. Consensus-based priorities identified in this document will be used to help guide the actions of Rhode Island and Massachusetts state agencies, regional planning organizations and non-governmental organizations. It will also provide guidance to federal agency partners such as the Natural Resources Conservation Service (NRCS), the National Oceanic and Atmospheric Administration) NOAA and the Environmental Protection Agency (EPA) that incorporate regional priorities into their workplans. The document will inform the development of municipal comprehensive plans throughout the region and for other state and local planning efforts. And it will provide the basis for collaborative actions in the Narragansett Bay Estuary Program's annual workplans.

Whether you are a town planner, state agency official, watershed group member or involved citizen, this plan provides common directions to be taken to better protect and restore watershed resources. Just as importantly, this approach will improve coordination and communication among government agencies, as well as between governmental and non-governmental organizations. It will help create effective collaboration among all institutions, organizations and individuals with a stake in the future of the Narragansett Bay region. By defining key goals and actions and establishing a system for tracking progress in meeting goals, plan implementation will increase accountability and allow us to assess progress toward common goals. And the NBEP will track progress made and report on it at five-year intervals via watershed forums and future plan updates.

FEDERAL AND STATE ENVIRONMENTAL GOALS

The content and implementation of estuary plans created through the National Estuary Program collaborative process are closely aligned with primary federal and state goals. Listed below are designated environmental goals from both federal law and the Rhode Island and Massachusetts Constitutions

Goal of the Federal Water Pollution Control Act (Clean Water Act):
"…to restore and maintain the chemical, physical and biological integrity of the Nation's waters."

From the Rhode Island Constitution:
"…it shall be the duty of the general assembly to provide for the conservation of the air, land, water, plant, animal, mineral and other natural resources of the state, and to adopt all means necessary and proper by law to protect the natural environment of the people of the state by providing adequate resource planning for the control and regulation of the use of the natural resources of the state and for the preservation, regeneration and restoration of the natural environment of the state."

From the Massachusetts Constitution:
"The people shall have the right to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and esthetic qualities of their environment; and the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources is hereby declared to be a public purpose."

Estuary plan development requirement under Section 320 of the Clean Water Act (National Estuary Program):
"…to develop a comprehensive conservation and management plan that recommends priority corrective actions and compliance schedules addressing point and nonpoint sources of pollution to restore and maintain the chemical, physical, and biological integrity of the estuary, including restoration and maintenance of water quality, a balanced indigenous population of shellfish, fish and wildlife, and recreational activities in the estuary, and assure that the designated uses of the estuary are protected."

CCMP Update 2012 is organized around a comprehensive set of goals for a sustainable Narragansett Bay region, as follows:

Protect and Restore Clean Water

Manage Land for Conservation and Community

Protect and Restore Fish, Wildlife and Habitats

Manage Climate Change Impacts to Human and Natural Systems

For each plan section, we present an overarching goal for that aspect of the environment, descriptive information regarding environmental condition (full details available at www.nbep.org), a table of priority objectives and strategies, and a summary of key management responses, completed and ongoing, that government agencies in Rhode Island and Massachusetts have employed to address environmental and community goals. These government-sponsored actions and programs, some legislatively-driven and others driven by recognized need, are important parts of the management framework to advance goals for clean water, healthy habitat, and effective land management. Without these important efforts, addressing environmental problems and understanding ecosystem functions would be much more difficult.

Actions identified as priorities are those that were either identified multiple times by stakeholders, considered to have a greater impact on near term needs, and/or support existing priorities of implementing parties. Note that not every agency or organization that may be a participant in a listed action is named in the implementing parties' column. That column is designed to list only key participants that direct resources, have a clear mandate or interest in that action, and/or logically will have a significant role. In addition, environmental indicators that are or can be used to measure change in environmental condition and progress toward goals are identified in the appendices (page 59) .

This plan is not a static or self-contained product; rather it is intended as an evolving framework for action. It is envisioned that the plan will be improved and updated—as projects are accomplished, new issues are identified, and new partners join the effort. The NBEP, and its Management Committee and partners, will review the plan at 5-year intervals to determine needed changes or adjustments. Our periodic update of the Bay and watershed environmental status and trends report will inform any CCMP revisions. This "adaptive management" approach provides for incorporation of new findings and knowledge into an ongoing process, to improve decision-making as time goes on. We hope and expect that *CCMP Update 2012* empowers stakeholders in Rhode Island and Massachusetts to create—together—a more prosperous and sustainable future for communities throughout the Bay watershed.

CCMP UPDATE 2012 – INTRODUCTION

Crossing the Newport Bridge on a clear summer day, one marvels at the beauty of Narragansett Bay. Sailboats, fishing craft, tugs, barges and cruise ships ply the waters of the East Passage. The skyscrapers of Providence shimmer on the northern horizon; Block Island lies low to the south. The wild shores and historic lighthouse of Rose Island are visible directly below. Beneath the water's glittering surface the Bay seems a public park, a place of business and a wilderness, all at once.

And yet there is so much more to Narragansett Bay than can be perceived from the summit of the bridge. The Bay lies at the heart of a 2000-square-mile area in two states. Three major river systems—the Pawtuxet, the Blackstone and the Taunton—connect the actions of two million people in a hundred cities and towns to the Bay and the ocean. These fresh and salt waters, in turn, contribute to our lives in incalculable ways: providing drinking water, seafood, recreation, jobs, and—most important—serving as the foundation for every aspect of our regional environment, from the upland forests of Purgatory Chasm in Sutton, Mass. to the rocky shores of Beavertail in Jamestown, R.I.

The Narragansett Bay Region is a remarkably diverse area, encompassing rugged hills, coastal plains, large lakes and extensive wetlands; bustling cities and quiet rural communities; working farms and busy fishing ports; highways and shopping malls; 19th century textile mills and world-class scientific research facilities. Nearly every aspect of the watershed has been shaped by centuries of human use and development: the locations and layouts of our cities and towns; the plants and animals in our forests and fields; the fish and shellfish in our rivers, lakes and estuaries.

Today, the Bay Region faces an unwritten chapter. Our history and geography present unique opportunities—and challenging legacies. Our exceptional salt and fresh water resources—Narragansett Bay and other estuaries, our rivers, lakes and ponds—are central to our regional identity, our physical and economic well-being, and our quality of life. Our densely developed former mill towns provide a footprint for smart growth and great potential for reduced ecological impacts—while currently contributing to stormwater flows and water pollution. A regional tradition of strong local government gives communities control of many environmental decisions—but makes large-scale regional planning and prevention of suburban sprawl difficult. Our pride of place fosters preservation—but this means that even beneficial change can be difficult to bring forward.

A watershed is the land area that drains to a low point, usually into a river, bay or estuary; watersheds were called basins in some past planning documents. The estuarine watersheds this plan addresses are complex and vital ecosystems. Plants, animals, physical processes and humans all interact to affect how ecosystems function and the benefits they bring to people. In managing our natural resources we need to recognize that when we change one part of the system, it can have effects, intended and unintended, positive and negative, on other parts. That is one of the reasons that it is critical we have a good scientific understanding of how these ecosystems work.

Major environmental and management challenges lay before us. Recessionary economic conditions have greatly reduced state and federal budgets for environmental protection (particularly important as both states rely heavily on federal funding for environmental management). Municipal budgets are also stressed and local capacity to implement environmental measures and better manage development using innovative techniques has been limited. While great progress has been made on controlling and reducing point source pollution impacts since the Clean Water Act was passed, nonpoint sources of pollution, in particular stormwater, have emerged as significant environmental stressors that need to be addressed. The documented increase in impervious surfaces throughout the watershed since the development boom starting in the 1960s (currently 14% of the watershed is impervious) has resulted in increased volumes and velocities of stormwater that produce a variety of impacts including increased loadings of nutrients, bacteria and sediment that degrade habitat and water quality. Addressing these impacts effectively calls for changes in how we manage land and value water. The implementation of new low impact (LID) development designs that keep water onsite will be a critical tool in reducing stormwater impacts and there will be need for significant investment in retrofitting existing urban and suburban drainage systems identified as significant sources of pollutants. Climate change impacts add a layer of complexity to environmental management and require us to direct resources to better understanding possible changes and define ways that we can, as a society, address those impacts. The ramifications of sea level rise and adaptation efforts will be a significant policy and economic challenge for coastal communities.

Aside from new initiatives that will require attention, both states operate environmental management programs that need to be continued—permitting, monitoring, environmental enforcement, education—programs that have proven to be valuable in our efforts to protect and restore watershed resources (see the R.I. and Mass. Environmental Management Core Program Capacities table on page 65 for a compendium of key agency management programs). Management actions not only seek to prevent and control impacts; restoration of resources is now also a primary element of environmental management. After centuries of losing and degrading vital habitats, we now pursue restoration of wetlands, eelgrass beds, fish runs and other habitats, fully integrating habitat restoration into our concept of ecosystem management.

There is no shortage of laws, regulations, plans and policies intended to protect and improve the environment of the Bay watershed. However, the persistence of long-standing problems like water pollution—and the rise of new ones, such as climate change and invasive species—demonstrate that the good faith efforts made to date and current approaches alone are not enough to address the challenges we face.

The jurisdictional complexity of the Bay region—federal requirements and two states, each with its own environmental laws and policies, and many distinct sets of municipal land-use regulations—demands an overarching approach that recognizes this regional set of watershed ecosystems as more than a patchwork of jurisdictions. Add to this the need to respond to a changing federal regulatory framework. Large-scale planning and action is further necessitated by the prospect of climate change, which is already producing regional impacts such as sea level rise, increased precipitation and flooding. An ecosystem-based approach will require increased coordination, collaboration and communication among states' governments, federal and local governments, watershed groups and nonprofits, universities, and citizens. Efforts are being made to do this; they need to be supported, expanded and recognized as necessary to achieve the consensus-based goals identified in this plan.

There are compelling ecological reasons to implement the actions in this plan but there are also economic reasons to protect and restore natural resources. Healthy watersheds provide significant ecosystem services that support our social and economic well-being. Services provided include filtering and cleaning our waters, mitigating greenhouse gas emissions that are a driver of climate change, providing storm protection and minimizing flooding, enhancing property values, providing recreational opportunities and quality of life benefits, and supporting food production and natural resource industries. These services are often under-valued and are rarely accounted for in land use decisions. Replacing or replicating this "natural infrastructure" is difficult and expensive if it can even be achieved. For example, in the Chesapeake Bay area, the wastewater facility cost for removing a pound of nitrogen from entering the bay is $8.56; to use forest buffers to remove that pound costs $3.10 (USEPA, 2012). It is far less expensive to protect and enhance the watershed resources that provide these services than to attempt to re-engineer solutions once those resources have been lost or degraded.

Over the last decade, both Rhode Island and Massachusetts have reduced the amount of state funding for environmental management. Staff levels have been reduced, grant funds cut back, and programs eliminated or reduced. Recently, this has been a result of the recessionary economic conditions we face but it is also a reflection that the environment has not been as significant a priority to the general population as it once was; recent polls surrounding the 2012 election bear that out. However, a reduction in public attention does not mean that environmental challenges have lessened or gone away; in some cases, for example climate change impacts, it is increasingly clear that these issues need to be addressed. And the impacts of polluted stormwater have made achieving water quality standards increasingly difficult; this has become more evident as point sources of pollution have been reduced. In order to ensure that support for environmental protection and restoration is commensurate with the challenges faced, it is important that the public and elected officials are educated regarding ecosystem issues. More effective ways of communicating this information are clearly needed.

One thing we have all learned about protecting and restoring our natural resources—there is a role for all to play. Governments have roles defined by law and need; cities and town are important partners and often pilot innovative action that leads to new and effective approaches to environmental problems. We are fortunate in New England to have many effective nongovernmental organizations working to protect and preserve our environmental resources and giving citizens a greater voice in decision-making. And citizens can make a huge difference – volunteering to monitor resources, remove invasive plants, build rain gardens, call local legislators to seek action, build land and water trails, support the work of land trusts, and educate people and policy-makers on important ecosystem issues.

CCMP Update 2012 is designed to help all stakeholders—state, federal and municipal agencies, non-governmental organizations, businesses, schools, and individuals—address key challenges, and more. If the actions in this plan are addressed, we will see improvements in the bay and watershed ecosystem and greater efficiency and effectiveness in the ways in which we manage it. Working together, we can chart a course which positions us for success in the 21st century, while preserving—indeed, improving—those aspects of our communities, our environment and our history which make the Narragansett Bay region an exceptional place.

Photo: Jamal Kadri

These priority issues were developed through synthesis of existing planning documents and extensive technical and community stakeholder input. The technical background on Narragansett Bay Region indicators relating to these issues is contained in the 2009 NBEP environmental status and trends report, *Currents of Change* (see www.nbep.org to review the report). As identified and discussed in the individual elements of this document, the following are key problems and issues in the Narragansett Bay Region that the actions in this CCMP update seek to address:

Nonpoint Source Pollution / Stormwater

While great progress has been made in controlling point sources, nonpoint source pollution and especially pollution and ecosystem impacts from stormwater continue to be a major challenge. Land development patterns have created large areas of impervious areas which channel water and concentrate volume and pollutants, directing flows into waterbodies and increasing pollution loads and water temperatures. Nutrient pollution from stormwater and onsite waste treatment systems via groundwater inputs is a serious issue for the region's rivers, lakes and coastal waters. Reduction of nutrients from point sources has been an ongoing effort.

Nutrient Impacts on Waterbodies

While control of point sources of nutrients (e.g., wastewater treatment facilities) has brought more effective regulation and reductions in the amount of nutrients entering the region's waterbodies, nutrient levels in both bay and freshwaters remain a significant problem. Controlling indirect, or nonpoint sources of nutrients including polluted stormwater runoff, septic systems, fertilizers and atmospheric deposition remains a major challenge. Excessive nutrient levels cause depletion of oxygen in waterbodies, making them unsuitable habitat for fish, shellfish and other aquatic organisms.

Loss and Degradation of Habitat

As we developed land at an accelerated pace over the last half of the 20th century, we fragmented and degraded natural habitat areas, disconnecting wildlife corridors, reducing ecosystem resilience to invasive species and climate change impacts, and reducing native biodiversity.


Photo: FEMA

Impacts of Climate Change

Climate change will have impacts on virtually all aspects of the environment including changes to the estuarine food web, alteration of ecosystem processes like nutrient cycling, shifts in plant and wildlife species, the rate of introduction of non-native species, watershed precipitation levels and flooding, and coastal sea level rise. Climate change also brings societal impacts like threats to public safety and welfare.

Science, Monitoring and Funding Needs


Photo: Jamal Kadri

As we seek to effectively manage our environmental resources, we recognize that we need better data on conditions and stressors in order to better craft solutions and measure progress. Many applied science research needs have been identified yet resources have been scarce to help address this need. Likewise, monitoring the condition of our lands and waters is critical to measuring change and evaluating current management measures – funding for monitoring activity is often the first budget item to be reduced. And funding for overall environmental management activities has not kept pace with the magnitude of our problems or for actions needed meet federal environmental requirements.

An Ecosystem-based Approach to Addressing Challenges

Environmental management can be at its most effective when applied at the ecosystem or watershed level. Stakeholders in the CCMP Update process recognized the need to more effectively integrate the principles and practices of ecosystem-based management into our current management regime. Management authorities have been adopting key practices such as collaborative planning, watershed stakeholder involvement, data sharing, targeting of resources and setting priorities, and regional or ecosystem-level planning and implementation can move us closer to achieving consensus-based ecosystem goals.

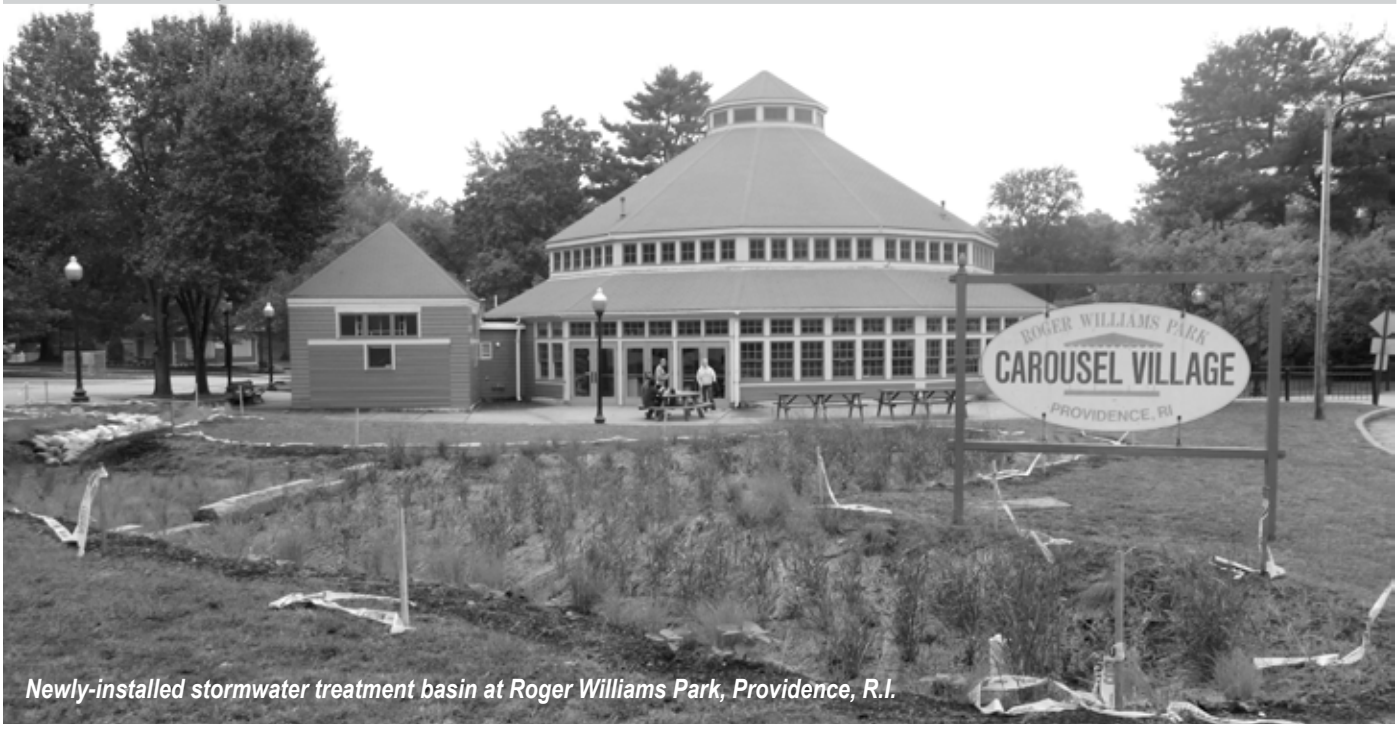
Actions identified as priorities are those that were either identified multiple times by stakeholders, considered to have a greater impact on documented problems, and/or support existing priorities and actions of implementing parties. These actions are oriented toward short term implementation and so do not reflect long term, planning-oriented actions and those with ongoing timelines.
(Year) = target completion date. ⟰ = in progress. ACRONYMS, see page 68.

Section 1 — Protect and Restore Clean Water

1.	Reduce pollution from wastewater sources	Primary Implementing Parties
1.1	Issue and implement revised EPA New England permits for nutrient controls at waste water treatment facilities (WWTFs) located in the Mass. portion of the Blackstone River and Ten Mile River watersheds (2017) ⟰	USEPA, MADEP, WWTFs
1.2	Complete upgrades needed to implement nutrient reductions at eleven R.I. WWTFs to achieve 50% reduction in total nitrogen discharges (May to October) from WWTFs discharging into upper Narragansett Bay or its major tributaries (2014) ⟰	RIDEM, select RI WWTFs
1.3	Accelerate the elimination of cesspools in R.I. by adoption of additional phase out requirements	R.I. General Assembly, RIDEM
1.4	Reduce the impacts of residential and commercial septic systems on water quality by implementing inspection, maintenance and financial assistance programs, and promoting adoption of more effective treatment technologies	RIDEM, RICRMC, MADEP, Mass. Boards of Health, clean water finance agencies

2.	Reduce pollution from stormwater sources	Primary Implementing Parties
2.1	Provide enhanced funding and technical assistance to municipalities in key areas of stormwater management—operations and maintenance, assessment, illicit detection, stormwater system retrofits, public communications, and financing	RIDEM, MADEP, NGOs, universities, NBEP, RI Env-MC
2.2	Prioritize retrofitting of BMPs to areas most affected by stormwater impacts, using Low Impact Development (LID) and including physical and habitat restoration where feasible to achieve water quality goals	RIDEM, MADEP, municipalities

3.	Reduce pollution from combined sewer overflows	Primary Implementing Parties
3.1	Complete planned NBC Phase 2 CSO abatement plan (2014) and initiate planning for Phase 3 that considers incorporating LID methods; complete CSO abatement projects in Newport (2015), Fall River (2019) ⟰	RIDEM, MADEP, NBC, WWTFs, clean water finance agencies



Newly-installed stormwater treatment basin at Roger Williams Park, Providence, R.I.

4.	Manage estuaries, rivers, streams and lakes to prevent degradation and restore beneficial uses	Primary Implementing Parties
4.1	Implement scientifically-based water management to restore and protect streamflow and ensure sustainable yields including methodology that accounts for current and future land uses, impacts on aquatic systems and inter-basin transfers (2015)	RI WRB, Mass. water management authorities, RIDEM, MADEP, water suppliers
4.2	Fully utilize watershed-based plans, such as stakeholder-based plans, NPS plans, TMDLs, and special area management plans to coordinate prioritized actions to protect, restore and manage the land and water (including groundwater) resources within watersheds (2015)	RIDEM, MADEP, NGOs, watershed groups, conserv. commissions
4.3	Build and increase capacity of nongovernmental organizations in implementing protection and restoration actions	RIDEM, MADEP, RICRMC, MACZM, RIDOT, MADOT, NBEP, USEPA, NGOs, NERRS, MA & RI NRCS

5.	Improve funding for water quality and quantity improvement and for resource assessment and monitoring	Primary Implementing Parties
5.2	Provide sufficient resources, staffing and operational funds to maintain and fill in gaps in existing monitoring and assessment programs in both Rhode Island and Massachusetts including designated monitoring coordinators in both states	RI & Mass. municipalities, NGOs legislatures, agencies, RI Env-MC, NBEP
5.3	Develop new or expand existing funding mechanisms at the state and local level (especially consider utility districts) to meet stormwater/water quality infrastructure needs (2015) ^	R.I. /Mass. Legislatures, RIDEM, MADEP, clean water finance agencies, RI Env-MC

6.	Improve information, science and analysis that support management efforts necessary to restore and protect fresh and salt waters	Primary Implementing Parties
6.2	Effectively manage, analyze, synthesize and make available data to support management decision-making, characterize environmental condition trends linked to ecological indicators, prioritize investments and communicate to the public. Continue development of data driven analytical tools, e.g., predictive models, biological indices, etc. ^	RIDEM, MADEP, RICRMC, MACZM, NBEP, Watershed Counts, RI Env-MC, federal agencies, universities, volunteer monitoring programs

Section 2 — Manage Land for Conservation and Community

1.	Implement low impact development	Primary Implementing Parties
1.1	Develop and adopt state and local policies, regulations, and ordinances as needed to fully implement LID approaches to development and redevelopment ^	RIDEM, MADEP, RIDOP, MACZM, RICRMC, municipalities, regional planning organizations

3.	Develop and use incentives and local zoning requirements that support compact, mixed-use walkable communities	Primary Implementing Parties
3.1	Direct sustainable growth by targeting grant funds, state investments and incentives for redevelopment, infrastructure improvements and/or added capacity to developed lands including Brownfield sites (in R.I., to state-designated urban service boundary and growth centers) (2016)	RIDOP, Mass. Regional Planning, MAEOEEA, RIDEM, MADCR, state economic development agencies

4.	Increase and maintain regional recreational opportunities and public access to shorelines and waterfronts	Primary Implementing Parties
4.2	Increase public access to watershed resources by developing public water and land trail systems that enable a range of user opportunities ^	RIDEM, MADCR, RI Blueways, NBEP, NGOs, water use interests

6.	Increase the role of watershed organizations and municipalities to serve as critical partners in watershed management	Primary Implementing Parties
6.1	R.I. and Massachusetts should provide technical planning resources to towns to proactively protect ecological resources and to support implementation of state and federal environmental regulatory requirements (2015)	RIDEM, MADEP, RIDOP, Mass. Regional Planning, State legislatures

Land uses define community character.

Section 3 — Protect and Restore Fish, Wildlife and Habitats

1.	Conserve existing natural landscapes that have been and will be adversely affected by development, climate change, and invasive species	Primary Implementing Parties
1.1	Focus resources and enhance land protection efforts by conservation agencies and organizations on less-developed areas, particularly areas threatened by new sprawl development in both states ^	RIDEM, MADCR, MADFW, municipalities, federal agencies

2.	Restore degraded or lost habitats and habitat functions	Primary Implementing Parties
2.1	Improve river connectivity and habitat by removing dams, upgrading culverts and creating structural fish ways to restore free-flowing rivers and anadromous fish passage; implement state fish passage plans ^	RIDEM, MADCR, MADFW, MADER, RICRMC, NBEP, federal agencies
2.2	Create a coordinated bi-state habitat sustainability strategy with a restoration component and identification of priority projects, comprehensive management principles, and implementation targets for fresh and salt water ecosystems (2015)	RIDEM, MADEP, MADCR, NBEP, federal agencies

3.	Manage habitats to sustain and enhance habitat function	Primary Implementing Parties
3.2	Manage waterfowl populations to reduce bacterial and nutrient pollution and habitat destruction in waterbodies ^	RIDEM, MADFW, federal agencies

4.	Monitor, control and prevent terrestrial and aquatic invasive species	Primary Implementing Parties
4.1	Update and implement state plans for preventing, controlling and managing terrestrial and aquatic invasive species including improving early detection and rapid response capabilities and educating key constituencies; coordinate R.I. and Mass. programs ^	RIDEM, MADFW, RICRMC, MACZM, NGOs, universities

5.	Improve science, communication, and information to guide management of habitats and biodiversity	Primary Implementing Parties
5.1	Establish a comprehensive set of NBR status and trends indicators for critical habitats to assess habitat changes (working off biological condition gradient), impacts, and conservation and restoration progress (2014) ^	RIDEM, MADFW, RICRMC, MACZM, NGOs, universities, NBEP

6.	Build capacity to implement ecological restoration at state (particularly in R.I.) and local levels and improve interstate coordination	Primary Implementing Parties
6.4	Create a R.I. Habitat Restoration program, similar to the Mass. Wetlands Restoration Division of Ecological Restoration, with dedicated, full time staff to support project implementation, work on needed restoration policy, and integrate agency actions (2015)	RIDEM, RICRMC, NGOs, universities

Section 4 — Manage Climate Change Impacts to Human and Natural Systems

2.	Improve public and private infrastructure to withstand anticipated climate change impacts	Primary Implementing Parties
2.2	Develop strategies and incentives to guide development away from high hazard zones and natural areas that provide storm protection and other benefits (2015)	RIDEM, RICRMC, MADEP, municipalities
2.3	Design stormwater treatment facilities and green stormwater infrastructure to have adequate capacity over the life of the facility for predicted increased, intensified flow resulting from climate change (2017)	RIDOT, MADOT, RIDEM, RICRMC, MADEP, MACZM, municipalities, state emergency mgmt. agencies

3.	Ensure adequate disaster mitigation and response planning to protect life and built environment	Primary Implementing Parties
3.1	Develop a shoreline change Special Area Management Plan to address coastal erosion and inundation in response to sea level rise and strategies and incentives to guide development away from special flood hazard areas and to protect natural resources that provide storm protection and other benefits (2015)	RICRMC, RI Sea Grant, R.I. municipalities

Property damage in Matunuck, R.I., from Hurricane Sandy storm surge. **Photo: Reuters**

Hurricane Sandy storm surge overtops a North Kingstown, R.I., coastal marsh; same site the next day. Coastal wetlands provide storm protection but also are vulnerable to changes due to sea level rise.

In 2007, the Narragansett Bay Estuary Program consulted forty agency, nonprofit, trade group, environmental business, academic, and watershed group stakeholders and asked them to identify critical issues that affect management of the Bay Region; their summary responses included:

…more effective ecosystem management is needed…

•

…broader watershed-wide bi-state engagement and public involvement is needed…

•

…need to remove barriers to new ideas and key actions…

•

…increase collaboration and coordination…

•

…better connect managers and scientists…

•

…information and data need to be of good quality and easily accessible…

•

…need to build consensus on solutions…

•

…need for sufficient investment in ecosystem management…

•

…need a neutral forum where multiparty discussions on important issues can take place…

These comments point to a four major needs: a framework of common goals to which many participants can contribute; mechanisms to coordinate activities, explore solutions and facilitate collaboration; adequate resources to manage effectively; and sustained support for needed science, monitoring, data interpretation and communication. A recurring theme in stakeholder comments regarding CCMP development from across the watershed highlighted the need for a policy and information framework that could carry out these actions.

Given the complexity of our governance landscape, protecting state-defined rights and resources requires a framework that provides timely, credible information, the means to act effectively on the information, and the measures to know if the actions have succeeded, including meaningful indicators that track progress against goals, baselines, and some measure of performance. *CCMP Update 2012* includes a number of recommended actions intended to address these needs. The creation of a multi-party implementation mechanism to address priority actions over the five-year initial planning horizon will be needed as part of any plan implementation strategy; this could build on the existing bi-state stakeholder-based NBEP Management and Policy Committees framework.

In order to effectively and efficiently manage environmental resources in the Narragansett Bay watershed, we need a watershed management approach that recognizes the interaction of human and natural systems and promotes cross-jurisdictional and regional cooperation and collaboration. A regional approach to natural resources is not a new idea in the area; in the 1990s, both Rhode Island and Massachusetts passed legislation allowing the formation of interstate compacts to better manage water and land resources. Those bills were built on an earlier model to create a Northeastern Resources Commission. Though those efforts were not brought to fruition, the idea of ecosystem management stays alive and resonates with watershed stakeholders.

The following implementation principles cut across all the topic areas of the plan and would allow us to draw on the good ideas of these earlier efforts as well as the perspective expressed by current environmental managers and practitioners to manage more effectively at the ecosystem level:

Better integrate water management planning including stormwater, wastewater treatment, water supply and septic systems to achieve efficiency and multiple benefits

Develop interstate and regional mechanisms that facilitate adoption of a watershed approach for ecosystem issues

Identify specific measurable environmental targets to address priority goals and objectives, and track progress toward them

Collaborate broadly to identify priority bay and watershed science issues, needs and solutions and invest in scientific research that will support effective management of natural resources

Evaluate and increase efficiency and effectiveness of existing management actions and agency coordination mechanisms in both states; allocate resources to proven best practices

Increase investment in environmental protection and restoration for ecosystem health, regional prosperity and quality of life

Monitor watersheds in a connected, coordinated and efficient way, supported by sufficient resources to collect, analyze and manage data

Identify priority bay and watershed science issues, needs and solutions using a regional, collaborative approach

Apply watershed based management principles at the bi-state level to address cumulative impacts of development and climate change impacts

Communicate with people and policy-makers in a way that enhances stewardship and creates action toward solutions for watershed problems

Build capacity of municipalities to implement priority actions

Build, support and coordinate partnerships between governmental and nongovernmental organizations to implement priority actions

After completion of the CCMP update, a critical next step is to work with implementing parties to better define implementation roles, responsibilities and possible collaborations in implementing what are agreed upon common actions toward priority goals. A bi-state watershed implementation strategy, agreed upon by key partners, could identify near term priority actions and agreed upon specific roles and activities for partners and enhance accountability regarding plan implementation. A study of regional initiatives done for the Partnership for Narragansett Bay (PNB, 2003) and funded by a U.S. Housing and Urban Development grant identified the lack of an implementation strategy and progress tracking as characteristics of planning efforts that failed to achieve long-term commitment and impact. The NBEP is interested in working with key implementing stakeholders to identify near term actions drawn from the plan priorities around which we could form working partnerships to implement. Many of the actions are already in some stage of implementation with commitments from agencies and organizations; others would need more discussion, planning work and resources to bring them to on-the-ground implementation. The likely primary implementing parties are identified in the action tables.

Beyond immediate implementation, the existing management and policy committee structure of the NBEP could provide a basis for an ongoing bi-state mechanism to better identify key issues and develop collaborative, coordinated actions to address issues. These committees include representatives of both states' agencies, EPA Region 1, key nongovernmental organizations and universities; membership could be expanded to bring in business interests, regional planning agencies, foundations, municipalities and other appropriate parties.

Thanks to community support and many partners, the first dam on the Pawtuxet River was removed in August 2011, restoring seven miles of habitat for migratory fish.

Governance over the region's watersheds is split among a wide number of federal, state and local authorities. Protection and sustainable use of the area's natural resources have been identified as a key state interest in many state and local plans. Rhode Island's constitution specifically calls for the preservation, regeneration and restoration of the natural environment of the state, while in Massachusetts the state law specifies the people's rights to clean air and water and the natural, scenic, historic, and esthetic qualities of their environment. Federal directives also have a primary role in watershed management in particular the Clean Water Act charge to protect and restore the chemical, physical and biological integrity of ecosystems. The Act also requires that estuary plans created under the National Estuary Program protect and restore indigenous species and recreational uses of the ecosystem.

In Rhode Island, the R.I. Department of Environmental Management (RIDEM) is the primary implementer of federal Clean Water Act requirements including pollution control and environmental permitting as well as other natural resource management responsibilities. Major issues that RIDEM is currently working to address are impacts of stormwater on state waters, managing nutrient loads from both point sources, stormwater and other sources, fulfilling its role in environmental permitting, managing the state and region's changing fisheries, and doing all this while state budgets continue to be cut. RIDEM also is responsible for managing wildlife, the state park system, land acquisition and management, forestry and agriculture, emergency response, air pollution control, the state shellfishing program, boating registration and environmental enforcement.

The R.I. Coastal Resources Management Council (RICRMC) oversees coastal zone management through planning and permitting within the state's coastal zone. RICRMC is the Rhode Island lead on ocean planning, managing marine aquatic invasive species, address coastal impacts of climate change as well as permitting projects in the coastal zone. Major permitting decisions are made by a council whose members are selected by the state's governor. RICRMC and RIDEM share responsibility for implementing the federally-funded Coastal Nonpoint Source Pollution program.

In addition, in 2004, the R.I. General Assembly created the R.I. Bays, Rivers, and Watersheds Coordination Team (RIBRWCT) with members from seven R.I. state agencies. The RIBRWCT is responsible for the coordination and integration of all state "functions, programs, and regulations that affect the bays, rivers, and watersheds [as] the most effective way to transcend the limited responsibilities and jurisdictions of each agency, address complex issues using an ecosystem-based approach, and provide for continuity over time."(RIGL 46-31) Accordingly, the RIBRWCT is tasked with working with other state agencies, local governments, federal agencies, other states, and non-government entities to develop and implement a "Systems-Level Plan" that establishes "overall goals and priorities for the management, preservation, and restoration of the state's bays, rivers, and watersheds, and the promotion of sustainable development" of Rhode Island's water-reliant economic sectors.

The R.I. Statewide Planning Program has authority over municipal comprehensive plans (created and updated per state land use planning legislation), develops and maintains the State Guide Plan which outlines required state principles and priorities and creates long term plans for various state activities. Massachusetts has created a Community Preservation Act that provides incentives for communities that develop and update local community plans. Regional planning nonprofits provide technical assistance to communities on a wide range of issues. State departments of health and transportation have major planning or regulatory responsibilities that affect funding, public health and natural resources. State emergency management agencies have an increasing role in planning for and addressing the impacts of climate change. R.I. municipalities have approval power over land use decisions while Massachusetts communities have a stronger home rule power with local authority over health and wetlands regulation.

Massachusetts has corresponding entities under the umbrella of the state Executive Office of Energy and Environmental Affairs, with separate divisions covering pollution control and permitting (Dept. of Environmental Protection), wildlife management, fisheries, and ecological restoration (Dept. of Fish & Game), land protection and recreation (Dept. of Conservation and Recreation), agriculture and forestry

(Dept. of Agricultural Resources), coastal zone management (Coastal Zone Management Program); other governmental programs address floodplain management, and climate change adaptation and mitigation.

In Massachusetts, local conservation commissions play an important role in environmental protection and management. Since 1957, conservation commissions in Massachusetts have identified important open space areas for acquisition or to secure state or federal protection for these land. They have managed lands for wildlife, recreation and other community values. The commissions review and issue permits for all development projects near or affecting wetlands and waterbodies. Commissions also work to educate citizens on important natural resource issues. They often serve as liaisons to state and regional planning agencies. Conservation commissions in Rhode Island do not have regulatory authority.

Another group of organizations that work at the state and local level are nongovernmental organizations (NGOs) such as Audubon Society or Rhode Island's Save The Bay. Major NGOs have done and continue to do work in many areas of environmental management including monitoring, mapping, habitat restoration, climate change adaptation and wildlife management. A decade ago in Massachusetts, the state organized watershed stakeholder efforts to create watershed plans as part of its effort to employ a watershed approach. Though funding ended for this effort in the latter part of the decade, citizen-based watershed groups continue to work and advocate for local watershed issues. In Rhode Island, the state passed legislation creating the R.I. Rivers Council which is an umbrella group for R.I.'s watershed organizations. The legislation provides a process for official designation as a state watershed council which gives these organizations better access to state funding and decision-making processes. The Rivers Council maintains a seat on the R.I. Bays, Rivers and Watersheds Coordination Team. To date, the state legislature has provided a modest amount of annual funding in the form of grants to individual watershed councils. The Narragansett Bay Estuary Program has provided organizational development training for a number of the state watershed councils.

In addition to state and local authority and action at the watershed level, numerous federal agencies have roles in environmental protection and restoration in the Narragansett Bay watershed. These include the Environmental Protection Agency, National Oceanic and Atmospheric Administration, USDA Natural Resources Conservation Service, U.S. Fish & Wildlife Service, U.S. Army Corps of Engineers, U.S. Food and Drug Administration, U.S. Coast Guard, and the U.S. Navy. States and municipalities often receive project funding and technical assistance from these federal partners. In fact, significant portions of both states' environmental budgets are derived from federal sources.

Even though there is a recognized need for stronger bi-state collaboration at the watershed level, there is no existing bi-state coordination mechanism to better connect state actions. Effective implementation of the CCMP Update will rely on closer coordination and cooperation between the two watershed states. One possible path to better coordination would be to build upon the existence of the NBEP Policy Committee, which consists of R.I. and Mass. agency heads along with the EPA Region 1 Administrator, in creating a coordination mechanism where the two states could agree on cross-watershed priorities and develop specific ways to work together and share resources to address such priorities.

Our local governance systems are not consistent with a watershed-based approach that recognizes the watershed as the basis for planning and action to improve ecological conditions. Land use decisions are also largely disconnected from such an approach. This state-local disconnect makes it difficult for federal programs to work more effectively at the watershed level. In 2009, a bi-state Policy Committee was created as part of the NBEP structure; it brings high level EPA and R.I. and Massachusetts state agency managers together to identify priority areas for interstate cooperation. This committee could provide a basis for a stronger bi-state coordination mechanism.

Environmental indicators are measurements that allow an assessment of the condition of the environment. Recent efforts to identify a common set of ecosystem indicators are intended to:

(a) allow more accurate statements on environmental conditions in the region to be made (and to effectively translate that information to the public);
(b) better track trends in conditions;
(c) allow more effective collaboration and pooling of resources to achieve monitoring goals; and
(d) support efforts to strengthen and increase efficiency of state and regional monitoring programs.

By tracking these measurements over time, governments can identify problems and check to see if management solutions are working. Both Massachusetts and Rhode Island take environmental measurements of water quality, fish and wildlife; some measurements are required by federal law and others are used by states to understand the ecosystems we live in and to better manage them. Indicators are most useful when they are tied to measuring progress toward goals, objectives and targets. While indicators are in use in many areas of the United States and there are many indicators that are common to these efforts, not all areas use the same indicators due to variations in local ecosystems. There has been significant effort at the federal level to develop and promote use of a common set of indicators in environmental programs.

In a report prepared for the Partnership for Narragansett Bay in 2003, technical experts agreed that we need better data on the Bay and watershed to assess condition and measure trends but that there were challenges involved in creating and maintaining a robust indicator system. First of all was getting agreement on what are the most important measurements. The cost of collecting and analyzing measurement data was also cited as was the capacity of government and others to operate the monitoring system that would be needed. Criteria need to be in place to help select the most useful indicators; criteria include relevance, appropriate scale, responsiveness to changes, quality and availability of data, and whether the indicator data was interpretable and meaningful to key audiences (PNB, 2003).

Federal funding sources have also increasingly required expanded ecosystem data in their reporting requirements. In 2009, the Narragansett Bay Estuary Program produced *Currents of Change*, a report on watershed status as defined by a broad selection of available environmental indicator data. A key finding of the report was identification of gaps (e.g., biological data, consistency in data, data that allows trend tracking, etc.) in spatial and temporal indicator data for the Bay watershed. Watershed stakeholders have also identified improving accessibility to existing data as another important problem that needs to be solved. Recent indicator efforts are concentrating on filling those identified data gaps.

Another challenge regarding indicators is that current monitoring practices are not developed around an ecosystem-based conceptual framework. Building off the recommendations in the 2003 PNB report, work is underway to make progress toward the goal of an integrated monitoring framework using agreed-upon key indicators that help us make more definitive statements about ecosystem condition. Currently, the Watershed Counts initiative (organized by the Narragansett Bay Estuary Program, the URI Coastal Institute, and the R.I. Environmental Monitoring Collaborative created under the RIBRWCT) are in the midst of an effort to identify and further refine indicators at the bi-state watershed level while reporting on environmental conditions to policy makers and the public. Also, monitoring programs in both states have been adjusting their practices to reflect improved indicators and monitoring technology.

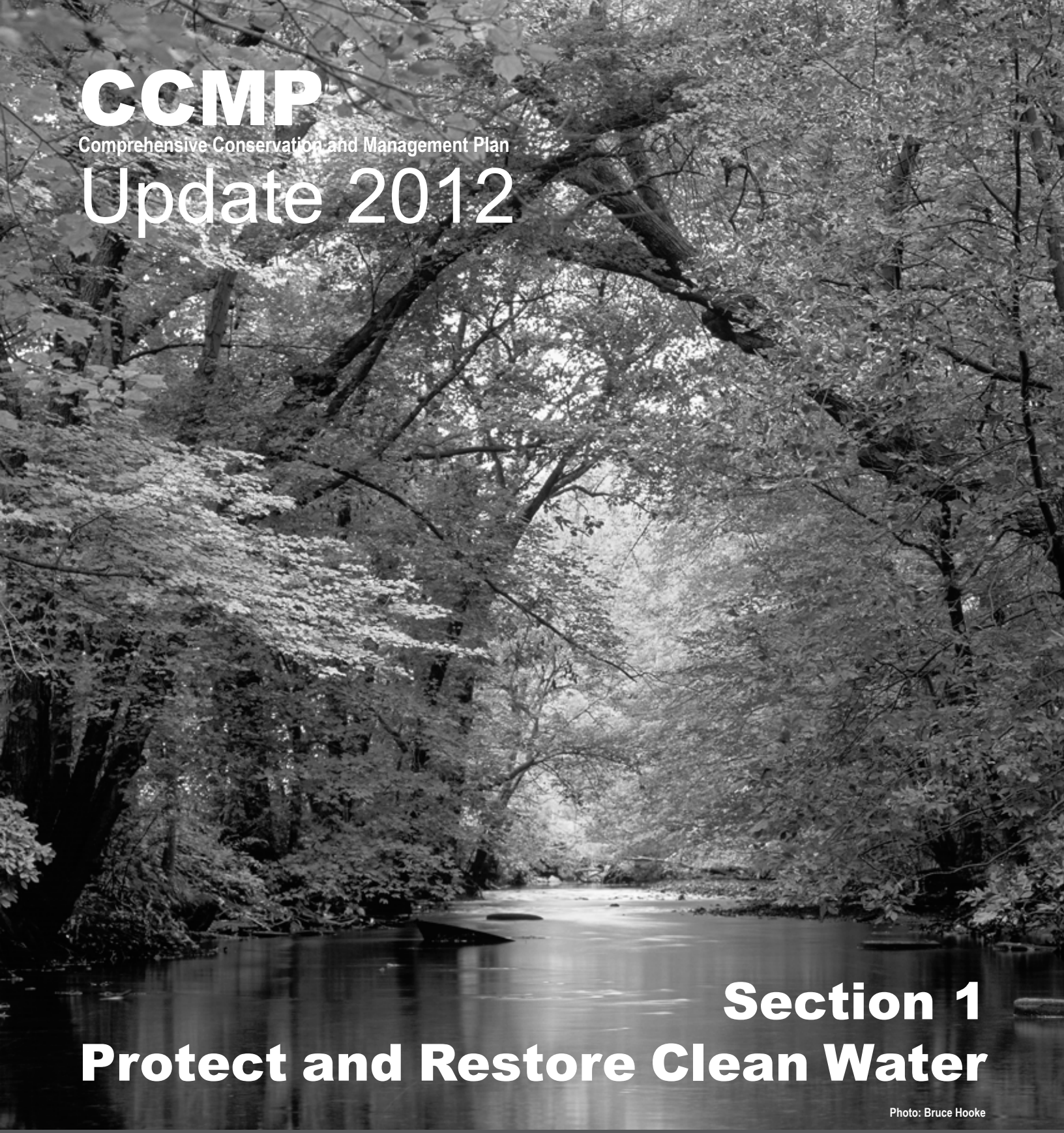
CCMP Update 2012 identifies indicators that are either in use or have been considered for use in measuring ecological conditions related to the plan topic areas. See the appendices (page 59) for a list of indicators by section that relate to assessing condition; some of these are in use while others have been identified as needed measurements. The ideal situation is to have an indicator system for the Narragansett Bay region that allows us to measure progress toward goals, increase our understanding of ecosystems and how they change, and develop ways we can better manage our natural resources.

Scientists survey dock for invasive species in Narragansett Bay.

CCMP

Comprehensive Conservation and Management Plan

Update 2012



Section 1
Protect and Restore Clean Water

Photo: Bruce Hooke

GOAL

Restore, conserve and maintain high quality fresh and salt water throughout the Narragansett Bay watershed, and ensure it is available in sustainable quantity to meet human and ecological needs such as fish and wildlife habitat, recreation, drinking, irrigation, commerce and industry.

OBJECTIVES

1. Reduce pollution from wastewater sources
2. Reduce pollution from stormwater sources
3. Reduce pollution from combined sewer overflows
4. Manage rivers, streams and lakes to balance human and ecological needs
5. Improve funding for water quality and quantity improvement and for resource assessment / monitoring
6. Improve science, analysis and management practices necessary to restore and protect fresh and salt waters.

PROBLEM

Pollutants from a variety of sources, alterations of flow and increasing demand are having negative impacts on water resources.

With over 40 inches of rain a year and an extensive riverine network, water has always been a resource we thought we could depend on whether for drinking, irrigating, or meeting industrial and commercial needs. Our water resources have met critical human and societal needs but have also provided the ecological foundation for a healthy ecosystem where rivers, wetlands, lakes and estuaries provide key habitat for fish and wildlife.

In recent times, we have placed increasing pressure on the use of our freshwater resources by expanding water supplies to meet increasing demand. As land conversion accelerated over the last 40 years, so has water consumption; a significant factor in water use has been for lawn irrigation. Concerns have been raised that we will have inadequate supply to support increased economic activity.

We also have created pollutants that harm water quality, engaged in land use practices that result in polluted stormwater, and altered freshwater flows that can degrade important habitats. We have used our waterbodies as a sink for pollutants.

Wastewater discharges from treatment plants, cesspools and on-site waste treatment systems and stormwater runoff from suburban and urban landscapes have negatively affected the rivers and estuaries of the region through bacterial contamination, streambed erosion, degraded habitat, low dissolved oxygen and nutrient enrichment. Though partially addressed by the first phase of construction of bedrock-level storage tunnels in the Providence and Fall River areas, combined sewer overflows in Providence, Worcester, Newport and Fall River discharge untreated wastewater after rain events, impacting urban rivers and Narragansett Bay. Aging sewer infrastructure that has been inadequately maintained has resulted in sanitary sewer overflows or SSOs (leaks, blockages and malfunctions of sewer systems). Atmospheric deposition is a significant source of mercury and also a source of nutrients. Land use patterns and water withdrawals affect stream flow, depressing flow during the summer and creating unnaturally high flows during rainstorms or snowmelt. Loss of infiltration on the landscape reduces water available for groundwater recharge, affecting drinking water supply and freshwater flow. Anticipated climate change impacts including increased storm intensity, temperature change and sea level rise will have to be accounted for in management responses to these problems. Reducing key pollutants will control and/or reduce the instances of low dissolved oxygen, improve the sustainability of aquatic life, including eelgrass, and reduce the number of days shellfish beds and beaches are closed to public use.

One issue that has been consistently raised in environmental management discussions is the need for continued funding for critical water programs (including stormwater, wastewater and water supply) many of which have seen significant funding reductions in recent years. Local communities have limited capacity and financial resources with which to address these needs. With ongoing changes in management practices and emerging impacts of climate change, it is even more important to track status and trends to better assess our management efforts and prepare for future change.

While our wastewater pretreatment programs have been successful in capturing toxic metals and organics in the waste stream (or removing them before they are discharged), new chemicals and chemical products—including pharmaceuticals, personal care products and fire retardants—have been introduced into the national and international marketplace that are now being detected in the environment and some have been shown to bio-accumulate in humans. The impacts of these new, untested chemicals are not known; what is known is that they have entered the ecosystem. And current wastewater treatment technology is not designed to remove these contaminants.

Bedrock-level storage tunnel for combined sewer overflow underneath Providence, R.I.

The area around Narragansett Bay is densely populated, with urban centers clustered around the upper Bay and its major rivers. This pattern has created a general water quality gradient along the Bay's north-south axis. Sources of pollution are concentrated in the Bay's upper reaches, including public waste water treatment facility (WWTF) discharges, stormwater and combined sewer overflow (CSO) outlets, and urban runoff from densely developed areas. These sources discharge either directly into estuarine waters, or into rivers which then carry pollution to the upper Bay.

Pollution tends to decrease toward the mouth of the estuary due to dilution by seawater moving up the bottom of the deep East Passage, as well as the fact that there are fewer point sources. Because of this gradient and the hydrodynamics of the Bay, the Bay has at least four significant sub-areas which do not necessarily behave similarly from the standpoint of water quality (Costa-Pierce et al., 2007). These are:

- Providence River and Seekonk River areas, from approxi mately Conimicut Point (Warwick, R.I.) north;
- Upper Narragansett Bay, from Conimicut Point south to approximately the north end of Prudence Island;
- The Mid-Bay, from the northern end of Prudence south to the Jamestown and Newport Bridges;
- Lower Narragansett Bay, from the bridges south to an imaginary line drawn from Point Judith, R.I., to Sakonnet Point. This line is often used to define the southern limit of Narragansett Bay, and also serves as the seaward boundary for the Narragansett Bay Region as defined by this report.

In Mount Hope Bay, a similar north-south pollution gradient is seen with pollution sources concentrated near highly urbanized Fall River, Massachusetts. In addition, there are exceptions to the overall pollution gradient created by Narragansett Bay's complex hydrography. Small embayments, harbors and coves such as Greenwich Bay and Wickford Harbor are potentially more vulnerable to local sources of pollution due to poor flushing. Greenwich Bay has been clearly documented to exhibit significant impacts (severe hypoxia) from excess nutrients.

One of the most important forms of pollution affecting Narragansett Bay (and other marine waters) is excess nutrients, specifically nitrogen, which can have profound effects on estuarine ecosystems. Excessive nutrient levels stimulate algae growth; when the algae die and decompose, the decomposition process involves bacteria that use up dissolved oxygen in the water column, which negatively affects aquatic life. Episodes of low dissolved oxygen can be caused by a number of factors including algae decomposition, reduced flushing, stratification of waters, rainfall events, wind direction, temperature and other biological factors. However, in terms of management of the areas' waters, reduction of nitrogen from human activities is the only factor we have any control over and nitrogen reduction practices have been shown to have a beneficial effect on water oxygen levels as evidenced in estuaries like Tampa Bay (Bay Soundings, 2008). Both states' assessments of state waters identify nutrient pollution as a major impairment in waterbodies (MADEP, 2010; RIDEM, 2010).

Before development of the Bay watershed, the greatest source of nutrients to the Bay was ocean bottom water. Agricultural and urban development created large new sources of runoff, carrying nutrients from the land. As development increased, human waste became a significant source of nutrients. In 1871, Providence centralized the city's public water system, bringing water initially from the Pawtuxet River to city residents and businesses. The introduction of running water changed waste disposal from an essentially dry disposal system (outhouses, etc.) to plumbing which disposed of wastewater into street gutters and cesspools, where it made its way into the rivers and bay.

The resulting pollution resulted in an immediate need for a sewage collection and disposal system. The number of people served by sewer systems in Providence and cities in the upper Bay steadily increased from 1871 until about 1950 and it has held relatively steady since that time (Nixon, et al. 2005). Today, two million people living in the Bay watershed contribute thousands of tons of nitrogen to the upper Bay annually by way of 35 wastewater treatment facilities (WWTFs) in Rhode Island and Massachusetts (NBEP, 2009). Nitrogen loads have begun to decline (35% drop in total nitrogen to the Upper Bay from WWTFs estimated for 2006) due to improved nitrogen removal at eight major WWTFs discharging to the upper Bay and its tributaries (Oviatt, 2012. pers comm.). Eventually, eleven WWTFs discharging to the Seekonk-Providence Rivers or just upstream will remove nutrients. In order to reach the State's desired goal of 50% decrease in nitrogen loads to the Upper Bay from WWTFs, several major upstream plants in Massachusetts must also participate. US EPA has issued permits with nutrient limits to three major WWTFs impacting the Seekonk-Providence Rivers and the Upper Bay. Efforts are also being made to reduce nonpoint source loadings of nutrients including nitrogen removal by specialized onsite wastewater treatment systems for some coastal areas not served by municipal sewers and stormwater treatment using both regulatory and public education means.

Heavy metals and other toxic compounds were formerly a major source of pollution to Narragansett Bay, as with other urbanized estuaries. Due to modern discharge regulations, improved wastewater pretreatment, and the decline of Northeastern manufacturing, these inputs have greatly decreased (NBEP, 2009), although many of these contaminants can still be found in the sediments of the rivers and upper Bay, where they create problems for fish consumption as well as management hurdles.

Bacterial pollution presents challenges – sources sometimes cannot be readily identified and fixes are not always obvious. Storm water and road runoff are now possibly the greatest sources of bacteria to Narragansett Bay, affecting estuarine habitats and prompting the permanent or conditional closure of beaches and shellfish beds. Aside from human sources, the Bay region has significant populations of waterfowl that are a major source of bacteria to waterbodies. Other environmental impacts on the bay include thermal and water withdrawal impacts and impingement/entrainment of young fish and fish larvae related to power generation facilities as well as atmospheric deposition of pollutants like mercury. These are often carried from distant sources including fossil fuel power generating facilities and mobile sources.

The region's rivers are significantly affected by stormwater inputs, flow issues, metals in river sediments and impaired biological communities. A number of rivers and streams in the watersheds are affected by changes in freshwater flow. There is a natural variability in terms of water volume based on precipitation but water withdrawals can exceed thresholds below which there are negative impacts to ecosystems and habitat. Also, developed landscapes lead to concentrated stormwater volume and rates that cause erosion, thermal impacts, flooding and carry pollutants into watercourses. Anticipated increased frequency and intensity of storm events due to climate change will need to be addressed in all areas of water management.

Rhode Island's coastal salt pond region faces problems related to its unique setting and conditions. It is a system of shallow, poorly flushed ponds surrounded by summer and year-round housing on septic systems. Population density in the area accelerated rapidly in the post-WWII era – the number of houses doubled every 15 years over the 1940-1990 period (Nixon, Buckley, 2007). A Rhode Island CRMC special area management plan identified nitrogen loading and bacterial contamination as its primary water quality issues (R.I. CRMC, 1999). It was estimated that 60-90% of nitrogen inputs to the ponds are from septic systems (Nixon, Buckley, 2007). Nutrient enrichment of the levels seen have multiple impacts including low levels of dissolved oxygen, food web changes, reduced biodiversity, loss of eelgrass beds, decreases in fish and shellfish, and appearance of harmful algal blooms.

INTEGRATED WATER MANAGEMENT

The waters of the NBR are connected in a variety of ways. Without clean and healthy rivers, streams, lakes, aquifers and wetlands, we cannot have a clean and healthy Narragansett Bay. We depend on our waters for drinking water supply, wastewater dilution, energy production, irrigation, recreation, transportation and habitat for healthy fish and wildlife. Our economic future depends on having sufficient clean water to support the growth and development of industry. Well-functioning water systems provide ecosystem services that are critical to our communities, preventing flooding and storm damage and providing productive habitat where fish and wildlife can thrive. The choice is not between a healthy environment and a strong economy – we need both. The real choice is between sustainable use of water resources that meets multiple community needs and non-sustainable use that meets only a few.

In 1996, the American Water Works Research Foundation produced a report (AWWA, 1996) on managing water resources in an integrated manner. It used the term "total water management" and listed principles for water management, including:

- Use water systems planning and management approaches that adapt to changing conditions;
- Balance competing uses through allocation processes that address cost effectiveness, social equity and environmental benefits and costs;
- Use collaborative and coordinated processes involving governments and stakeholders;
- Promote water conservation, source protection, water reuse, and water supply development to enhance water quantity and quality;
- Promote public health, safety and address community needs.

A recent report by the Massachusetts River Alliance, Water 2020 (MRA, 2010), highlights the need to take a holistic perspective to water management and identifies four ways we can protect and sustainably manage vital water resources. These are:

- Keep rivers flowing during dry times and minimize flooding in wet times;
- Clean up polluted waters and make sure they stay clean;
- Ensure that our waters support fish and other aquatic life;
- Invest in water and water infrastructure.

In Rhode Island, the R.I. State Planning Council has recently adopted a new State Guide Plan Element, entitled RI Water 2030 (RIDOA, 2012). The document supports taking an integrated approach to water management and planning. It promotes regional action, conservation and efficiency, tying land uses to water supply capacity, use of land management techniques to protect waterbodies and wetlands, use of low impact designs (LID) to manage stormwater and recharge groundwater, better connecting local land use plans to watershed protection strategies, and managing use and withdrawals based on capacity, public health and protection of aquatic resources. If we can implement a framework based on these principles, we will better ensure that we can meet current needs while also providing for future needs.

WATER QUALITY MONITORING

Water quality monitoring is a critical component of both states' environmental management efforts. USEPA lists five major reasons that monitoring is so important. It allows managers and scientists to:

- Characterize waters and identify changes or trends in water quality over time;
- Identify specific existing or emerging water quality problems;
- Gather information to design specific pollution prevention or remediation programs;
- Determine whether program goals—such as compliance with pollution regulations or implementation of effective pollution control actions—are being met; and
- Respond to emergencies, such as spills and floods.

The state Clean Water Act agencies in Rhode Island and Massachusetts, RIDEM and MADEP, have primary responsibility for monitoring activities at the state level. Water quality monitoring data is needed in order to assess compliance with state and federal permits and to identify specific water quality problems in state waters. Massachusetts and Rhode Island have both developed comprehensive state water quality monitoring strategies that identify a range of activities; at present, only some components of those strategies are operational. Both states conduct five-year rotating assessments of subwatersheds and do targeted monitoring to support TMDL development. Massachusetts is monitoring to assess bio-accumulation. Rhode Island used federal earmarks to build a fixed station network of 13 data buoys in Narragansett Bay to provide real-time data. Since the early 1990s, RIDEM has conducted macroinvertebrate monitoring at a range of sites on R.I. non-wadeable streams while Massachusetts uses rapid bioassessment protocols (RBPs), based on those developed by EPA, to monitor the health of benthic macroinvertebrate communities. The Narragansett Bay Commission (NBC) operates an environmental monitoring program measuring nutrients, totals suspended solids, chlorophyll,

water clarity, fecal coliform, and other water quality parameters in the Upper Bay and also measures these parameters on major rivers entering the Bay from Rhode Island and Massachusetts (NBC, 2011). NBC, with the support of the RIBRWCT and the URI Graduate School of Oceanography (URI-GSO), recently began monitoring the phytoplankton population of the Providence River, which complements the URI-GSO phytoplankton monitoring in the lower Bay. RIDEM provides funding to URI's Watershed Watch volunteer monitoring program to collect data on 133 lake sites since 1988.

Through joint funding agreements with partners, the USGS maintains 45 streamflow gauges in the Narragansett Bay region—15 in Massachusetts and 30 in Rhode Island (USGS, 2012). Real time flow readings are available on the USGS website. In Rhode Island, funding from the R.I. Bays, Rivers and Watersheds Coordination Team partially supports the streamflow gauge network.

The R.I. Environmental Monitoring Collaborative, created under the RIBRWCT, identifies state agency monitoring priorities and needs and makes recommendations to the RIBRWCT regarding the use of Team funding (derived from state fees) to support a number of water quality monitoring efforts. The seven state agencies represented on the RIBRWCT have voted to provide funding support for a number of critical state water quality and other monitoring efforts. (R.I. Env-MC, 2010). See http://www.ci.uri.edu/Projects/RI-Monitoring/Docs/2010RIEMCReport-FINAL.pdf for details.

SUMMARY OF WATER QUALITY / QUANTITY MANAGEMENT INITIATIVES

As primary implementers of the Clean Water Act and other federal and state laws, Rhode Island and Massachusetts state agencies have worked closely with local governments, NGOs, the public, and federal partners for over 30 years to manage and reduce existing sources of pollution, avoid creation of new ones, and ensure that our water bodies achieve the highest possible biological, physical, and chemical integrity. In recent years, state agencies and conservation NGOs have worked on new approaches to help municipalities proactively plan for environmental protection and improvement using low impact development and other cost effective techniques.

There is an extensive network of regulatory programs in both states. Key agency regulatory programs include total maximum daily load (TMDL) assessments, water quality monitoring programs, wastewater treatment facilities, onsite waste treatment, industrial pretreatment, wetlands permitting, combined sewer overflow, sanitary sewer overflow, management of fish and wildlife, air quality, forestry, land management and coastal resources management. Water-based discharges are regulated in both states; Rhode Island has federally-delegated authority to do so but discharge permitting in Massachusetts is overseen by the EPA (Massachusetts is not a delegated state). One issue related to TMDLs is that the program can assess water quality problems but capacity for local implementation is problematic; communities often lack the resources to take needed action.

Rhode Island has made impressive progress in its work to address combined sewer overflows. A project to construct bedrock-level tunnels to store combined sewer and stormwater was undertaken by the Narragansett Bay Commission (NBC) and completed in 2008. Since it has gone into operation, a 26% reduction in fecal coliform bacteria counts per 100 ml sample size has been seen in the Upper Bay after a rainfall event. Removing sampling data from the extreme precipitation events that took place in March 2010, the percentage increases to 34% in the Bay. In Upper Bay conditional shellfishing areas, there has been a 62% decrease in bacteria counts (excluding the March 2010 readings) (NBC, 2012). State protocol has been adjusted accordingly to allow more open days per year of shellfishing in these conditionally opened areas. NBC also has instituted a stormwater mitigation program the requires developers to evaluate and incorporate low impact design practices into project design plans; since implemented in 2003, the program has prevented over 6.1 million gallons of stormwater from entering the NBC collection system (NBC, 2012).

Regional sewer infrastructure, most of which was constructed in the U.S. between 30 and 100 years ago (EPA, 2012), has in many cases deteriorated over time and led to increased incidence of sanitary system overflows (SSOs) which are releases of untreated sewage into the environment. This has been a problem in both watershed states and state environmental agencies have been working with EPA on an integrated strategy to increase system maintenance to prevent SSO occurrences. Both states have also been working to update WWTF plans to address impacts of climate change. Wastewater treatment facilities have also experienced a demand for increased level of treatment and a need for more advanced infrastructure, increasing the financial and technological burden on sewage treatment agencies.

Both Rhode Island and Massachusetts have worked to better manage nutrient loadings to water systems. In Rhode Island, state legislation passed in 2004 mandated a 50% reduction in nitrogen loads from major wastewater treatment facilities discharging to Narragansett Bay. Wastewater facilities have been implementing these reductions and, combined with new CSO treatment, it is anticipated that there will be measureable changes in nutrient impacts in the Upper Bay. The Massachusetts Estuaries Project (http://www.oceanscience.net/estuaries/about.htm) has analyzed the state's coastal waters to determine nutrient sources, loads, and allocations in an effort to better manage nutrient pollution. The state is assessing 89 embayments and developing information on hydrodynamics, land use, and water quality to be used in models that indicate how land management techniques will affect nutrient loads. EPA's Region 1 office and the Atlantic Ecology Division lab have initiated a new Nutrients Sustainability project for Narragansett Bay to help address nutrient problems at a regional scale. The Narragansett Bay Commission (NBC), working with University of Rhode Island researchers, has conducted work using models of the Upper Bay to predict circulation, mixing and transport processes. NBC also operates an Upper Bay receiving water monitoring program to measure (www.narrabay.com, 2012) water quality parameters including dissolved oxygen, bacteria, temperature, chlorophyll and salinity.

Stormwater has been identified by both Mass. and R.I. as a priority issue for the watershed. Programs targeting stormwater include requirements that both states and municipalities have to address in order to prevent stormwater impacts, maintain current stormwater infrastructure and retrofit existing problems. Both states are required to implement the federally-mandated Phase 2 stormwater permitting

program. Under the Phase 2 program, municipalities located in urban areas as defined by the Census Bureau are required to obtain National Pollutant Discharge Elimination System (NPDES) permit coverage for discharges from their municipal separate storm sewer systems (MS4s). In addition, construction sites that disturb one acre or more are required to be covered under the NPDES general permit for storm water discharges.

Both states have developed and implemented updated stormwater manuals that provide communities and the building community with guidance and requirements for treating and managing stormwater. A major issue is retrofitting existing infrastructure which is the source of significant stormwater discharges; new state policy needs to be developed and implemented to better address this problem. There is a need for closer collaboration and coordination between both states on this issue.

Both Rhode Island and Massachusetts are promoting the use of green infrastructure practices which are "systems that mimic natural processes in order to infiltrate, evaporate, and/or reuse stormwater. Green infrastructure uses soils, topography, and vegetation in a way that minimizes the impacts of anthropogenic disturbance and maintains the pre-development hydrology and water quality of urban environments" (SUNY, 2012). Green infrastructure techniques are often referred to as low impact development (LID) practices. Rhode Island has declared that the implementation of LID designs and techniques will be its primary policy for new development and certain types of redevelopment. Promotion and implementation of LID is one area where both watershed states could work more closely together; they have started that process in a joint stormwater technical assistant project in the Blackstone and Ten Mile River watersheds. LID implementation requires changes and new perspectives in managing development – it takes advantage of capturing water onsite, better conserving water and treating it as a resource that should not just be channeled away. R.I. is planning on creating a builders' workgroup to broaden understanding of how LID can be applied and to assess how the state can best address LID implementation. Both states have been exploring the development of stormwater utility districts at the municipal level as a way to create revenue to fund stormwater management; particularly the higher costs associated with retrofitting existing drainage systems. A new stormwater utility pilot project is underway in Middletown, R.I.

Local capacity – both staff and funding - to act on these requirements has been an impediment to stormwater management efforts. And many of these programs rely on federal agency sources of funding to support state programs. Both states share the challenges above as well as the challenge of sustainable funding for these critical government programs that address ecosystem goals. In recent years, spending for environmental management in both states has been significantly scaled back. Massachusetts' innovative stakeholder-based Watersheds Program was eliminated in budget cuts several years ago. Recognizing the effectiveness of the watershed approach model of management, a new EPA initiative is requiring state nonpoint source pollution plans be oriented toward watersheds and broader in scope than was previously required. The plans are designed to be interactive and adaptive, use a holistic process, be geographically defined, be integrated with other planning efforts, and use a collaborative and participatory process (EPA, 2008).

Municipal authorities make land use decisions and, in Massachusetts, manage public health and handle permitting for wetlands and onsite waste systems. In Rhode Island, state law requires that local zoning ordinances be consistent with long term municipal comprehensive plans which are required to address environmental issues. In both states, lack of capacity has hindered environmental management actions at the local level.

Nongovernmental organizations provide additional capacity in the areas of training, education, land acquisition, environmental monitoring, coastal and watershed restoration, and advocacy. NGO capacity is variable; those organizations with permanent staff have a greater ability to implement. A number of these organizations have increased capacities and have taken increasingly significant roles in recent years to help move toward watershed goals. Sustainable funding and increasing public engagement are challenges for these organizations in these recessionary times. In Rhode Island, the legislatively-created R.I. Rivers Council works to build capacity for local watershed groups.

Management of freshwater flow is handled differently in each state. Massachusetts has a water withdrawal permitting process and water use data reporting requirements that are not available in Rhode Island, giving Massachusetts authorities better information on which to develop management options and demand projections. A new element of the R.I. State Guide Plan addressing water supply, R.I. Water 2030, includes recommended actions that would increase reporting requirements for water users and provide needed use data to the state. The plan element also recommends that stream flow depletion standards be established.

Polluted stormwater causes serious water quality problems in the Narragansett Bay region.

Priority Actions = shaded blocks; (Year) = target completion date, ⟳ = in progress, ACRONYMS see page 68.

1.	Reduce pollution from wastewater sources	Primary Implementing Parties
1.1.	Issue and implement revised EPA New England permits for nutrient controls at waste water treatment facilities (WWTFs) located in Mass. portion of the Blackstone River and Ten Mile River watersheds (2017) ⟳	U.S EPA, MADEP, WWTFs
1.2.	By 2014, complete upgrades needed to implement nutrient reductions at eleven R.I. WWTFs to achieve 50% reduction in total nitrogen discharges (May to October) from WWTFs discharging into upper Narragansett Bay or its major tributaries (2014) ⟳	RIDEM, select RI WWTFs
1.3	Accelerate the elimination of cesspools by adoption of additional phase out requirements (2014)	R.I. General Assembly, RIDEM
1.4	Reduce the impacts of residential and commercial septic systems on water quality by implementing inspection, maintenance and financial assistance programs, and promoting adoption of more effective treatment technologies ⟳	RIDEM, RICRMC, WWTFs, RICWFA, MADEP, RI municipalities, MA local boards of health
1.5	Pursue changes to state laws that will ensure that properties with onsite wastewater treatment systems in existing service areas will be connected to sewer lines	RI & Mass. legislatures, RIDEM, MADEP, WWTFs, municipalities
1.6	Extend sewer service to critical areas with failing onsite waste systems including Island Park (Portsmouth) and areas surrounding Greenwich Bay.	RIDEM, municipalities
1.7	Ensure that existing wastewater treatment and conveyance infrastructure is sufficiently maintained on an ongoing basis to detect, reduce instances of, and prevent Sanitary System Overflows (SSOs) and other system problems	RIDEM, MADEP, EPA, state legislatures
1.8	Determine areas where advanced septic system treatment systems should be required to protect sensitive waters and other resources.	RIDEM, MADEP, EPA, municipalities

2.	Reduce pollution from stormwater sources	Primary Implementing Parties
2.1	Provide enhanced funding and technical assistance to municipalities in key areas of stormwater management – operations & maintenance, assessment, illicit detection, stormwater system retrofits, public communications, and financing	RIDEM, MADEP, NGOs, universities, NBEP
2.2	Prioritize retrofitting of BMPs to areas most affected by stormwater impacts, using LID and including physical and habitat restoration where feasible to achieve water quality goals	RIDEM, MADEP, municipalities
2.3	Evaluate compliance and effectiveness of existing Phase II MS4 permits; use this information to devise strategies and incentives to improve compliance	RIDEM, MADEP,USEPA NPDES, municipalities
2.4	Use the Phase 2 stormwater permitting process as a tool to encourage more effective local management of stormwater including adequate maintenance, use of best management practices, and appropriate pre- and post-construction stormwater controls	RIDEM,USEPA NPDES, municipalities, RIDOT, MADOT
2.5	Use the joint technical assistance RIDEM/MADEP project in the Blackstone, Ten Mile and other relevant stormwater efforts to pilot an approach for providing technical assistance to municipalities in implementing Phase II stormwater requirements ⟳	RIDEM, MADEP, USEPA NPDES, municipalities
2.6	Support regional efforts to reduce and manage fertilizer use	State legislatures, RIDEM, MADEP, NRCS, NEIWPCC, NBEP, USEPA
2.7	Ensure that data systems capture information on stormwater BMPs to assess effectiveness and track performance	MADEP, RIDEM, RIGIS, MAGIS
2.8	Update soil erosion and sediment control manuals in both Rhode Island and Massachusetts	RIDEM, RICRMC, MADEP, NRCS
2.9	State and local governments should work with retail operations to reduce or eliminate the use of single-use, non-biodegradable plastic bags through incentives, bans or other methods to reduce pollution of waterways and protect aquatic life	State legislatures, municipalities

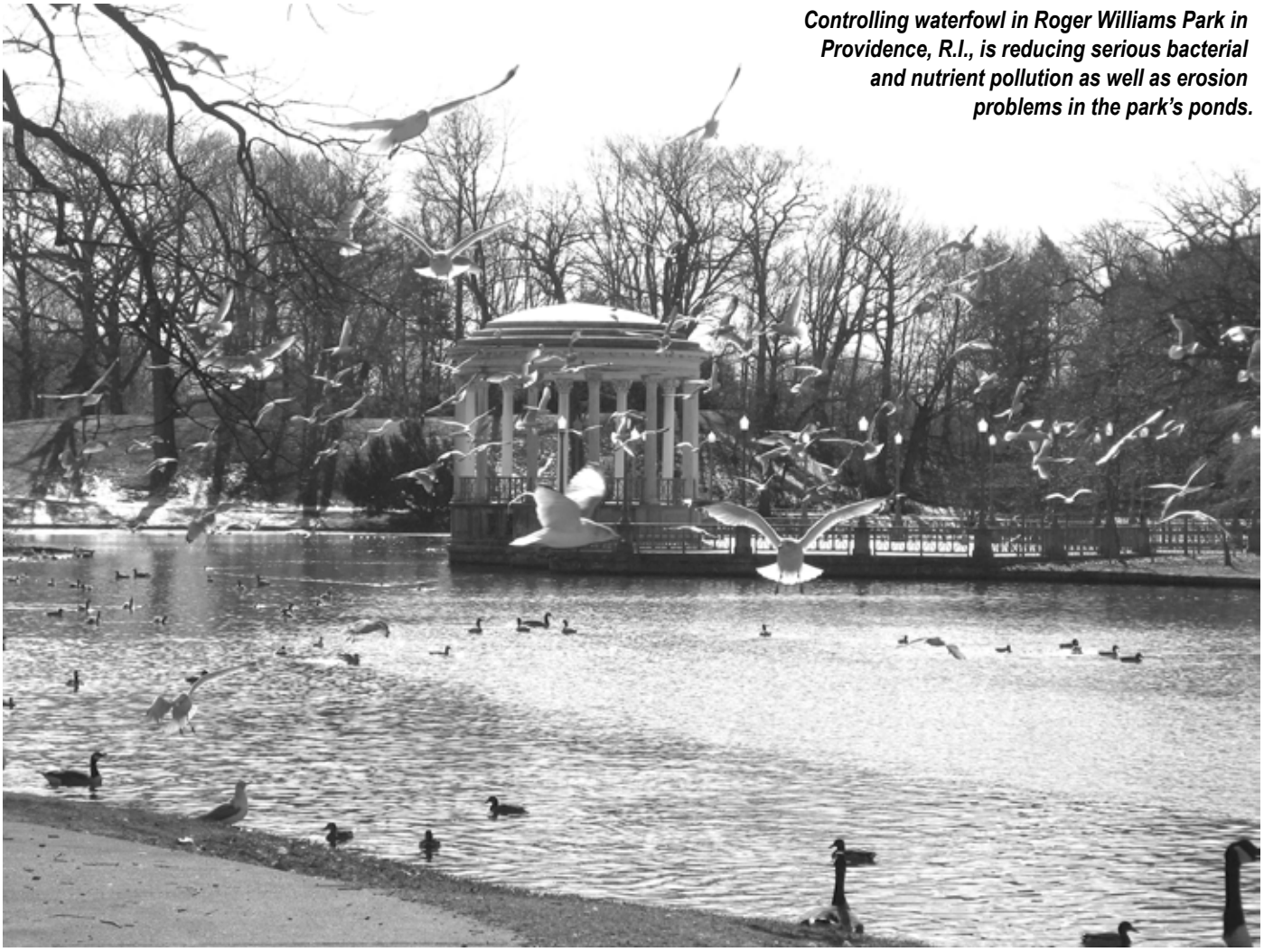
2.10	Enhance state DOTs capacity to construct prioritized stormwater retrofits using LID practices as identified in state stormwater manuals	RIDEM, MADEP, RICRMC, RIDOT, MADOT, legislatures

3.	Reduce pollution from combined sewer overflows	Primary Implementing Parties
3.1	Complete planned NBC Phase 2 by 2014 and initiate planning for Phase 3 that considers incorporating LID methods; complete CSO abatement projects in Newport (2015) and Fall River (2019) ⌃	RIDEM, MADEP, NBC, WWTFs
3.2	Complete assessment of Providence CSO phase 1; report on results and assess effectiveness of other CSO projects as completed ⌃	RIDEM, MADEP, NBC
3.3	Identify and implement LID and urban green infrastructure programs and practices that will optimize the performance of CSO abatement projects	NBC, RIDEM, MADEP, Fall River, municipalities

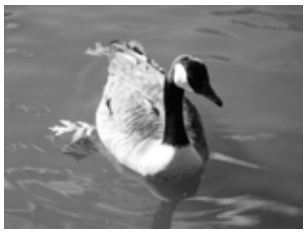
4.	Manage estuaries, rivers, streams and lakes to prevent degradation and restore beneficial uses	Primary Implementing Parties
4.1	Implement scientifically-based water management to restore and protect streamflow and ensure sustainable yields including methodology that accounts for current and future land uses, impacts on aquatic systems and inter-basin transfers (2015)	RI WRB, Mass. water management authorities, RIDEM, MADEP, water suppliers
4.2	Fully utilize watershed-based plans, such as stakeholder-based plans, NPS plans, TMDLs, and special area management plans to coordinate prioritized actions to protect, restore and manage the land and water (including groundwater) resources within watersheds (2015)	RIDEM, MADEP, NGOs, watershed groups, conservation commissions
4.3	Build and increase capacity of nongovernmental organizations in implementing protection and restoration actions	RIDEM, MADEP, RICRMC, MACZM, RIDOT, MADOT, NBEP, USEPA, NGOs, NERRS, MA & RI NRCS
4.4	Rhode Island and Massachusetts should work with EPA to identify nutrient management regimes that identify specific management goals or targets for nutrient levels in both states' waterbodies	USEPA, RIDEM, MADEP
4.5	Update and implement state management plans to protect ground water and surface water resources from priority pollutant risks ⌃	RIDEM, MADEP

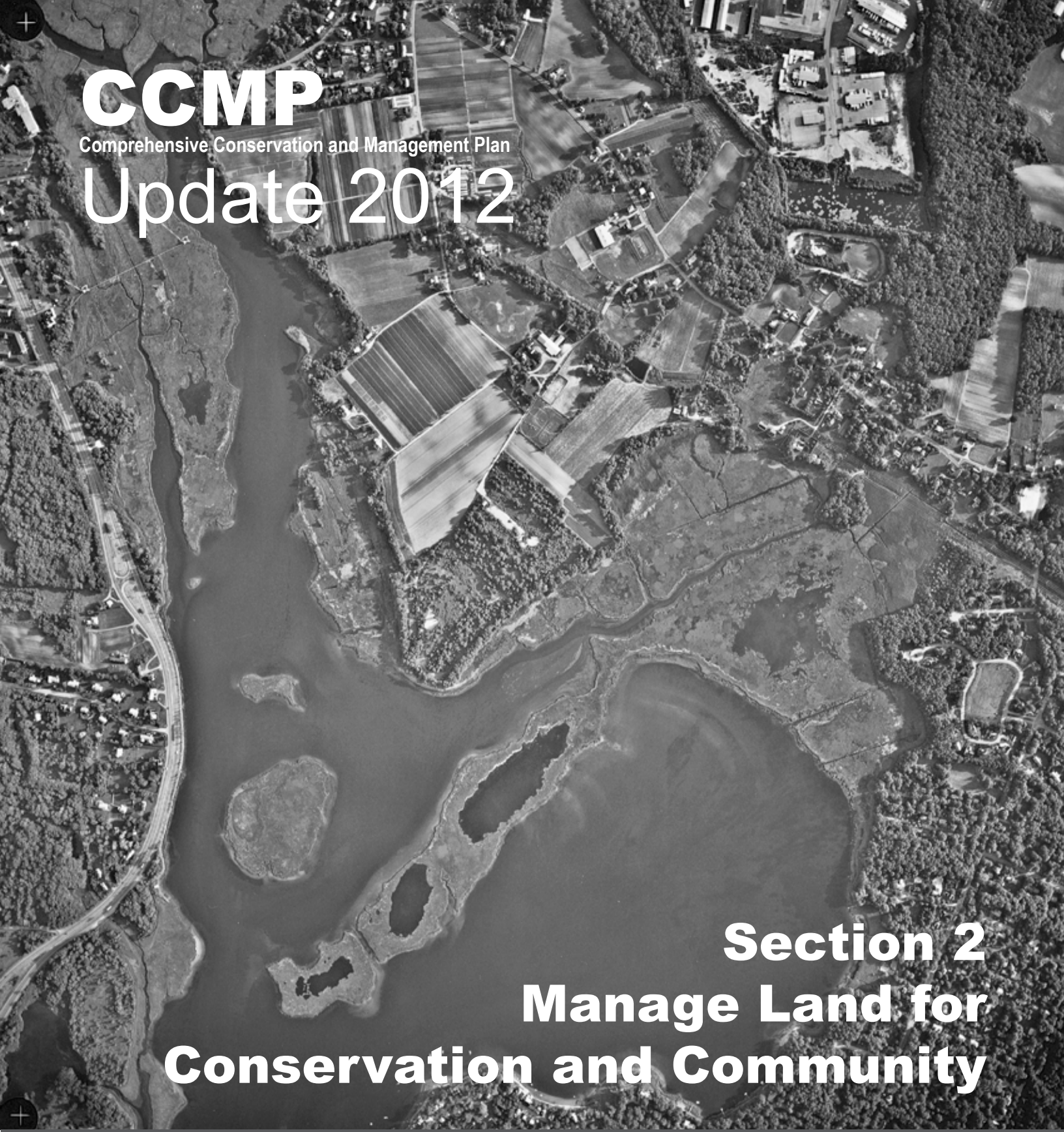
5.	Improve funding for water quality and quantity improvement and for resource assessment and monitoring	Primary Implementing Parties
5.1	Provide sufficient resources, staffing and operational funds to maintain and fill in gaps in existing monitoring and assessment programs in both Rhode Island and Massachusetts including designated monitoring coordinators in both states	RI & Mass. municipalities, NGOs, legislatures, state agencies
5.2	Develop new or expand existing funding mechanisms at the state and local level (especially consider utility districts) to meet stormwater/water quality infrastructure needs ⌃	RI & Mass. Legislatures, RIDEM, MADEP
5.3	Advocate for adequate federal SRF and other federal funding for water and wastewater infrastructure, stormwater treatment, and nonpoint source pollution management and other actions in an approved CCMPs and nonpoint source management plans ⌃	RI & Mass. municipalities, legislatures and agencies
5.4	Support and advocate for environmental bond funds in both states to support water quality and resource goals	Municipalities, NGOs, citizens
5.5	Develop mechanism (e.g., regional workgroup) to examine local capacity to implement required environmental programs; examine regional solutions; report on funding issues related to local capacity to implement	RIDEM, MADEP, municipalities, NGOs, NBEP, universities
5.6	Develop improved state mechanisms that efficiently distribute and manage small grants to partner organizations and facilitate access to grant funding while meeting governmental fiscal management requirements; examine governmental fiscal management requirements for improvements that will advance this action	RIDEM, MAEOEEA, RICRMC, RIDOP, Mass. regional planning agencies
5.7	Continue support for the R.I. CSSLP program to encourage cesspool removal and OWTS upgrade; in Massachusetts, consider adopting a funding mechanism similar to the R.I. Community Septic System Loan Program (CSSLP)	RIDEM, MADEP, RICWFA
5.8	In non-sewered areas, increase the number of municipalities that participate in R.I.'s CSSLP	RIDEM, municipalities, RICWFA

6.	Improve information, science and analysis that support management efforts necessary to restore and protect fresh and salt waters	Primary Implementing Parties
6.1	Effectively manage, analyze, synthesize and make available data to support management decision-making, characterize environmental condition trends linked to ecological indicators, prioritize investments and communicate to the public. Continue development of data driven analytical tools, e.g., predictive models, biological indices, etc. ^	RIDEM, MADEP, RICRMC, MACZM, NBEP, Watershed Counts, RI Env-MC, federal agencies, universities, volunteer monitoring programs
6.2	Ensure public access to water quality and other monitoring data acquired with public funds; where not required, require that permit and grant-funded monitoring data be submitted in an accessible digital format (2014)	RIDEM, MADEP, RICRMC, MACZM, other state agencies, universities, RIDOP, Mass. Regional Planning, federal agencies
6.3	Support and develop volunteer monitoring programs where appropriate, building on existing volunteer monitoring programs; where feasible ensure resulting data helps fill gaps and has adequate quality assurance / quality control parameters to be used for state purposes	RIDEM, MADEP, URI Watershed Watch, watershed groups, volunteer monitoring groups, NBEP, EPA
6.4	Work with universities and federal agencies to improve scientific knowledge of water resource issues and technology including climate change implications and emerging contaminants; integrate new findings into management schemes	University programs, RIDEM, MADEP, RICRMC, MACZM, EPA, NBEP
6.5	Measure progress and provide the public with ongoing reports on key water quality implementation progress, e.g., TMDLs, nutrients, stormwater	RIDEM, MADEP, RI Evn-MC



Controlling waterfowl in Roger Williams Park in Providence, R.I., is reducing serious bacterial and nutrient pollution as well as erosion problems in the park's ponds.





CCMP

Comprehensive Conservation and Management Plan

Update 2012

Section 2
Manage Land for Conservation and Community

GOAL

Land development is directed toward compact, livable urban and rural centers in a way that conserves natural resources, open space, and regional character--especially historic New England village patterns and rural lands.

OBJECTIVES

1. Implement low impact development
2. Preserve open space and natural systems
3. Develop and use incentives and local zoning requirements that support compact, mixed-use walkable communities
4. Increase and maintain regional recreational opportunities and public access to shorelines and waterfronts
5. Improve science and information to support effective land use management
6. Build capacity of watershed organizations and municipalities to serve as critical partners in watershed management

PROBLEM

The impacts of land development are a primary driver of natural resource degradation.

Land use, transportation and development patterns influence watershed health and water quality, and thus the health of fresh and marine waters throughout the Narragansett Bay Region (NBR). Urban development creates impervious surfaces which can cause water quality and quantity problems, as well as loss of natural habitat. As more people discover the beauty of the region, its special qualities are threatened. It is a constant challenge to address human needs while preserving the quality of water and wildlife habitat. Urban communities struggle to balance housing, transportation, and non-residential growth while maintaining the quality of life that made their communities attractive in the first place. Rural communities are challenged by changing markets for their locally-produced products while managing the pressures of regulation, competition for employers and businesses, and the encroachment of suburban growth. It is crucial to manage future growth in a manner that will not adversely affect water and habitat quality while at the same time providing sites for economic development, housing and other needs.

Restoration of the quality and functions of the region's watershed lands and waters that define our quality of life will not succeed without maintaining a healthy watershed "infrastructure" of habitat, biotic communities, water chemistry, and intact watershed processes. Healthy, functioning watersheds provide the building blocks that anchor water quality restoration efforts. And the ecosystem services provided are critical to our economic health – tourism, commercial and recreational fishing, and forest-based industries all depend on a healthy environment. Wetlands filter and clean our waters, provide nursery and feeding areas for fish and wildlife and protect property from flood damage. Protecting these land-based resources through effective land use planning and policies is critical element of the implementation of this plan.

LAND MANAGEMENT STATUS & TRENDS SUMMARY

Land consumption and transportation patterns in the NBR are such that land has been developed at a rate several times greater than population growth. As stated in the R.I. Statewide Planning Program's Land Use 2025 report, "…our current rate of land consumption is a major departure from our historic pattern of dense urban centers and is not sustainable in the long and short term." This trend is significant because it increases impervious surfaces that alter the flow and quality of water in the watershed (the Bay watershed now averages about 14% impervious surface with denser percentages concentrated in urban areas). The result has been the emergence of non point source pollution carried by stormwater as a primary threat to the health of the NBR ecosystem. Storm water runoff carries a variety of pollutants to the NBR's rivers, lakes and estuaries. The strong relationship between impervious surface and water quality presents a serious challenge for watershed managers in the watershed. Imperviousness represents a common currency that can be measured and managed by planners, scientists, and engineers. It links activities of an individual development site with its cumulative impact to the watershed. Another major impact of our land development patterns is impairment, fragmentation and loss of natural habitat areas.

A series of reports issued by Mass Audubon entitled *Losing Ground* provide data on issues of land development in Massachusetts. The reports identify the "Sprawl Frontier"—communities where the pressure to develop is highest—and state that there are two significant clusters of high-growth development in Massachusetts. The towns in these clusters comprise 75% of the Sprawl Frontier in Massachusetts (Mass Audubon, 2009):

"…one concentrated in the Blackstone River watershed (formed by the towns of Shrewsbury, Grafton, Northbridge, Upton, Hopedale, Hopkinton, Ashland, Medway and Franklin) and one primarily in the Ten Mile and Narragansett Bay watersheds (made up of the towns of North Attleboro, Seekonk, Rehoboth, Swansea, Somerset and Berkley)."

These areas also show the highest rates of ecological function degradation. Many of the land areas that have been identified as important natural landscapes lack permanent protection. While development pressure has slowed since the onset of the current recession in 2008, when the economy recovers, the pressure to develop will once again ramp up. *Losing Ground* advocates taking advantage of the slowdown and land price reductions to increase permanent protection of vital watershed lands and waters. Land protection strategies can also help slow the rate of watershed lands converted to impervious areas. Many Bay region subwatersheds are still lightly developed; watersheds that have less than 10% of impervious surface are generally considered to be in the best ecological shape.

The total area of the Narragansett Bay watershed and R.I. coastal watersheds is 2,066 square miles. Of that total, 53% (1,095 sq. mi.) is classified as undeveloped, 13% (268.5 sq. mi.) wetlands, 11% (227.3

sq. mi.) low intensity developed, 9% (186 sq. mi.) developed open space, 6% (124 sq. mi.) medium intensity developed, 3% (62 sq. mi.) high intensity developed, 4% (82.6 sq. mi.) open water, and 1% (20.6 sq. mi.) cultivated crops. The amount of permanently protected land in the Narragansett Bay Region has been calculated at 354 square miles or just over 17% of the total land area (NBEP, 2009).

In Rhode Island, the total amount of developed land increased by 43% over the period 1970-1995 (RIDOA, 2010). The total developed land increased by 43%. According to the R.I. Land Use 2025 plan, if the current land use trends continue, 45% of Rhode Island lands will be developed by 2025 with forest and farmland the categories most often converted to other uses. As in Rhode Island, the rate of land development in Massachusetts has dramatically outpaced population growth. In the period 1971-1999, residential land in Massachusetts increased by 47% and Worcester County experienced one of the highest rates of land conversion. Land in the Taunton River watershed has been developed over the last 25 years at 2.5 times the rate of population growth. Both the Blackstone and Taunton River watersheds have been within the fastest growth zones in Massachusetts over that time period. And, based on the use of an index of ecological factors, these areas also saw the highest loss of ecological integrity as noted in the MassAudubon Society's Losing Ground report. Rate of growth trends in these analyses were based on growth rates from the 1960s to the early 2000s, a period of robust growth for the watershed; future growth rates may be reflect the recession of the late 2000s in which the rate of land development slowed significantly.

Recent GIS analyses (RIDEM, 2009) of impervious land in the Narragansett Bay watershed show that about 14 percent of the land is covered by hardened surfaces. The greatest amounts of impervious land tend to be near waterbodies where the impact of polluted runoff is greater. 56.4% of all Bay area subwatersheds have greater than 10% impervious surface cover. Studies have shown that, under certain conditions, watershed degradation can occur when as little as 10% of the watershed is impervious.

Based on the 2009 RIDEM GIS analysis, the amounts of permanently conserved land in the region are: Rhode Island - 192 square miles; Massachusetts - 146 square miles. This is just about 17% of the total land area (NBEP, 2009).

SUMMARY OF LAND MANAGEMENT INITIATIVES

Both Massachusetts and Rhode Island have long recognized that land development impacts were a major driver of environmental degradation. Efforts to better manage land have been ongoing and have led to legislative and regulatory change as well as to non-regulatory strategies to protect lands including land protection, technical assistance to communities and education programs regarding land management. Because land use decisions are made primarily at the local level, both states have required or encouraged communities to create long range plans that lay out a vision for future land use. Even with strong local authority, decisions made by the state also have major land use implications and effects, for example, in siting transportation facilities, state institutions, landfills and energy and port facilities.

In the early 1990s, Rhode Island passed historic land planning laws the required the creation of community comprehensive plans, designed to address the major functional areas of land use and economic and social development. Companion legislation updated the state's subdivision regulations and required that zoning ordinances be consistent with community comprehensive plans. As does Rhode Island, Massachusetts has in place subdivision and zoning acts. Subdivision acts govern the division of land into legal buildable lots while zoning ordinances set minimum lot sizes, densities, parking and road requirements and zone a community's land for appropriate placement of uses. Subdivision laws and zoning ordinances are intended to address and preserve public health, safety and welfare. Currently, there is an effort to pass new Massachusetts state legislation creating the Land Use Partnership Act (LUPA) that would reform Massachusetts zoning laws. LUPA would provide communities with new flexibility in zoning and permitting to foster housing affordability and open-space protection, and close loopholes that undermine planning efforts. It would also improve local regulatory procedures, streamline reviews, and promote mediation of appeals. In addition, LUPA would allow municipalities to opt-in to a higher performance standard and thereby receive new tools for directing development. (MassAudubon, 2009)

In 2000, Massachusetts passed legislation creating the Community Preservation Act (CPA) – an act designed to help communities preserve and improve their character and quality of life. The act re-

Impervious surfaces concentrate and channel polluted stormwater into local waterbodies.

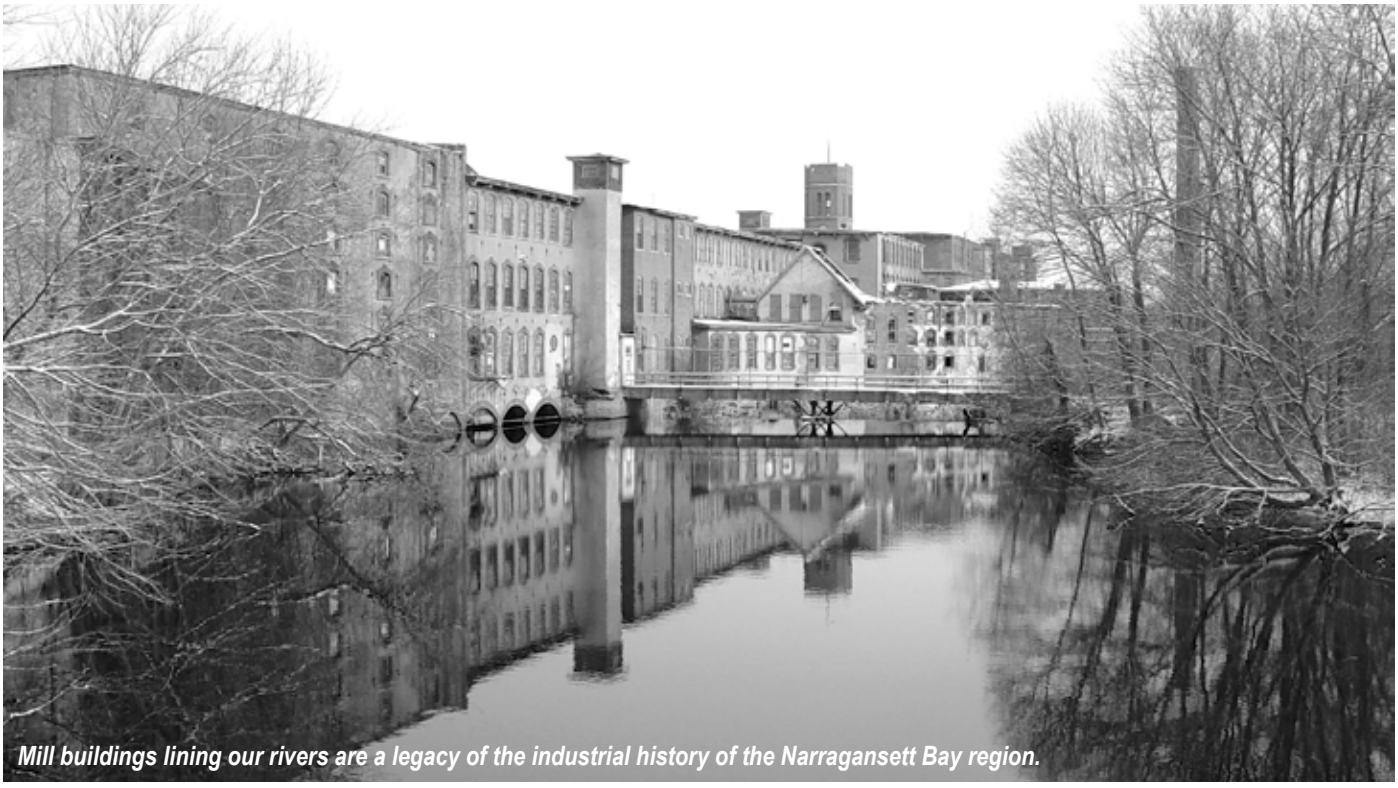
quires municipalities to adopt the CPA by referendum and allows communities to create a community preservation fund dedicated to open space protection, historic preservation, outdoor recreation and affordable housing. These funds are fed by a real estate levy of no more than 3%. The act also created a statewide Community Preservation Trust Fund for communities that have adopted the act. 148 municipalities (42% of all Mass. communities) have so far adopted the act and over $1 billion has been raised for community preservation.

In recent years, communities have expanded their zoning ordinances to create more flexibility to better preserve natural and cultural resources. Examples include conservation and cluster development, density bonuses, transfer of development rights and overlay districts. 14 of Rhode Island's 39 municipalities have adopted conservation development ordinances. The RIDEM Sustainable Watersheds office provides technical planning assistance on resource protection and environmental design to communities and has successfully promoted the adoption of conservation development ordinances in R.I. municipalities. Both states have legislatively-created incentives including density bonuses to increase the amount and distribution of affordable housing available to meet community planning targets. At the state level, Massachusetts has the Massachusetts Environmental Policy Act (MEPA) designed to be a state counterpart to the federal National Environmental Policy Act (NEPA). Its purpose is to review major projects and state-agency actions to avoid and minimize environmental impacts. It also provides a public participation and comment process for citizens.

While there has been an increasing level of planning rules and analysis that municipal planning offices have to address, municipal budgets for planning have been under great pressure. This has resulted in a significant lack of capacity at the local level to handle not only development review and comprehensive plan management, but also meeting state and federal requirements for stormwater permits and other environmental and/or community planning requirements not to mention seeking to secure state, federal and other grant funding support community needs. Massachusetts had a successful watershed initiative program but that was cut from the budget in 2006. Rhode Island once had a planning technical assistance program operating out if its Statewide Planning Program but it too fell victim to budget cutting. While other state, NGO and university partners have sought to help meet these needs, there still exists a capacity gap at the local level.

In states, land protection and acquisition has been an ongoing and successful strategy to protect sensitive and valuable lands. The RIDEM Land Acquisition Program identifies and, working with partners including communities, land trusts, NGOs like the Nature Conservancy, foundations, and federal programs, uses state Open Space bond funds to significantly leverage other sources to acquire key land parcels. A separate commission, the Agricultural Land Preservation Commission, oversees preservation of important agricultural lands through the purchase of development rights. This method allows farmers to retain some ownership rights and provides funding support for them to continue to operate farms.

The Massachusetts land protection program has a stated goal of acquiring land to protect and perpetuate ecosystems that contain significant hunting and fishing resources and to conserve the biological diversity of the state. A Lands Committee identifies and prioritizes acquisitions. The state land protection program has an annual land acquisition budget of about $5 million. The state currently owns over 155,000 acres (240 square miles) across the state. $1.5 million of this amount is derived from the states Land Stamp program which applies a fee to the sale of each hunting and fishing license sold in the state. The balance of program funding comes from the passage of state Open Space bonds.



Mill buildings lining our rivers are a legacy of the industrial history of the Narragansett Bay region.

The Narragansett Bay Region contains some of the most highly urbanized watersheds in the United States.

Photo: James Warcup

Priority Actions = shaded blocks; (Year) = target completion date, ⟰ = in progress, ACRONYMS see page 68.

1.	Implement low impact development	Primary Implementing Parties
1.1	Develop and adopt state and local policies, regulations, and ordinances as needed to fully implement low impact development approaches to development and redevelopment ⟰	RIDEM, MADEP, RIDOP, MACZM, RICRMC, municipalities, regional planning organizations
1.2	Provide technical assistance to municipalities to identify and implement green infrastructure and LID techniques; agencies should assign designated staff as point of contact on LID issues (permits, training, technical assistance, etc.)	RIDEM, MADEP, RICRMC, MACZM, EPA, universities, NGOs
1.3	Develop and implement incentive programs to provide LID-based treatment to existing impervious surface areas not covered by current regulatory requirements	RIDEM, MADEP, RICRMC, municipalities

2.	Preserve open space and natural systems	Primary Implementing Parties
2.1	Identify and prioritize areas for acquisition, protection and restoration on an interstate basis; target acquisition of priority areas (2014)	RIDEM, MADCR, MADFW, MACZM, municipalities, universities, NGOs, land trusts, USDOI
2.2	Prioritize and permanently protect open space areas in both states that are now under non-permanent protection status (time-limited development rights, etc.)	RIDEM, MADCR, RIDOP, MADFW , Mass. Regional Planning
2.3	Provide technical assistance, grants and financial and permitting incentives to expand use of conservation development designs and ordinances	RIDEM, MADCR, RIDOP, Mass. Regional Planning

3.	Develop and use incentives and local zoning requirements that support compact, mixed-use walkable communities	Primary Implementing Parties
3.1	Direct sustainable growth through targeting grant funds, state investments and incentives for redevelopment, infrastructure improvements and/or added capacity to developed lands including Brownfield sites (in R.I., to state-designated urban service boundary and growth centers)	RIDOP, Mass. Regional Planning, MAEEOEA, RIDEM, MADCR, state economic development agencies
3.2	Work with municipalities to promote growth within the urban service boundaries by implementing RI Land Use 2025 and similar measures in Massachusetts; for communities outside of urban service boundaries, develop criteria and incentives to properly locate new growth centers	RIDOP, Mass. Regional Planning, municipalities
3.3	Enhance existing or develop new mechanisms to provide planning resources to communities	RIDOP, Mass. Regional Planning Agencies, MAEEOEA
3.4	Revamp transportation systems to enable greater intermodal connections and promote alternatives to reliance on individual vehicles	RIDOP, Mass. Regional Planning, MAEEOEA, RIDEM, RIDOT, MADOT, USDOT, EPA

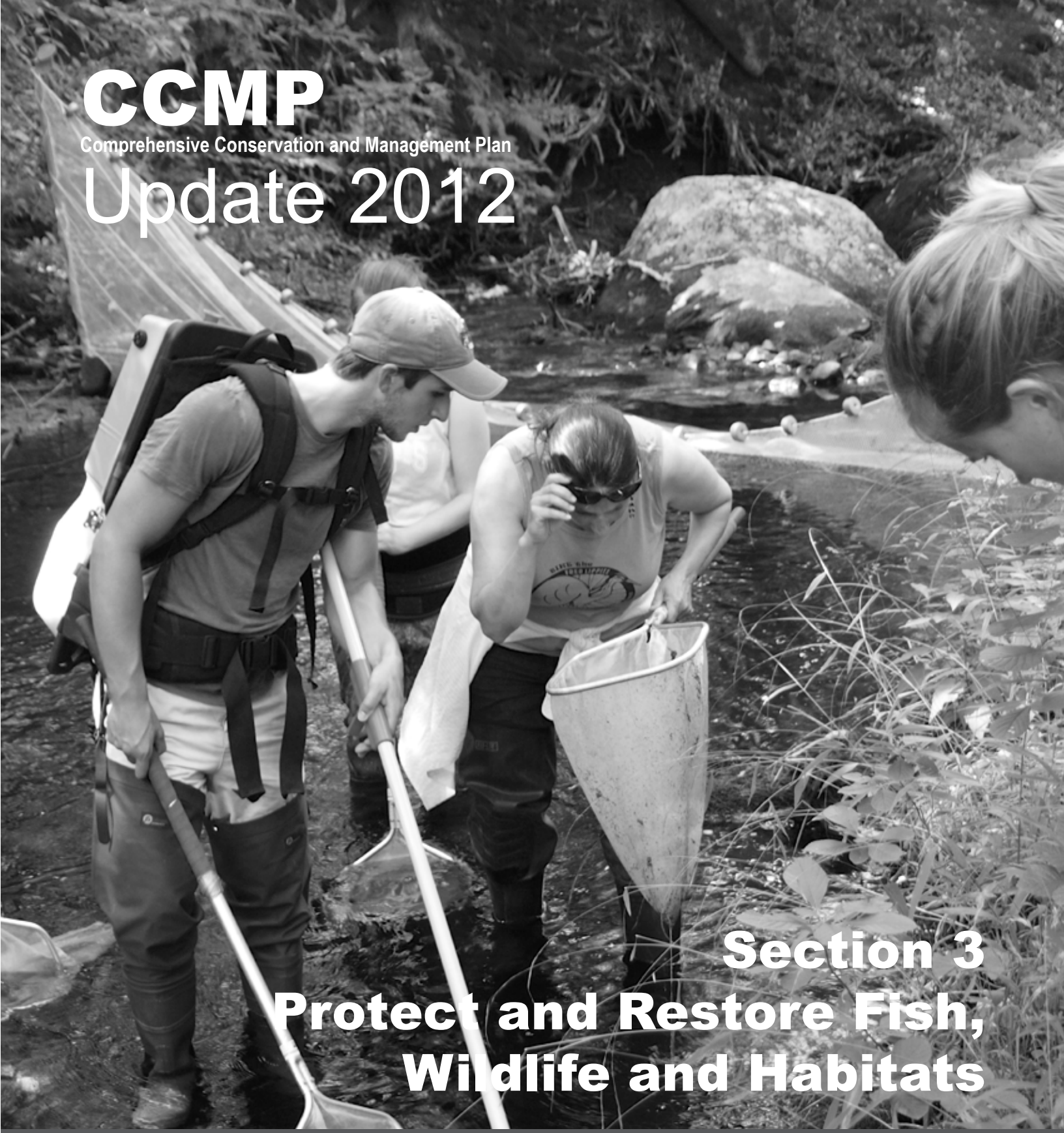
4.	Increase and maintain regional recreational opportunities and public access to shorelines and waterfronts	Primary Implementing Parties
4.1	Increase public access to watershed resources by developing public water and land trail systems that enable a range of user opportunities (2014) ⟰	RIDEM, MADCR, RI Blueways, NBEP, NGOs, water use interests
4.2	Require public access where feasible in development and redevelopment projects that abut public waterbodies and river shorelines in both states (2015)	RIDEM, RICRMC, MADEP, MACZM, municipalities, federal agencies, land holders
4.3	Continue to plan and develop public fishing piers, boat ramps and other forms of public access to fresh and salt waters in the Narragansett Bay Region	RIDEM, MADCR, municipalities

4.4	Improve, expand and promote coastal rights-of-way designations (assessment, signage, mapping, parking) in both states	RICRMC, MACZM, RIDEM, MADCR, municipalities, land trusts
4.5	Identify and address obstacles that impede public access to freshwater sites in both states	RIDEM, MADCR, municipalities, land trusts

5.	Improve science, information and communication to support effective land use management	Primary Implementing Parties
5.1	Use communications and outreach efforts to promote important watershed resources and ways in which citizens and governments can protect and restore the value of these resources ⌃	RIDOT, RIDEM, MADCR, MADOT, Mass. Regional planning, municipalities, NGOs, NBEP
5.2	Create a mechanism to assess cumulative impacts of development at regional and bi-state watershed scales	RIDEM, MADEP, MADCR, RIDOP, MADFW , RICRMC, MACZM, Mass. Regional Planning, federal agencies

6.	Increase the role of watershed organizations and municipalities to serve critical partners in watershed management	Primary Implementing Parties
6.1	R.I. and Massachusetts should provide technical planning resources to towns in less developed areas to proactively protect ecological resources and to support implementation of state and federal environmental regulatory requirements (2015)	RIDEM, MADEP, RIDOP, Mass. Regional Planning, State legislatures
6.2	Provide technical assistance to local NGOs and watershed groups to support local implementation of environmental improvement projects; include structuring state and federal funding opportunities in ways that facilitate participation by those groups ⌃	State agencies, state legislatures, federal agencies
6.3	Pass legislation in Massachusetts that addresses the reforms included in the Comprehensive Land Use Reform & Partnership Act	Massachusetts legislature
6.4	Massachusetts and Rhode Island communities should update community master plans to meet current state requirements	Mass. municipalities, Mass. regional planning agencies
6.5	Massachusetts should broaden municipal participation in adopting the Community Preservation Act	Massachusetts municipalities, Massachusetts regional planning agencies
6.6	Support bi-state cooperative work by nongovernmental organizations like the Blackstone River Coalition and the Taunton River Watershed Alliance	Federal/state agencies; regional planning agencies; major NGOs
6.7	Develop training and information programs for conservation commissions to help communities meet planning and regulatory needs; transfer lessons learned from Mass. conservation commissions	RIDEM, MADEP, MADFW, NBNERR, NBEP, NGOs, MA Regional Planning, USEPA


Photo: David Ward



CCMP

Comprehensive Conservation and Management Plan

Update 2012

Section 3
Protect and Restore Fish, Wildlife and Habitats

GOAL

To provide and protect healthy, interconnected and diverse natural systems, providing desired ecosystem services and economic benefits, resilience to climate change, and well-functioning habitat to support fish and wildlife throughout the Narragansett Bay Region. Protect core undisturbed habitat in watersheds and the Bay while preserving and enhancing valuable habitats in developed areas.

OBJECTIVES

1. Conserve existing natural landscapes that have been and will be adversely affected by development, climate change, and invasive species
2. Restore degraded or lost terrestrial habitats and habitat functions
3. Preserve and restore fresh and salt water populations, habitats and habitat functions
4. Manage habitats to sustain and enhance habitat function
5. Monitor, control and prevent land and aquatic invasive species
6. Improve science and information to guide management of terrestrial and aquatic habitats and biodiversity
7. Build capacity to implement ecological restoration at state (particularly in R.I.) and local levels and improve interstate coordination

PROBLEM

Pollution, landscape and Bay habitat changes, hydro-modifications and invasive species are having negative impacts on habitats and fish and wildlife populations in Narragansett Bay and regional watersheds, including coastal and estuarine areas, wetlands, rivers, ponds, riparian buffers, forests and uplands. Biodiversity has been on the decline, reducing ecosystem resiliency.

Hundreds of years of intense human use and development of the lands and waters of the Narragansett Bay Region have degraded the region's natural habitats, reduced its native biodiversity and caused declines in fish species and altered wildlife populations (DeGraaf, Yamasakil. 2001). Principal factors affecting habitats include:

• **Direct physical alteration:** A byproduct of urbanization is the "replumbing" of natural watersheds—replacing wetlands and watercourses with pavement and pipes. Clearing land, filling and draining of wetlands, shoreline filling, navigational dredging and damming of rivers are just a few of the many ways in which we've altered natural habitats throughout NBR—reducing the ability of these areas to support native fish and wildlife.

• **Water pollution:** Discharges of nutrients and toxics have had serious ecological impacts on urban rivers and upper Narragansett Bay, while shoreline and estuary habitats are subject to ongoing pollution impacts from stormwater and nutrient impacts. In terms of use impacts, serious bacterial pollution loadings are linked to waterfowl concentrations and management in the region.

• **Land use impacts:** Built infrastructure in the watershed, including roads and dams, cut streams into disconnected segments and creates small islands of habitat. Though they appear natural, these pieces are incapable of supporting many native species which require movement among habitats, or genetic mixing, to survive. The rapid changes in land use over the last five decades have had significant affects on wildlife. Grasslands and young-forest species are declining while mature forest species are increasing and agricultural lands have been converted for development or reverted to forest (DeGraaf, Yamasaki). Climate change will also cause shifts in species composition and abundance.

• **Invasive species:** Alien species introduced into the Narragansett Bay region accidentally or intentionally replace native species, degrade food webs, and reduce biodiversity. With globalization, the pace of introductions – both aquatic and terrestrial - has increased. Modern transportation modes have had a major role in the introduction of invasive species. One recent example is the Asian long-horned beetle which has infested trees in New York and Massachusetts. Both fresh and salt water systems in both R.I. and Massachusetts have been affected by these introductions. There have been invasive species impacts in marine waters including shifts in crab species dominance but, as far as has been discovered, impacts are not major at this point. However, invasive plants are having a serious effect on our lakes and ponds and we have seen the spread of diseases that affect plants and bay organisms. And the range of some species is expanding due to climate change.

• **Biodiversity:** Both states have documented declines in biodiversity and/or shifts in species (DeGraaf, Yamasaki. 2001). Anticipated impacts of climate change may intensify the rate of change in biodiversity as plant and animal ranges shift. There are significant monitoring and data needs to be addressed in order to better understand how biodiversity has and is changing and in assessing impacts and developing management responses.

• **Climate change impacts on habitat:** Climate change will affect water temperatures, salinities, flow regimes, species range, key habitat areas and the estuarine food web. It will be challenging to develop the science needed to help predict or assess these impacts as well as adapting to changes in the ecosystem that result from climate change. Important commercial fish species may increase or decrease in number, become more susceptible to disease, or move into other coastal waters better suited to their ecological niches.

Healthy habitats provide valuable resources and services to human occupants of the watershed, such as clean air and water and fishing, agriculture, and forest industries, as well as supporting the area's biodiversity. Impaired habitats have reduced recreational value and leave the human community more prone to flooding, storm damage, and the effects of climate change.

While habitat restoration has become an integral part of environmental management, the pace and scale of restoration must be significantly increased in order to more fully address past and future impacts. This will require expanded resources and more comprehensive planning. Habitat restoration officials and practitioners in the Bay region

recognize that it is unlikely that habitat can be restored to replicate pre-colonial conditions but effort is going toward establishing habitat restoration targets and restored functionality that we can all work toward. Restoration efforts now also need to account for climate change impacts including sea level rise, increased temperatures, changes in precipitation and introductions of invasive species both animal and plant.

SCOPE OF THIS SECTION

This section discusses both terrestrial/freshwater and estuarine habitat issues. While there are obviously significant differences between watershed and fresh water and salt water habitats, many of the management principles and actions needed cut across these habitat types. For the purposes of this report, fisheries issues are viewed through the context of habitat function, restoration and protection as opposed to detailed, species-specific fisheries management actions. Finfish are largely managed as part of a larger regional management structure involving fishery councils.

HABITAT STATUS & TRENDS SUMMARY

Coastal and Estuarine Habitats

The main seagrass species of concern in Narragansett Bay is eelgrass which provides protection and forage for fish, shellfish, waterfowl and other fauna. Eelgrass was once widespread in the Bay but it is now mostly limited to the lower part of the Bay where water quality is better. Eelgrass is sensitive to nutrient loads as well as increased temperature. There were significant losses in the middle decades of the last century due to a wasting disease that affect the plant; that, coupled with increasing pollution, had a serious impact on eelgrass in the Bay. A 2007 study of the Bay's eelgrass beds revealed that 404.3 acres were remaining.

For Narragansett Bay's coastal wetlands, the NBEP completed a thorough analysis of wetland change over a 44-year period and, working with partners, a comprehensive 1996 baseline of coastal habitats.

Wetland Habitats

Freshwater wetlands are monitored in Massachusetts by MADEP as part of the Wetlands Information Resource database (WIRe), which integrates permitting, enforcement and aerial photogrammetric wetland loss analyses to track changes in wetlands over time. In Rhode Island, actual freshwater wetland change is not directly monitored, although the state tracks permitted losses and gains, as well as losses and gains related to enforcement actions. The U.S. Fish & Wildlife Service, as part of its National Wetlands Inventory (NWI) program, is completing a new coverage of wetlands that will update and improve upon the coverage currently used in Rhode Island that is based on 1988 imagery. The new NWI coverage will be based on 2003 true color photographs and will be enhanced by the use of new analytic measures including water flow patterns, water type and landscape features. The NWI work is also to include some level of measuring wetland functional value (Murphy, pers. comm., 2012).

Like other New England states, during the 19th and 20th century, Narragansett Bay Region wetlands were filled and altered on a large scale. Massachusetts analyses conclude that the state has lost about 33% of its original wetland acreage (MassAudubon, 2009). Since the 1970s and the introduction of much more protective wetlands regulations, wetlands loss has slowed considerably. Analysis of date over the 1991-2001 period shows that 398.5 acres were lost in the Massachusetts part of the watershed over that time frame. Total freshwater acreage in 2001 in the Massachusetts part of the watershed was 89,905 acres, making up 14% of the land area. There were losses and gains, depending on wetland type, with wooded swamps and shrub swamps showing the greatest increases (9% and 2%, respectively) while bogs, cranberry bogs, deep marshes, and shallow marshes showing losses. The status of freshwater wetlands in Rhode Island shows 79,191 existing acres, comprising 16% of the state's land area. Trends in Narragansett Bay coastal wetlands show a loss of 215 acres (less than 1% of total Bay coastal wetlands) over the 1950s-1990s timeframe.

River, Pond and Riparian Habitats

There are more than 600 dams in Rhode Island and more than 3,000 in Massachusetts, which also has an estimated 30,000 culverts and bridges, many of which interfere with the movement of fish and wildlife. Dams and culverts can impair movement of fish and other aquatic animals. They also impact water quality and alter the natural flow of sediment, water and organic material. Unless provisions for fish passage are made, hydropower facilities create barriers to anadromous fish runs. Rhode Island has 8 licensed FERC facilities in this plan's geographic scope – five on the Blackstone River, one on the Branch River, and two on the Pawtuxet River. Only one FERC-licensed facility is located on the Blackstone River in Massachusetts at the Riverdale dam; there are none on the Taunton or other Massachusetts rivers within NBR (FERC, 2012).

Aquatic Invasive Species

Aquatic invasive species (AIS) are second in importance only to habitat destruction as a cause of declining biodiversity in the United States. Established marine aquatic invaders in the Narragansett Bay Region include the European green crab, Asian shore crab, the red macroalgae, Grateloupia turuturu, and various species of sea squirts and shellfish pathogens. Rapid assessment surveys for marine aquatic invasive species in Narragansett Bay were conducted in 2000, 2003 and 2010; the surveys identified more than two dozen non-native aquatic species in Bay waters. Massachusetts communities in the Plymouth area recently experienced an invasion of an aggressive Japanese seaweed that threatened wildlife and negatively affected local tourism. The red seaweed, Heterosiphonia japonica, was first identified in 2009 off the coast of Rhode Island. It was transported here in ships' ballast waters. Layers of the seaweed coated local beaches and created foul odors as it decomposed. It has had significant economic impacts on local communities in terms of lost tourism dollars and costs associated with removing it from beaches (Boston Globe, 2012).

In freshwater systems, aquatic macrophytes such as variable watermilfoil and fanwort are spreading in lakes and ponds. RIDEM, in collaboration with the R.I. Natural History Survey and the University of R.I. Watershed Watch Program, compiles data on the occurrence of freshwater invasive species. It reports that of as of 2011, 59% of lakes surveyed had one or more invasive species present; and that 61% of the infested lakes (48 lakes) had two or more invasive species present. (RIDEM, 2012) In RI, the most commonly found invasive plant

species include variable milfoil and fanwort. Water chestnut is also present in five locations, with active management occurring at most of the sites. Of the more than 800 lakes in Massachusetts that have been assessed for aquatic invasive species, only 5% were found to be free of invasives. In addition, the majority of Massachusetts lakes remain un-assessed and at risk for new invasions.

RINHS scientists also surveyed forests in Rhode Island and documented infestations of 33 invasive plant species including Japanese barberry, Asian bittersweet, Japanese knotweed, multiflora rose and others.

Forest and Upland Habitats

Development in the Bay watershed has converted land from natural habitat to residential, commercial and industrial use (see Manage Lands chapter). This development has increased fragmentation of habitat both directly and indirectly. According to the USDA Forest Service, 59% of Rhode Island is forested (393,000 acres); however, 76% of this forestland is in private hands making it a vulnerable component of the states wildlife habitat and important natural communities. With the decline of agriculture and maturation of forests there has been a decline in grassland acreage, resulting in the loss of wildlife attracted to these areas. Habitat change is not always negative; over the time period from about 1900 to 1970, the region was largely reforested with the abandonment of farms and disuse of firewood.

A study by NatureServe in 2002 ranked both Rhode Island and Massachusetts low on the scorecards for biodiversity (natural species richness). Out of all the states, Rhode Island ranked 47th for biodiversity, Massachusetts 38th. At the other end of the scale, Massachusetts ranked second nationwide in the risk to its reptile populations, with Rhode Island close behind in 6th place. This is to a large measure due to the long history of human impact and level of urbanization we have seen in both states; many species became extinct before tracking was initiated over the last few decades. The 2003 Massachusetts report, LivingWaters, concluded that freshwater biodiversity had reached a critical juncture, for native as well as rare and endangered species. The Rhode Island Natural Heritage Program has been inactive for several years and the state list of endangered, threatened or special concerns species is in need of updating. However, in January 2012, RIDEM indicated that it anticipates renewed agency effort and involvement in this program (Sparks, 2012, pers. comm.). In the last Natural Heritage Program update in 2007, it had listed 148 animals and 321 plants listed; the state's Comprehensive Wildlife Conservation Strategy identifies 364 animal species as being of "greatest conservation need" and 64 key habitats supporting those species.

Fish Species Composition

Since 1960, the composition of marine fish and shellfish populations in Narragansett Bay has changed significantly (NBEP, 2009). Analysis of fisheries monitoring data has shown significant shifts in the species that make up Narragansett Bay's ecosystem. Resident demersal fish species including commercially valuable species like winter flounder, which historically comprised an important part of the Bay biomass, have declined, while decapod crustaceans such as spider crabs, rock crabs and squid and warm-water migrants such as butterfish and scup, have increased. Striped bass populations have greatly rebounded since the 1980s due to improved regional management. In recent years, monitoring programs revealed significant declines in fish species in Mt. Hope Bay that were linked to thermal pollution, and impingement and entrainment of young fish and larvae from a power generation plant.

Andromous Fish

Today, more than 600 dams in Rhode Island alone prevent the movement of native riverine species—including spawning migrations of fish such as Atlantic salmon, American shad, blueback herring and alewives. The dams create a great deal of warm-water habitat for species such as large and smallmouth bass, which were introduced to NBR in the 19th and early 20th centuries, as well as invasive species such as common carp, which dominate some urban systems. NBR's recreational fresh-water fisheries also rely on hatchery production of several species of trout, which are stocked in selected waters in Rhode Island and Massachusetts.

Commercial Fisheries

Fisheries generate significant economic benefits for the Narragansett Bay Region although most landings come from outside of the Bay. In 2007, Rhode Island's commercial fisheries accounted for $77 million in dockside value (down from a high of $86 million in 1999). A report by NOAA estimated that commercial fisheries in Rhode Island generated a total of $700 million in sales in 2006, suggesting a tenfold multiplier in the economic value of landed catch. Massachusetts' commercial fishing sector is larger than Rhode Island's; however its principal ports are located outside of the Narragansett Bay Region. There is a small commercial fleet in Fall River.

Recreational Fishing

In 2007, more than 400,000 recreational anglers participated in 1.5 million fishing trips in Rhode Island. In 2006, recreational anglers spent $116 million on fishing trips and gear in Rhode Island. For 2006, NOAA estimated the economic impact of Rhode Island's recreational fishery at $167 million in sales. Again, Massachusetts' recreational fishery is larger ($803 million); however the NOAA report does not allow us to identify the portion of this activity occurring in NBR. According to RIDEM, striped bass, fluke, bluefish, tautog, and scup are the most important recreational species in Rhode Island.

Tall stands of Phragmites (common reed) are mowed as part of site assessment work prior to the Town Pond salt marsh restoration project in Portsmouth, R.I.

In Massachusetts, the state's Department of Fish and Game includes a Division of Ecological Restoration (DER) that has been very active across a variety of aquatic systems over the last decade in developing restoration policy and practices, identifying restoration projects, securing funding, lining up partners and managing restoration projects. The DER website notes that their projects emphasize the "recovery of an ecosystem that has been degraded, damaged or destroyed," and include salt marsh, freshwater wetland and riparian restoration, and stream daylighting and continuity projects (culvert replacement and retrofit) as well as dam removal and urban stream revitalization. Restoration projects solicited through an open public process within the state's procurement system and are evaluated, scored and prioritized using an ecosystem-based subwatershed approach focusing on the factors that most impact river and stream health. Partnerships and collaboration with communities, watershed groups, NGOs, other state agencies and federal partner are key operational strategies for the Division. To date, the Division has completed over 60 restoration projects, restoring hundreds of acres of coastal and watershed habitats; many of these projects have been situated in the Narragansett Bay region. DER and its restoration partners have successfully obtained and leveraged significant federal resources for habitat projects from federal partners including U.S. EPA, U.S. Fish & Wildlife Service, USDA Natural Resources Conservation Service, and the National Oceanic and Atmospheric Administration (NOAA). Local, regional and foundation funds have also supported restoration activity in both Massachusetts and Rhode Island.

Massachusetts uses a computer-based program and approach for prioritizing land conservation – the Conservation Assessment and Prioritization System (CAPS). This approach assesses the ecological integrity of various ecological communities within target areas and focuses on habitat condition rather than individual species. Different landscape-based variables are measured, weighted, and then used to create an index of ecological integrity for natural areas. Factors used in ranking include connectedness, land use intensity, microclimate alterations and others.

Coastal & Estuarine Habitat

Rhode Island benefits by strong community and NGO support and action to restore habitats; much of the actual restoration activity has focused on fish runs and coastal habitats. In the early 2000s, the NBEP, Save The Bay and the R.I. Coastal Resources Management Council combined forces to help create and support the R.I. Habitat Restoration Team – a multi-interest habitat restoration workgroup formed to increase collaboration and effectiveness in implementing restoration projects and to build support at the state and federal level for restoration. The nonprofit group Save The Bay has played an important role in watershed restoration particularly in seagrass and wetlands restoration projects and, like the NBEP, works across the bi-state bay watershed.

In 2003, the state created the R.I. Coastal and Estuarine Habitat Restoration Trust Fund which draws on a petroleum products shipping fee to annually provide $250,000 for eligible projects in the state. The Trust Fund and project grant awards are managed by R.I. CRMC. Projects submitted for funding under the Trust Fund process are reviewed and evaluated by a restoration stakeholder team which then recommends projects for funding. State agencies (including RIDEM and R.I. CRMC), NGOs and local groups have been very successful in leveraging this funding to secure much more in federal funds and resources from sources including U.S. EPA, U.S. Fish & Wildlife Service, USDA Natural Resources Conservation Service (NRCS), and NOAA. R.I. NRCS has provided funding and technical assistance for eelgrass, wetlands and river restoration projects in the Bay region. In addition, the U.S. Army Corps of Engineers has been instrumental in the development and implementation of major restoration projects in the state such as the Galilee Marsh Restoration in Narragansett, R.I., and the Town Pond Salt Marsh Restoration in Portsmouth, R.I. These projects also depended on the work and support of a broad coalition of local and state partners.

While lacking a dedicated state restoration program as in Massachusetts, RIDEM developed and is working with federal and local partners to implement a strategy to restore anadromous fish runs in the state. It has worked in partnership with R.I. CRMC, Save The Bay, Narragansett Bay Estuary Program, USDA NRCS, NOAA, USF&W Service, watershed groups and municipalities in efforts to construct fish passage projects in a number of R.I. communities. RIDEM and R.I. CRMC also participated in the state's largest dam removal project on the Pawtuxet River. In 2012, Rhode Island created the Renewable Energy Sitting Partnership, a technical workgroup charged with creating community guidelines for the siting of renewable energy facilities including wind power generators and hydropower facilities. The guidelines will include information on how energy development can impact the state's natural resources and provide strategies to protect these important resources when planning and siting energy generating facilities. Massachusetts has an Energy Facilities Siting Board that is charged with ensuring a reliable lowest-cost energy supply for the Commonwealth with a minimum impact on the environment. The Board licenses the construction of major energy infrastructure in Massachusetts, including large power plants, electric transmission lines, natural gas pipelines and natural gas storage facilities.

The USDA Natural Resources Conservation Service initiated a project entitled the Coastal Zone Soil Survey Initiative to map submerged habitats in coastal waters shallower than 5 meters. Federal funding to initiate work in R.I. waters was secured by Senator Jack Reed in 2008. Initial implementation of this work in the Narragansett Bay Region involved mapping shallow water soils in R.I.'s south shore coastal ponds. Linked to this work is the R.I. Sea Grant-funded BayMap project which targets mapping of waters deeper than those covered by the NRCS survey effort. A cooperative alliance of organizations in the Narragansett Bay Region (federal, state, universities, NBEP) with the same interest was built off these projects – the MapCoast Partnership. The data from both efforts is important to a range of restoration and habitat protection efforts.

Over the late 1990s and into the next decade, there had been a concerted effort to restore eelgrass to Narragansett Bay. Historical records indicated that, at one time, the Bay had hundreds of acres of eelgrass beds. The most recent assessment of eelgrass extent in the Bay (Bradley, et. al. 2007) measured just over 400 acres of eelgrass.

Eelgrass restoration began in 1995 with a Greenwich Bay transplant project organized by NBEP. Since that time, partners in eelgrass restoration have included the University of Rhode Island, Save The Bay, RIDEM, R.I. CRMC, NBEP and NOAA. Eelgrass seeding was attempted in 2001 by URI using federal funding; several seeding projects followed but with germination rates of less than 10%, this method was discontinued. Hand transplanting of eelgrass shoots became the preferred method with Save The Bay leading efforts to plant and monitor eelgrass at several locations in the Bay. The long term results have been mixed and eelgrass advocates now feel we should be focusing on improving water quality that will promote natural growth of eelgrass beds.

Fisheries Management

The ecosystem of the Narragansett Bay Region provides the foundation for recreational and commercial fisheries which rank among the most important cultural, recreational and economic uses of the region's fresh and salt waters.

Fresh water fisheries in the Narragansett Bay Region are based largely on non-native species in created habitats. Human impacts of the colonial period and later resulted in native freshwater fish species that were very limited in number and extent. Some native cold-water species survive in limited numbers; cold-water streams are threatened by land use changes. Large- and smallmouth bass were probably introduced from upstate New York in the late 19th century, but are now popular game fish which thrive in the man-made lakes and ponds created by mill dams throughout the region. Massachusetts and Rhode Island operate hatcheries to stock trout in rivers, lakes and ponds throughout the state. Common carp were intentionally introduced in the late 19th or early 20th century, and are now nuisance species in urban rivers and ponds, where they proliferate and degrade habitat.

In 2005, Massachusetts began implementing a Target Fish Community (TFC) approach to most of the state's main stem rivers. The TFC approach sets a template for defining a fish community one would expect to find in a southern New England river. It is an attempt to understand the impact of habitat impairments on fish communities and to provide targets for restoration and conservation efforts.

While a comprehensive program to measure pollutants in fish tissue is not in place, selected studies have shown levels of mercury and PCBs in fish tissue that exceed federal standards and have resulted in fish consumption advisories for certain species including bluefish and striped bass. Both states list freshwater bodies from which fish are subject to advisories, mostly due to mercury but also some listed for DDT and PCBs.

RIDEM's Division of Marine Fisheries manages salt water fish and shellfish in consultation with the R.I. Marine Fisheries Council; in Massachusetts this work is done by the Department of Fish and Game – Division of Marine Fisheries along with local management authorities. Size and seasonal limitations, as well as possession limits, are placed on key species important to both commercial and recreational fishing. Both states have enforcement powers and officers (plus local authorities in Massachusetts) out on the water to enforce all fishery regulations. In Rhode Island, monthly trawl surveys conducted by state and university staff were initiated in 1959 and track 130 species but focus on key species, e.g., lobster, Atlantic herring, bluefish, winter flounder, scup, horseshoe crab and butterfish. Massachusetts conducts an annual fisheries survey at 108 stations in state waters that tracks 90 species but focuses on key commercial species. The U.S. Fish & Wildlife Service provides funding for fish and wildlife management through a variety of grant programs and resource user fees. In 2010, R.I. created a marine recreational fishing license with an annual fee to support enhanced fisheries data collection. Massachusetts has existing salt water recreational fishing license program with revenues dedicated to improving the management of the state's marine recreational fisheries, particularly with regard to developing more accurate assessments of recreational catch and effort. The revenue is also used to enhance recreational fishing access opportunities in the state.

Recent legal challenges brought by the States of R.I. and Massachusetts have resulted in permit changes at the Brayton Point power plant on Mt Hope Bay. Thermal impacts and entrainment of fish and fish larvae were a significant factor in the serious decline in fisheries in that section of Narragansett Bay. New water cooling towers have been constructed that will reduce the temperature of water discharged back into Mt. Hope Bay.

Shellfish Management

Shellfish constitute one of Narragansett Bay's most important fisheries, and many of the state's largest and most productive quahog beds are located in the Bay. Since the late 1800s, shellfish populations and extent have been affected by pollution, fishing pressure and disease. Scallops were once abundant in the Bay but became scarce due their sensitivity to pollution and human impacts; only in recent years have they started to reappear in Bay and coastal waters. The hard shell clam fishery has a long history and is still considered an important resource by the state. Pollution has forced permanent closure of many areas of the Bay and stormwater-derived bacteria loadings continue to cause closures. Both states are concerned with coastal water quality as it is essential to the shellfishing and aquaculture industries. Both seek to remediate and reopen closed shellfishing areas. Fiscal and staff resources at both the state and local level for environmental review, technical assistance, administration, research, enforcement and aquaculture development are seriously strained.

Both states maintain programs for shellfish management to ensure that the requirements of the federal National Shellfish Sanitation Program are met and that shellfishing activity in each state is well-managed. The RIDEM Shellfish program ensures consistency with federal requirements for shellfish safety and monitors shellfish areas for bacteria, bio-toxins and poisonous substances. Prohibited and conditional closure areas are identified and managed and temporary closures due to rain events are publicized. Shellfish transplants from closed areas to open areas to increase harvests have taken place on an ad hoc basis. Periodically, shellfish population surveys have been conducted though not at the frequency and extent that managers would like to see. Rhode Island has identified a need for a more effective shellfish management plan, supported by new data and scientific information on the resource. This would also require a better understanding of benthic habitat and circulation in the Bay. The Massachusetts Shellfish Sanitation and Management Program works in cooperation with local elected officials and shellfish constables to create and implement management plans for the state's 294 growing areas that cover hard

clams, bay scallops, conch and surf clams. Both states map shellfish beds, provide closure notifications and monitor bacterial levels. Both states also sample for naturally occurring marine biotoxins like "red tide." Naturally occurring bacteria Vibrio Parahaemolyticus and Vibrio Vulnificus are now present in Mass. and R.I. waters in the summer month due to the increased water temperatures. These bacteria have caused incidents of illness in both states. Massachusetts has had to initiate harvesting restrictions and R.I. may follow suit if additional cases are reported in the next year.

Massachusetts also maintains a depuration program using a state depuration facility at Newburyport. Both states have used relay programs to relocated contaminated shellfish to clean waters for natural depuration. In Massachusetts the Shellfish program regulates the state's aquaculture industry whereas in Rhode Island it falls under the purview of the state's Coastal Resources Management Council with a certain level of dual permitting and management authority held by RIDEM.

There is an effort to create a statewide R.I. Shellfish Management Plan. Such a plan would include all molluscan shellfish produced by aquaculture operations and licensed wild harvesters. There already exists user conflict between the free and common fishery and the practice of leasing marine areas for aquaculture. RIDEM, RI CRMC and user groups would need to be engaged in the development of such a plan.

Fisheries Monitoring

Key species are tracked by both states. These include winter and summer flounder, black sea bass, scup, northern sea robin and American lobster. In Rhode Island, monthly trawl surveys conducted by state and university staff that were initiated in 1959 track 130 species but focus on key species, e.g., lobster, Atlantic herring, bluefish, winter flounder, scup, horseshoe crab and butterfish. The trawl surveys track seasonal and long-term abundance patterns of fish and invertebrates providing a long-term picture of abundance of key species in Narragansett Bay. Recently, as part of permit requirements for a power generation plant, data on fish species in Mt. Hope Bay have been collected. Massachusetts fisheries monitoring focuses on key species including winter and summer flounder, black sea bass, scup, northern sea robin and American lobster.

Aquaculture

The value of aquaculture operations in Rhode Island waters has steadily increased to about $2.4 million in 2011, primarily shellfish. In 2011, there were 43 aquaculture farms in the state with an area of 160.25 acres under cultivation. Oysters are the primary product with nearly 4 million sold for consumption. The expansion of aquaculture in R.I. has been identified as a priority for the R.I. General Assembly and has had strong support from the state's Congressional delegation. The R.I. Aquaculture Initiative – a collaboration of state, university and industry stakeholders – was created to set priorities for aquaculture science and development projects to be funded under federal grants secured by Sen. Jack Reed. R.I. CRMC has created a working group of government and private sector representatives to address issues like aquaculture leasing, disease prevention, industry regulation and invasive species.

In Massachusetts, aquaculture today is estimated to have a value of $8.6 million. It consists of both in-water operations and on-land recirculating facilities in the western part of the state. The landed facilities produce hybrid striped bass, tilapia, trout, summer flounder and other finfish. Marine aquaculture operations focus on hard clams and oysters with some smaller amounts of scallops, soft shell clams and mussels produced. In 1995, the Massachusetts coastal zone agency – also using an inclusive working group process - developed an aquaculture strategic plan to better manage and promote aquaculture in the state. The plan addresses conflicting uses, research needs, regulatory changes, technology, sea food safety, and legal and economic aspects of the industry. It recommended that the state establish an aquaculture coordinator position to oversee implementation of the strategy.

Wildlife Management

Both Rhode Island and Massachusetts have regulatory and management divisions that manage wildlife in the Bay watershed. In R.I., RIDEM's Division of Fish and Wildlife enforces state laws and rules and conducts management activities that support wildlife; the Massachusetts Department of Fish & Game is their counterpart. Activities covered include hunting and fishing regulations, wildlife rehabilitation programs, animal control, restoration actions, land acquisition, fish stocking, public education, targeted research regarding wildlife, and conservation programs. Both states produce a Comprehensive Wildlife Conservation Strategy (CWCS), as required by federal law. The CWCS must cover eight required elements in order to receive U.S. Fish & Wildlife Agency state grants. Species and habitats in greatest need of conservation and related management strategies must be identified in the strategy. Massachusetts' CWCS is organized around 22 different habitat types of differing scales.

Rhode Island has 24 wildlife management areas totaling over 46,000 acres and the division also manages 200 boat launching sites. Four freshwater fisheries are operated by the division. 90% of the costs of fish and wildlife activities are covered by dedicated funding sources including special federal excise taxes on fishing, hunting and boating equipment. Massachusetts wildlife programs involve over 165,000 acres of land (the state's park system includes over 450,000 acres).

Within the Massachusetts Department of Fish and Game, under the Division of Ecological Restoration, the Riverways program works with federal, state and local partners to foster stewardship for rivers and wetlands. The Riverways program carries out the mandates of the Massachusetts Rivers Protection Act of 1996 – the law that created a 200-foot managed riverfront area on both sides of rivers; the riverfront area is reduced to 25 feet in urban areas. The program seeks to prevent pollution, protect water supplies and groundwater, protect critical riverine habitat areas for fish and wildlife, and help control flooding and storm damage.

In recent years, resident populations of non-native Canada geese and other waterfowl have appeared in the Bay area. Attracted by expanses of lawn, an abundance of ponds and a human population with an affinity for feeding them, these species have a major impact on bacterial pollution to waterbodies. Current management of these species for the most part does not link water quality and wildlife management and has not effectively controlled this pollution source. Canada geese are protected under the federal Migratory Bird Treaty and any management

actions must be approved by state and federal authorities. These birds also can cause significant shoreline habitat impacts through activities that cause shoreline erosion, exacerbating water pollution problems.

Non-managed Vertebrates and Invertebrates

In both states, plants and non-game animals are managed according to a natural heritage methodology that identifies rare species and habitats and tracks both known population locations and priority habitats. Ideally, these programs involve field surveys and species inventories, habitat protection and restoration, state-based and multi-state data management networks, mapping, environmental reviews that support state permitting, education, and land protection activities. In both Massachusetts and Rhode Island, natural heritage management is largely funded through project specific funds, fees, federal grants, and voluntary contributions (e.g. income tax check off). Though resources devoted to natural heritage are under severe pressure in both states, the Massachusetts Natural Heritage and Endangered Species Program has successfully pursued a comprehensive priority setting project called BioMap which directs regulatory and land protection and stewardship efforts toward sites that are most critical for continuing existence of rare species and their habitats, exemplary natural communities, and diverse ecosystems. Though the non-profit Rhode Island Natural History Survey (RINHS) conducts site inventories as part of its programs, and RINHS, TNC, URI, and RIDEM are cooperating to maintain minimal biodiversity data management capability, there is no comprehensive effort to identify critical and supporting habitat in Rhode Island equivalent to that in Massachusetts.

Invasive Species

Rhode Island has an Aquatic Invasive Species Management Plan, developed in 2007 by R.I. CRMC, RIDEM, RINHS and URI with review and input from a wide range of stakeholder organizations, that identifies a management framework for addressing aquatic invasive species. It provides recommendations regarding coordination, communication, monitoring, research, prevention and control, and legislation/regulation. Recognizing that eradication of invasive species is expensive and often ineffective, the plan emphasizes the prevention of introductions of invasive species and regular monitoring efforts. In addition, R.I. collaborates with other New England states, New York and the Province of Quebec, Canada, through the federally authorized Northeast Aquatic Nuisance Species Panel.

The Rhode Island Invasive Species Council, a non-regulatory collaborative formed in 2000, collects and disseminates information on the presence, distribution, ecological and economic impacts, and management of invasive species. It also promote uses of native species and non-invasive alternatives throughout Rhode Island and works cooperatively with researchers, conservation organizations, government agencies, the green industries, and the general public to identify and manage invasive species pro-actively and effectively.

In an effort to halt the importation and use of invasive plants often used in landscaping and fish tanks, in 2006 Massachusetts created a list of over 140 plant species considered noxious or invasive that it prohibited from sale or distribution in that state. Rhode Island has passed such legislation but it has not yet finalized the list of prohibited species and so is not fully implemented at this time (Kiernan, pers. comm., 2012)

The Massachusetts Department of Conservation and Recreation published the Aquatic Invasive Species Assessment and Management Plan in 2010. This plan described the current status of aquatic invasive species in the state and detailed a management plan designed to control new infestations and prevent new introductions (MADCR, 2010).
In 2012, Rhode Island produced a report for state leadership on the state of its lakes and ponds, focusing on water quality and aquatic invasive species concerns. It provided information on the type and extent of invasive species (mostly plants) in the state's lakes and ponds, and recommended actions that should be taken to address this problem. It recommended that a lakes management program be created and included other recommendations regarding monitoring, prevention and response, public education, and water quality management (RIDEM, 2012).

MIT Sea Grant, as part of a New England-wide assessment, has conducted three rapid assessment surveys since 2000 to assess the extent of marine invasive species in Narragansett Bay with support from R.I. CRMC, NBEP, NBNERR and other partners.

Data Challenges

Ecosystem-based management of commercial and recreational fisheries is made challenging by a variety of factors, including the lack of baseline data for an unimpacted ecosystem, the concern by fishers about the possible economic impacts of regulations and policies, the difficulty in collecting accurate and timely data, and the difficulty in separating environmental factors from fishing impacts.

ABOVE Fish ladder at Bradford, R.I. provides access over a mill dam.
BELOW Site of the Town Pond salt marsh restoration project in 1939, 1996, and 2008 – original pond, filled pond, and restored pond and marsh.

Priority Actions = shaded blocks; (Year) = target completion date, ⟳ = in progress, ACRONYMS see page 68.

1.	Conserve existing natural landscapes that have been and will be adversely affected by development, climate change, and invasive species	Primary Implementing Parties
1.1	Focus resources and enhance land protection efforts by conservation agencies and organizations on less-developed areas, particularly areas threatened by new sprawl development in both states ⟳	RIDEM, MADCR, MADFW, municipalities, federal agencies
1.2	Improve and coordinate both state and federal habitat protection and restoration policies	RIDEM, MADEP, MADFW, EPA, USFWS, ACOE, NOAA, NRCS, NPS

2.	Restore degraded or lost habitats and habitat functions	Primary Implementing Parties
2.1	Improve river connectivity and habitat by removing dams, upgrading culverts and creating structural fish ways to restore free-flowing rivers and anadromous fish passage; implement state fish passage plans ⟳	RIDEM, MADCR, MADFW, MADER, RICRMC, NBEP, federal agencies
2.2	Create a coordinated bi-state habitat sustainability strategy with a restoration component and identification of priority projects, comprehensive management principles, and implementation targets for freshwater and saltwater ecosystems (2015)	RIDEM, MADEP, MADCR, NBEP, federal agencies
2.3	Develop a strategy to assess dams comprehensively addressing public safety, ecology, cultural values, and power generation	RIDEM, MADFW, MADER, RICRMC, emergency management agencies

3.	Manage habitats to sustain and enhance habitat function	Primary Implementing Parties
3.1	Manage waterfowl populations to reduce bacterial and nutrient pollution and habitat destruction in waterbodies ⟳	RIDEM, MADFW, federal agencies
3.2	Create and implement a comprehensive shellfish management plan for all R.I. marine waters including Massachusetts marine waters in Narragansett Bay that recognizes shellfish as an ecological as well as an economic resource (2014)	RIDEM, MADFW
3.3	Assess and consider for use in Rhode Island the Massachusetts Conservation Assessment and Prioritization System (CAPS) to evaluate the integrity of ecological communities	RIDEM
3.4	Acquire needed data to revise and implement R.I. and Mass. wildlife plans that address important species and associated habitats identified by the states and The Nature Conservancy	RIDEM, MADFW, federal agencies
3.5	Develop and sustain wildlife monitoring programs	RIDEM, MADFW, MACZM, RICRMC
3.6	Educate land owners, resource users and the public regarding habitat and wildlife conservation	RIDEM, MADFW, NGOs, watershed & user groups
3.7	Identify and protect cold water fishery streams/headwater areas using Clean Water Act tools, state, federal, and non-profit land acquisition programs and other strategies	RIDEM, MADFW, MADCR, TNC, RIDOP, Mass Regional Planning

4.	Monitor, control and prevent terrestrial and aquatic invasive species	Primary Implementing Parties
4.1	Update and implement state plans for preventing, controlling and managing terrestrial and aquatic invasive species including improving early detection and rapid response capabilities and educating key constituencies; coordinate R.I. and Mass. programs ⟳	RIDEM, MADFW, RICRMC, MACZM, NGOs, universities

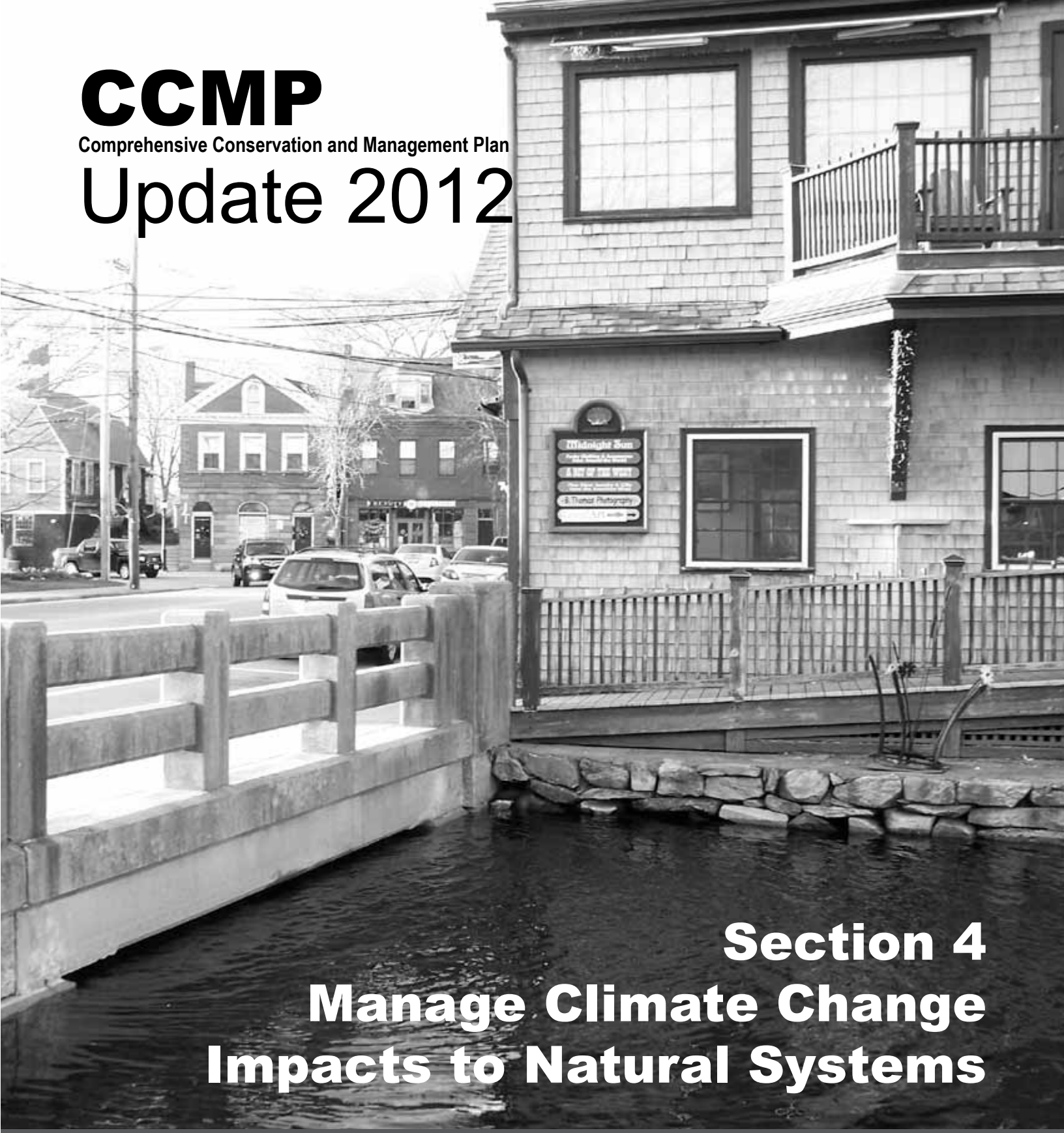
5.	Improve science, communication, and information to guide management of habitats and biodiversity	Primary Implementing Parties
5.1	Establish a comprehensive set of NBR status and trends indicators for critical habitats to assess habitat changes (working off biological condition gradient), impacts, and conservation and restoration progress (2014) ⌃	RIDEM, MADFW, RICRMC, MACZM, NGOs, universities, NBEP
5.2	Restore/re-fund Rhode Island Natural Heritage program through a multi-organization partnership	RIDEM, RI General Assembly
5.3	Continue and enhance ecological approaches to fisheries management including monitoring, applied research, technical training	RIDEM, MADFW, universities, NBEP
5.4	Improve fish contamination studies and consumption advisories, particularly as pertains to urban and ethnic communities and populations at risk.	RIDEM, MADFW, MADEP, RIDOH, Mass. Health Depts., universities
5.5	Examine science and assess need for additional land and water protections, including identifying applied research needs related to habitat and habitat function; provide resources to conduct needed research.	RIDEM, MADCR, MADFW, NGOs, RIDOP, Mass Regional Planning
5.6	Identify compatibility issues related to hydroelectric power generation and river ecosystems; incorporate into hydropower development strategies ⌃	RIDEM, MADFW, RIDOP, Mass Regional Planning, RIRESP, NBEP
5.7	Develop tools and information on biodiversity and priority habitats and make them available to the public and local and other officials to help with planning and management	RIDEM, MADFW, RICRMC, MACZM, NGOs, universities
5.8	Develop incentives for private property owners to participate in habitat restoration projects	RIDEM, RICRMC, MADFW, MACZM, NGOs
5.9	Working with commercial fishermen and shellfishermen, NBNERR, universities, angler associations and other community and technical stakeholders, examine potential for additional protected areas in Narragansett Bay and other coastal waters.	RIDEM, RISAA, NBNERR, fishing interests, universities, RISG, MACZM
5.10	Use hydrographic models of the Bay and other methods to assess the relationship between areas closed to shellfishing due to pollution and shellfish harvest areas in terms of effects on shellfish populations and potential use of sanctuary or refuge areas for shellfish	RIDEM, MADFW, NBC, universities
5.11	Develop baseline data on condition and extent of riparian buffer areas	RIDEM, MADFW, universities, NGOs

6.	Build capacity to implement ecological restoration at state (particularly in R.I.) and local levels and improve interstate coordination	Primary Implementing Parties
6.1	Create a R.I. Habitat Restoration program, similar to the Mass. Wetlands Restoration Division of Ecological Restoration, with dedicated, full time staff to support project implementation, work on needed restoration policy, and integrate agency actions (2015)	RIDEM, RICRMC, NGOs, universities
6.2	Develop state policies, plans and practices to improve integration of water quality improvement, stormwater measures and physical restoration	RIDEM, MADEP, MADCR
6.3	Support and expand R.I. Coastal and Estuarine Habitat Restoration Trust Fund funding, the Mass. Division of Ecological Restoration, NGO-based restoration efforts and federally funded restoration programs (NRCS, USFWS, NBEP, etc.) (2015)	RIDEM, RICRMC, MADEP, MADCR, NGOs, federal agencies
6.4	Maintain and expand state-wide and regional mapping of critical watershed and coastal habitats including biodiversity hot spots; use data to support restoration, conservation planning, and enhanced enforcement ⌃	RIDEM, MADFW, RICRMC, MACZM, NGOs, universities, USEPA, NOAA
6.5	Support the efforts of the R.I. Habitat Restoration Team to improve and coordinate habitat restoration projects, funding and policy	RIDEM, RICRMC, RI General Assembly, NBEP, STB
6.6	Develop a continuing seagrass mapping program in R.I. and Mass. coastal waters ⌃	RIDEM, MADEP, RICRMC, MACZM, NGOs, universities, STB, NBEP
6.7	Create R.I. state lake management program, coordinated with Mass. lakes management that includes requirements for lake management plans that address water quality and invasive species.	RIDEM

CCMP

Comprehensive Conservation and Management Plan

Update 2012



Section 4
Manage Climate Change Impacts to Natural Systems

GOAL

A Narragansett Bay region which has minimized risks to human life, public infrastructure, private property and native ecosystems posed by storms, floods and other natural hazards; is prepared for extreme events; and is resilient and prepared for climate change.

OBJECTIVES

1. Maximize preservation and restoration of green infrastructure to increase coastal and floodplain resilience
2. Improve public and private infrastructure to withstand anticipated impacts
3. Ensure adequate disaster mitigation and response planning to protect life and property
4. Develop funding mechanisms for improved preparedness and response
5. Improve science and information necessary for preparedness and response
6. Ensure that coastal habitat restoration efforts take sea level rise into account and Natural Systems

PROBLEM

Human and natural systems will be affected by increases in sea level rise, storm intensity and precipitation as well as temperature change affects on natural systems; impacts need to be managed to protect ecological resources, avoid economic damage, and protect infrastructure and public safety

The communities of the Narragansett Bay region, in both Rhode Island and Massachusetts, are vulnerable to a variety of natural hazards. These vulnerabilities are exacerbated by climate change, which is under way and will continue through the 21st century, as well as existing patterns of Narragansett Bay region development. Native ecosystems are also threatened by climate change and communities will likely face significant costs associated with climate change impacts. Challenges include:

•Sea level rise will lead to greater storm surges, coastal flooding and increased wave damage from hurricanes and Nor'easters, increasing threats to coastal neighborhoods and infrastructure

•Coastal wetland accretion may not be able to keep up with sea level rise, leading to increased wetland loss rates and coastal erosion

•Increased precipitation is increasing the frequency and extent of river flooding; communities and businesses are made more vulnerable by flood plain development; flooding mobilizes pollutants that increase stress on fresh and estuarine waters

•Much of the watershed's infrastructure is aging (19th century dams and bridges; 1950's highways and shopping malls, etc.). Many roads, bridges and dams are not engineered to withstand these increasing pressures and are therefore highly vulnerable to damage. Outdated infrastructure can worsen climate change impacts—for example when dams fail, or when insufficiently sized bridge crossings impound upstream waters. In addition, there is a lack of coordinated management of dams and other water release structures to help address major flows during intense precipitation events.

•Increased water and air temperatures threaten native species by making them more vulnerable to disease and parasites while increasing ecosystem vulnerability to invasives; changes in timing of species cycles (e.g., earlier blooms, longer mosquito seasons) have implications for species changes and human health.

CLIMATE CHANGE STATUS & TRENDS SUMMARY

Sea Level Rise

Locally, measurements of sea level rise show that it has accelerated at a rate faster than projected by climate change scientists. Sea level rise at Newport has increased by almost ten inches since 1930. Climate models show that this rate will accelerate as temperatures continue to warm. These trends are expected to continue through the 21st century while the pace of climate change may well increase. Further, climate change is expected to increase the intensity of storms and result more storms affecting coastal regions. A 2012 report in Nature Climate Change presented evidence that sea level rise does not occur and will not continue at the same rate everywhere. The report stated that the coastline between Cape Hatteras and Boston, Mass. is a hotspot for sea level rise with rates 3 to 4 times higher than the global average (Sallenger, et. al., 2012), making the issue even more important for the Narragansett Bay region to address.

Coastal Erosion

Coastal beaches in the Narragansett Bay region especially along the south coast of R.I. between Watch Hill and Point Judith have erosion rates that average greater than three feet per year in some places—a rate that can be substantially exceeded during a single major storm event. Erosion rates are dependent on the frequency and intensity of storm events. We are likely to see increases in erosion rates due to the fact that tropical storm intensity has increased in the North Atlantic over the last 40 years with a doubling of the number of category 4 and 5 storms since the 1970s (Webster et al. 2005).

Precipitation

Average precipitation in the Northeast has increased by more than 11.8 inches per year over the past century, an increase in the range of 16-30 percent, and river flow reflects the higher intensity and timing of rainfall events. Not only has Rhode Island precipitation seen a 27% increase over the time period 1895-1999 (Smith, et al., 2010), there has been an 88% in the frequency of extreme rainfall events since 1984 (Madsen and Figdor 2007).

Dam Hazards

There are estimated to be more than a thousand dams on the region's rivers and streams, ranging from small stone weirs to relatively large structures classified as "significant" and "high hazard" dams—those

with the potential to cause death or extensive property damage in the event of failure. According to MADEP, the highest density of dams per stream mile occurs in the Blackstone River watershed. Many of these structures pose risks of failure in the event of a flood; this problem will increase greatly over the coming decades, as regional precipitation continues to increase and the dams—most of which date to the early 19th century—continue to deteriorate. Left in place, many of the dams have ongoing environmental impacts—preventing the movement of fish and wildlife; raising stream temperatures; and displacing riverine habitat. About 15% of Rhode Island's 663 dams are rated high hazard dams, meaning that dam failure would likely cause significant property damage and threat to human life (RIDEM, 2010).

Rising Temperature

Sea surface temperature on Narragansett Bay and average annual air temperature at Providence have each increased by more than 1.8 degrees Fahrenheit one degree over the past half century (Smith et al., 2010). 2010 was the warmest year on record (neaq.org 2011). The Massachusetts Climate Adaptation Strategy reports that the Northeast has been warming at a rate of nearly 0.5 degrees Fahrenheit per decade. Winter temperatures are rising at an even faster rate - 1.3 degrees Fahrenheit per decade.

SUMMARY OF CLIMATE CHANGE ADAPTATION MANAGEMENT INITIATIVES

Both Rhode Island and Massachusetts have been proactive in preparing for climate change impacts. In September 2011, Massachusetts, as part of the requirements of the state's Global Warming Act of 2008, completed its Climate Change Adaptation Strategy – a comprehensive plan on how to adapt to a changing climate across many sectors from natural resources to infrastructure and the economy. Both states were part of a partnership of New England states that successfully secured American Recovery and Reinvestment Act (ARRA) funding to acquire light detection and ranging (LIDAR) elevation data for their coastal regions. This LIDAR data will allow shoreline and floodplain maps to be accurately updated and open the door to many different types of analyses needed to prepare for or mitigate climate change impacts.

In 2008, Rhode Island's coastal zone agency amended the state's coastal resources management plan with a set of policies designed to address climate change impacts, in particular sea level rise. The policies are based on an expectation that, by 2100, sea level will rise by three to five feet; it will use this new standard in revising coastal development and redevelopment requirements. In 2011, the R.I. Legislature passed the Climate Risk Reduction Act which created the R.I. Climate Change Commission – a stakeholder-based commission charged with studying the projected impacts of climate change and identifying adaptation methods. As of August 2012, the commission is working on a report of its findings and recommendations that will be presented to the R.I. General Assembly. Prior to this legislative action, the state had developed a greenhouse gas action plan in 2002 and Rhode Island agencies had then formed a greenhouse gas public/private consortium to find ways to reduce greenhouse gas emissions. Over the last 5 years, Rhode Island has enacted legislation designed to increase energy efficiency, reduce emissions and increase use of renewable energy sources. Massachusetts passed the Global Warming Solutions Act in 2008; as part of this act, the state sets economy-wide greenhouse gas reduction goals targeting a reduction by 2020 of between 10 and 25 percent below statewide 1990 greenhouse gas emission levels.

The R.I. Statewide Planning Program has partnered with R.I. CRMC, the University of R.I., and the Town of North Kingstown, R.I., to create a pilot program using available LIDAR data to show impacts of sea level rise along the Town's coastline under different scenarios of sea level rise. This effort, now completed, is intended to provide a tool and guidancefor other communities to be able to better project impacts from sea level rise and design measures to protect public health and safety. The U.S. EPA and NOAA have provided grant funding for local projects to advance knowledge and better prepare for climate change.

Both Rhode Island and Massachusetts operate floodplain management programs based on three main components: flood insurance, regulations and mapping. In return for access to the National Flood Insurance Program, states and municipalities agree to develop and implement regulations that minimize threats to people and property. These take the form of requirements in state building codes, local ordinances and state permitting processes. Flood hazard maps are produced by the federal government and are used to identify areas subject to flooding. The programs in both states provide technical assistance to communities on floodplain management issues (pers. comm., R. Zingarelli).

Rhode Island operates a state dam safety program which classifies dams based on hazard risk, identifies owners, and works with owners and federal partners to repair unsafe dams, where feasible. Dams are classified as high, significant or low hazard. The dam safety program has 668 dams in its inventory of which 97 are classified high hazard, meaning that dam failure would result in a probable loss of human life. The Massachusetts Department of Conservation and Recreation also operates a dam safety program. Recent changes to state law requires that dam owners are now responsible for registering, inspecting, reporting inspection results to the Office of Dam Safety and maintaining their dams in good operating condition.

SCOPE OF THIS SECTION

There are many adaptation strategies that can be part of a climate change adaptation plan but the actions identified in this section reflect actions that have an ecosystem impact mainly in the areas of risk of pollution or damage or loss of habitat. This reflects the overall nature of the *CCMP Update 2012*. Actions that were more administrative or strictly public safety-oriented were not included. Both states have climate change adaptation efforts or plans that address those other aspects of climate change impact.

Priority Actions = shaded blocks; (Year) = target completion date, ⟳ = in progress, ACRONYMS see page 68.

1.	Maximize preservation, conservation and restoration of green infrastructure to increase coastal and floodplain resilience	Primary Implementing Parties
1.1	Identify, protect and restore watershed and riverine natural resources, e.g., wetlands and riparian areas to ensure their continuance as cost-effective protection.	RIDEM, RICRMC, MADCR, MACZM, municipalities, federal agencies
1.2	Remove dams where practicable and beneficial to public safety and/or river ecology; where dams must be retained, ensure that high and moderate hazard dams are fully maintained ⟳	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies, NBEP
1.3	Improve dam condemnation policies to provide more effective mechanisms for dam removal in R.I. and Mass.	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies, NBEP
1.4	Use state and local permitting processes and adaptive restoration programs (e.g., living shorelines) to protect natural coastal features like salt marshes and beaches as well as coastal shoreline processes so that they can continue to provide cost-effective coastal protection.	RIDEM, RICRMC, MADCR, MACZM, municipalities,

2.	Improve public and private infrastructure to withstand anticipated climate change impacts	Primary Implementing Parties
2.1	Develop strategies and incentives to guide development away from high hazard zones and natural areas that provide storm protection and other benefits (2015)	RIDEM, RICRMC, MADEP, municipalities
2.2	Design stormwater treatment facilities and green stormwater infrastructure to have adequate capacity over the life of the facility for predicted increased, intensified flow resulting from climate change (2017)	RIDOT, MADOT, RIDEM, RICRMC, MADEP, MACZM, municipalities, state emergency mgmt. agencies
2.3	Develop and implement natural hazard mitigation and adaptation plans for publicly-owned wastewater facilities to reduce potential for pollution impacts from climate related events	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies, RISG
2.4	Improve dam inspection and maintenance requirements and enforcement	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies
2.5	Mandate a regular review of state and local plans and risk assessments to incorporate advancements in coastal hazards science	RIDEM, RICRMC, MADCR, MACZM, municipalities, RISG
2.6	Evaluate the projected effects of salt water intrusion on coastal onsite wastewater treatment systems, drinking water and stormwater infrastructure	RIDEM, RISG, URI-CE, Mass. universities

3.	Ensure adequate disaster mitigation and response planning to protect life and built environment	Primary Implementing Parties
3.1	Develop a shoreline change Special Area Management Plan to address coastal erosion and inundation in response to sea level rise and strategies and incentives to guide development away from special flood hazard areas (2015) ⟳	RICRMC, municipalities
3.2	Develop mechanisms to coordinate responses across the range of interests affected by climate change impacts – state and federal agencies, private sector, institutions, and municipalities	State emergency mgmt. agencies, municipalities, RIDOP, MA regional planning
3.3	Create coordinated water release and storage strategies to help address problems related to flows (flooding, infrastructure damage, etc.) from intense storm events.	State emergency mgmt. agencies , municipalities, dam managers

3.4	Assess and identify the most effective adaptation responses; prioritize implementation of these identified activities (2015)	State emergency mgmt. agencies, municipalities, RIDOP, Mass Regional Planning

4.	Develop funding mechanisms for improved preparedness and response	Primary Implementing Parties
4.1	Develop funding mechanisms for infrastructure retrofits for affected utilities and structures most likely to be affected by a disaster; identify those critical to public health and environmental priorities (2015)	RIDEM, RICRMC, MADCR, MACZM, municipalities, state EMAs
4.2	Develop additional funding for prioritized dam inspection, maintenance and removal; identify potential funding mechanisms to create a dam management fund	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies
4.3	Develop/leverage funding for acquisition of properties most vulnerable to damage from climate change impacts, targeting those which could provide multiple benefits such as habitat retreat, recharge, open space, recreation, and flood storage	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies, RISG
4.4	Modify and enhance state State Revolving Fund programs to encourage communities to address climate change impacts and avoid investment in highly vulnerable areas	State legislatures, RIDEM, MA EOEEA
4.5	Increase state resources and secure additional federal resources to meet identified science research needs	State legislatures, RIDEM, MA EOEEA

5.	Improve science and information necessary for preparedness and response	Primary Implementing Parties
5.1	Continue to improve accuracy of inundation models for coastal and riverine floodplains to support long term planning; apply the results of state pilot projects and NEP Climate Ready Estuaries projects in planning for resilience ⓐ	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies, RISG, USEPA
5.2	Identify applied research needs to better assess impacts of climate change on watershed and bay ecosystems	RIDEM, RICRMC, MADEP, MACZM, universities, federal agencies
5.3	Use data generated by regional Light Detection and Ranging (LIDAR) topographic surveys and high-resolution bathymetry databases to support floodplain mapping, sea-level rise and storm surge modeling	RIDEM, RICRMC, MADCR, MACZM, municipalities, state EMAs, RISG

6.	Ensure that coastal habitat restoration and conservation efforts take sea level rise into account	Primary Implementing Parties
6.1	Develop land conservation and adaptation plans for wetland migration to include protection of adjacent upland areas (2015)	RIDEM, RICRMC, MADCR
6.2	Assess effectiveness and determine feasibility for use of Living Shorelines programs in the Narragansett Bay Region	RIDEM, RICRMC, MADCR
6.3	Adopt an approach, where possible, that accommodates rather than resists flood waters by restoring flood plain buffers for use as marsh or forest land; Employ resilience design where possible to absorb stormwater in extreme events, particularly in light of projected increased precipitation	RIDEM, RICRMC, MADCR

NARRAGANSETT BAY
ESTUARY PROGRAM

CCMP

Comprehensive Conservation and Management Plan

Update 2012

Appendices

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R.I. AND MASS. ENVIRONMENTAL MANAGEMENT CORE PROGRAM CAPACITIES

This table represents important state and local environmental management programs and activities in Massachusetts and Rhode Island that are critical to effective management. These programs are predominantly funded through state and federal sources. Some of these activities, e.g., habitat restoration, have significant involvement from NGOs, watershed groups and other entities.

ACTIVITY	RHODE ISLAND	MASSACHUSETTS.
WATER QUALITY		
State water quality monitoring programs	RIDEM	MADEP
State water quality standards	RIDEM	MADEP
Assess state waters; report to federal authorities	RIDEM	MADEP
Pollution prevention programs	RIDEM	MADEP
Conduct TMDL studies and implement actions	RIDEM	MADEP
Implement state pollution discharge elimination systems for point source wastewater discharges	RIDEM	USEPA, MADEP
Oversee implementation of combined sewer overflow abatement projects	RIDEM	MADEP
Oversee wastewater facility planning	RIDEM	MADEP
Implement stormwater management plans including federally mandated MS4 programs	RIDEM	MADEP
Conduct clean watersheds needs surveys to identify capital needs	RIDEM	MADEP
Implement pretreatment programs to prevent introduction of toxics that are harmful to wastewater treatment	RIDEM	MADEP
Implement sludge and septage management programs	RIDEM	MADEP
Oversee operation and maintenance of wastewater treatment facilities	RIDEM	MADEP
Conduct training for wastewater treatment facility operators	RIDEM	MADEP
Oversee siting, design and construction of onsite waste disposal systems	RIDEM	Municipalities
Ensure that failing onsite waste disposal systems are repaired or replaced	RIDEM	MADEP, municipalities
Encourage the use of and approve innovative wastewater treatment technologies	RIDEM	MADEP
Prevent discharge of pollutants into ground waters that serve as water supply sources	RIDEM	MADEP, municipalities
Implement the underground injection control program	RIDEM	MADEP
LAND ACQUSITION		
Identify and target lands for protection and acquisition	RIDEM, municipalities	MADFG, municipalities
Partner and negotiate for land and development rights purchase	RIDEM, municipalities	MADFG, municipalities
FISH & WILDLIFE MANAGEMENT		
Monitor fish and wildlife populations	RIDEM	MADFG
Enforce fisheries laws	RIDEM	MADFG
Implement shellfish growing area management plans; conduct shoreline surveys for pollution sources	RIDEM	MADFG, municipalities
Endangered species law enforcement/permitting	RIDEM	MADFG
Enforcing hunting regulations	RIDEM	MADFG

LAND MANAGEMENT		
Wetlands protection and permitting	RIDEM, RICRMC	MADEP, municipalities
Waterways programs		MADEP
Stormwater management	RIDEM, RICRMC, municipalities	MADEP, municipalities
Review and permitting of development projects	Municipalities	Municipalities, regional planning agencies
Areas of critical environmental concern programs		MADEP
State review of large projects for cumulative impacts		MEPA
Water supply regulations	RIWRB	MADEP
Habitat restoration	RICRMC, RIDEM, municipalities	MADFG
Forest health management	RIDEM	MADFG
Forest health monitoring	RIDEM	MADFG

HAZARDOUS WASTE		
Permitting use and disposal	RIDEM	MADEP
Oil spill response	RIDEM	MADEP
Cleanup and site remediation	RIDEM	MADEP
Regulating hazardous materials facilities	RIDEM	MADEP

AIR QUALITY		
Permitting emissions	RIDEM	MADEP
Monitoring air quality	RIDEM	MADEP
Develop air quality standards	RIDEM	MADEP

CURRENT AND POTENTIAL ECOSYSTEM INDICATORS—NARRAGANSETT BAY REGION

Below is a list of environmental indicators by section that relate to assessing condition; some of these are in use while others have been identified as needed measurements. These are drawn from national models and local indicator workshops.

WATER RESOURCES INDICATORS

Water resources indicators where data, to some degree, has been available include nitrogen, phosphorus, turbidity, dissolved oxygen, temperature, pH, chlorophyll a, biomass/macroalgae, beach closures, impervious surfaces, and stream flow. Both R.I. and Mass. monitoring strategies incorporate the following indicators:
(F indicates use in freshwaters; S for salt waters)

- •Dissolved oxygen (F/S)
- •Pathogens/beach closures/shellfish bed closures (F/S)
- •Nitrogen (F/S)
- •Chlorophyll (F/S)
- •Invasive species (F/S)
- •Fish assemblages (F/S)
- •Toxics in fish tissue (F/S)
- •Temperature (F/S)
- •Mercury (F/S)
- •PCBs (F/S)
- •pH (F/S)
- •Pesticides (F/S)
- •Macroinvertebrate communities (F)
- •Flow (F)
- •Phosphorus (F)

LAND USE/MANAGEMENT INDICATORS

- •Reduction in the rate of growth of impervious surface
- •Change in the amount of impervious surface treated
- •Change in land cover/use
- •Change in amount of prime farmland
- •Amount/rate of land developed vs. population change
- •Acres/percent of protected land
- •Extent of marine shoreline armoring

HABITAT INDICATORS

- •Extent/rate of change of freshwater wetlands
- •Acres of protected wetlands
- •Extent/rate of change salt and brackish marshes
- •Extent/rate of change eelgrass/seagrass beds
- •Extent/rate of change cold water streams
- •Extent/rate of change forested habitat
- •Extent/rate of change to floodplains
- •Extent/rate of change rivers/streams dammed
- •Food web structure (phytoplankton, zooplankton, etc.)
- •Water quality measurements that affect fisheries habitat (dissolved oxygen, nutrients, temperature, pH, salinity, etc.)
- •Indices of ecological integrity (e.g., Mass. CAPS); can be used to assess number and percent of stream/river miles, lake acres, estuary acres, wetland acres, etc.

CLIMATE CHANGE INDICATORS

Because climate change is expected to have a broad range of effects on ecosystems, there are many indicators that relate to change impacts. States are making decisions on which data is most needed to assess the rate of change and to shape management strategies. Indicators that measure impact include:

- •Coastal shoreline tide gauge levels
- •Coastal erosion rates
- •Air temperature
- •Water temperatures – rivers, lakes, coastal waters
- •Tropical storm intensity
- •River/stream water levels
- •Snow cover
- •Frequency/duration of heat waves
- •Drought periods
- •Precipitation levels – annual average; frequency and intensity of heavy events
- •Lake ice (freeze and thaw times)
- •Length of growing seasons
- •Plant hardiness zones
- •Leaf and bloom dates
- •Invasive species

For more information on Narragansett Bay bi-state watershed indicators, see the Narragansett Bay Estuary Program status and trends report, *Currents of Change* (http://www.nbep.org) and the Watershed Counts website at http://watershedcounts.org/. Information regarding the R.I. Bays, Rivers & Watersheds Environmental Monitoring Collaborative is at (http://www.dem.ri.gov/bayteam/envirocollab.htm). Indicators related to the R.I. state water quality monitoring are discussed in the R.I. Water Monitoring Strategy 2005-2010 (http://www.ci.uri.edu/Projects/RI-Monitoring/Docs/DEM_WQ_Oct_14_05.pdf). The Massachusetts water quality monitoring strategy is available at (http://www.mass.gov/dep/water/resources/stratgy9.pdf).

ACRONYMS

Acronym	Meaning
ACEC	Areas of Critical Environmental Concern
AIS	Aquatic Invasive Species
ARRA	American Recovery & Reinvestment Act
BMP	Best Management Practice
CAPS	Conservation Assessment & Prioritization System
CCMP	Comprehensive Conservation & Management Plan
CPA	Community Preservation Act
CRC	Coastal Resources Center
CSO	Combined Sewer Overflow
CWCS	Comprehensive Wildlife Conservation Strategy
DDT	dichlorodiphenyltrichloroethane
DER	Division of Ecological Restoration – Mass.
EMA	Emergency Management Agency (R.I. and Mass state agencies)
EPA	Environmental Protection Agency
EPA-NPDES	National Pollution Discharge Elimination System
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
LID	Low Impact Development
LIDAR	Light Detection And Ranging
LUPA	Land Use Partnership Act
MA CZM	Massachusetts Coastal Zone Management
MA DCR	Massachusetts Division of Conservation and Resources
MADEP	Massachusetts Department of Environmental Protection
MADFW	Massachusetts Department of Fish & Wildlife
MADOT	Massachusetts Department of Transportation
MAEOEEA	Massachusetts Office of Energy & Environmental Affairs
MPA	Marine Protected Area
MS4	Municipal Separate Storm Sewer System
NBC	Narragansett Bay Commission
NBEP	Narragansett Bay Estuary Program
NBJ	Narragansett Bay Journal
NBNERR	Narragansett Bay National Estuarine Research Reserve
NBR	Narragansett Bay Region
NEIWPCC	New England Interstate Water Pollution Control Commission

NEPA	National Environmental Policy Act
NGO	Non Governmental Organization
NOAA	National Oceanic And Atmospheric Agency
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service
OWTS	Onsite Wastewater Treatment Systems
PCB	Polychlorinated Biphenyl
PNB	Partnership for Narragansett Bay
QA/QC	Quality Assurance/Quality Control
RIBRWCT	R.I. Bays, Rivers & Watersheds Coordination Team
R.I. CSSLP	R.I. Community Septic System Loan Program
RI DOH	R.I. Department of Health
RI DOP	R.I. Division of Planning
RI DOT	R.I. Department of Transportation
RI Env-MC	R.I. Environmental Monitoring Collaborative
RI RESP	R.I. Renewable Energy Siting Partnership
RI WRB	R.I. Water Resources Board
RICRMC	R.I. Coastal Resources Management Council
RICWFA	R.I. Clean Water Finance Agency
RIDEM	R.I. Department of Environmental Management
RINHS	R.I. Natural History Survey
RISAA	R.I. Saltwater Anglers Association
RISG	R.I. Sea Grant
SSO	Sanitary System Overflows
TFC	Target Fish Community
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TPL	Trust for Public Land
TU	Trout Unlimited
URI	University of Rhode Island
URI-CE	University of Rhode Island - Cooperative Extension
URI-CI	University of Rhode Island – Coastal Institute
URI-GSO	University of Rhode Island – Graduate School of Oceanography
USDA	U. S. Department of Agriculture
USDOI	U.S. Department of Interior
USFWS	U.S. Fish & Wildlife Service
WWTF	Waste Water Treatment Facility

AREAS OF CRITICAL ENVIRONMENTAL CONCERN

A designation adopted by Massachusetts regarding important ecological areas that receive special recognition because of the quality, uniqueness and significance of their natural and cultural resources. These areas are identified and nominated at the community level and are reviewed and designated by the state's Secretary of Environmental Affairs. ACEC designation creates a framework for local and regional stewardship of critical resources and ecosystems. See http://www.mass.gov/dcr/stewardship/acec/index.htm

AQUACULTURE

The breeding, rearing, and harvesting of animals and plants in all types of water environments including ponds, rivers, lakes, and the ocean. Aquaculture is used for producing seafood for human consumption; enhancing wild fish, shellfish, and plant stocks for harvest; restoring threatened and endangered aquatic species; rebuilding ecologically-important shellfish habitat; producing nutritional and industrial compounds; and providing fish for aquariums.

ADAPTIVE MANAGEMENT

A structured, iterative process of robust decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. In this way, decision making simultaneously meets one or more resource management objectives and accrues information needed to improve future management.

BIODIVERSITY

The range of variation (species richness) found among microorganisms, plants, fungi, and animals that form complex assemblages of communities and ecosystems.

BIOLOGICAL INTEGRITY

The capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region. See http://www.epa.gov/bioiweb1/html/biointeg.html

CLEAN WATER ACT

The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name with amendments in 1972. http://www.epa.gov/lawsregs/laws/cwa.html

COMBINED SEWER OVERFLOWS

Overflow conditions caused by heavy rains in sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe.

ECOSYSTEM

The interaction of a community of living organisms (plants, animals and microbes) in conjunction with the nonliving components of their environment (air, water, minerals and soil).

ECOSYSTEM BASED MANAGEMENT

A place-based approach to natural resource use that aims to restore and protect the health, function and resilience of entire ecosystems for the benefit of all organisms.

ECOLOGICAL SERVICES

The benefits arising from the ecological functions of healthy ecosystems. Such benefits accrue to all living organisms, including animals and plants, rather than to humans alone. There is a growing recognition of the importance to society that ecological goods and services provide for health, social, cultural, and economic needs.

ENVIRONMENTAL INDICATOR

Measures of environmental conditions that tell us what is happening in the natural world. They are a means of evaluating and reporting on the acceptability of current conditions, and measuring progress and change over time.

ESSENTIAL FISH HABITAT

Fish require healthy surroundings to survive and reproduce. Habitats identified under the NOAA Essential Fish Habitat designation include all types of aquatic habitat—wetlands, coral reefs, seagrasses, rivers—where fish spawn, breed, feed, or grow to maturity. See http://www.habitat.noaa.gov/ourwork/efh.html

ESTUARY

A coastal area where freshwater from rivers and streams mixes with saltwater from the ocean.

GREEN INFRASTRUCTURE

Systems that mimic natural processes in order to infiltrate, evaporate, and/or reuse stormwater. Green infrastructure uses soils, topography, and vegetation in a way that minimizes the impacts of anthropogenic disturbance and maintains the pre-development hydrology and water quality of urban environments.

GREENHOUSE GAS

A greenhouse gas is one that allows sunlight to enter the atmosphere freely. When sunlight strikes the Earth's surface, some of it is reflected back towards space as infrared radiation (heat). Greenhouse gases absorb this infrared radiation and trap the heat in the atmosphere. The main greenhouse gases are: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and fluorinated gases (synthetic gases such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride). See http://epa.gov/climatechange/ghgemissions/gases.html

HARMFUL ALGAL BLOOMS

A small percentage of microscopic algal species that produce toxins that can kill fish, mammals, and birds, and may cause human illness.

INVASIVE SPECIES

Species (plants, animals, or pathogens) that are non-native (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm, or harm to human health. http://www.invasivespecies.gov/main_nav/mn_faq.html

LIVING SHORELINES

Living shorelines is a management concept that utilizes a variety of structural and organic materials, such as wetland plants, submerged aquatic vegetation, oyster reefs, coir fiber logs, sand fill, and stone to prevent erosion, provide storm surge protection, and protect coastal habitats.

LOW IMPACT DEVELOPMENT (LID)

An innovative approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. See http://www.lid-stormwater.net/background.htm.

MS4 PERMITS

A term from the federal nonpoint source pollution permitting program. Polluted stormwater runoff is commonly transported through municipal separate storm sewer systems (MS4s), from which it is often discharged untreated into local waterbodies. To prevent harmful pollutants from being washed or dumped into an MS4, operators must obtain a NPDES (National Pollutant Discharge Elimination System) permit and develop a stormwater management program. See http://cfpub.epa.gov/npdes/stormwater/munic.cfm/

NATIONAL ESTUARY PROGRAM (NEP)

A network of voluntary community-based programs that work to safeguard the health of important coastal ecosystems across the country. The NEP was established under Section 320 of the 1987 Clean Water Act (CWA) Amendments as a U.S. Environmental Protection Agency (EPA) place-based program to protect and restore the water quality and ecological integrity of estuaries designated by Congress as of national significance.

NONPOINT SOURCE POLLUTION

Pollution that comes from many diffuse sources. It generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification. The term “nonpoint source” is defined to mean any source of water pollution that does not meet the legal definition of “point source” in section 502(14) of the Clean Water Act.

NUTRIENTS

Major elements (e.g., nitrogen and phosphorus) and trace elements (including sulfur, potassium, calcium, and magnesium) that are essential for the growth of organisms. Nitrogen and phosphorus are nutrients that are important to aquatic life, but in high concentrations they can be contaminants in water. These nutrients occur in a variety of forms. Nutrients are affected by chemical and biological processes that can change their form and can transfer them to or from water, soil, biological organisms, and the atmosphere.

RIPARIAN BUFFER

Vegetated areas next to water resources that protect water resources from nonpoint source pollution and provide bank stabilization and aquatic and wildlife habitat. The formal definition of riparian buffer is diverse and depends on the individual or group defining the term. See http://www.soil.ncsu.edu/publications/BMPs/buffer.html

SANITARY SEWER OVERFLOW

A condition whereby untreated sewage is discharged into the environment prior to reaching treatment facilities thereby escaping wastewater treatment. Leaking sewer pipes and pump stations are examples.

SEA LEVEL RISE

Sea level rise is occurring when the mean high tide level increases year after year. Since the mid-19th century, sea level has been rising; recent accelerated sea level rise rates are considered a result of human-induced climate change. See http://www.climate.org/topics/sea-level/index.html

STORMWATER RUNOFF

Unfiltered water from storm events that reaches streams, lakes, sounds, and oceans by means of flowing across impervious surfaces. These surfaces include roads, parking lots, driveways, and roofs. Stormwater often contains pollutants including fertilizers, petroleum products, pesticides and pathogens.

STORMWATER RETROFIT

Reconfiguration and reconstruction of existing local drainage systems to better address erosion, stream protection and water quality goals.

TOTAL MAXIMUM DAILY LOAD

A calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.

WATERSHED

The land area that drains into a common waterway such as a lake, river, stream or estuary.

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DEDICATION

This document is dedicated to the many citizens and volunteers throughout the Narragansett Bay Region who devote their time and energy to protecting and restoring our natural resources. Organized under watershed councils, land trusts, conservation commissions and community groups, or acting under their own initiative, these folks help monitor our waters, build rain gardens, set aside lands for protection, clean our beaches, advocate to policy-makers for better environmental protection, and teach our children to respect nature and use our resources wisely. They play a vital role in ecosystem management and their effort and commitment are much appreciated.

CCMP

Comprehensive Conservation and Management Plan

Update 2012

NARRAGANSETT BAY ESTUARY PROGRAM

Envisioning an Ecological Future for the Narragansett Bay Region

CCMP Update 2012 was produced by the Narragansett Bay Estuary Program (NBEP). The NBEP is one of the 28 estuaries in the National Estuary Program. NBEP receives funding through the U.S. Environmental Protection Agency under the authority of Section 320 of the Clean Water Act. Other program funding sources include federal, state and foundation competitive grants. Significant in-kind match for the EPA grant is provided by the University of Rhode Island (URI), R.I. Dept. of Environmental Management and the Narragansett Bay Commission. The program is affiliated with the URI Coastal Institute and is located at the URI Bay Campus in Narragansett, R.I. More information on NBEP is available at www.nbep.org.

Photo: James Warcup

"In the course of my travels, I became struck by the intimate connections between people and water."

—Charles H.W. Foster, JFK School of Government, Harvard University