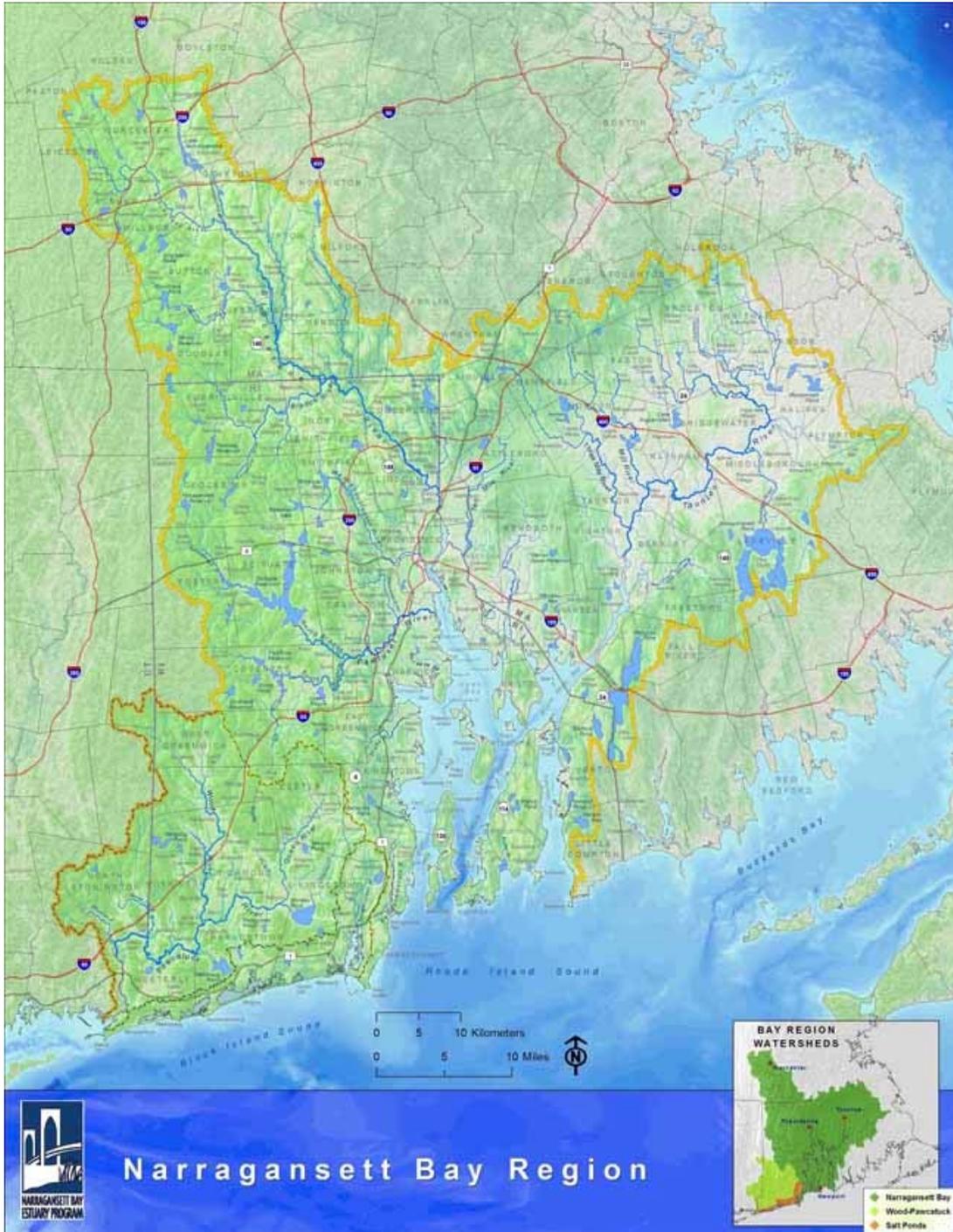


Narragansett Bay Region Plan

Review Draft
12 September 2011



Review Draft

Toward a Sustainable Narragansett Bay Region

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Table of Contents

1. A Shared Vision and Commitment
2. The Narragansett Bay Region
3. Purpose of This Plan
4. Priorities for Near Term Action
5. Goals for the Narragansett Bay Region
 5. A. Manage Watershed Lands for Human and Ecological Needs
 5. B. Restore and Protect Water Resources
 5. C. Protect and Restore Vital Habitats
 5. D. Sustain and Restore Fish and Wildlife
 5. E. Restore Prosperity while Preserving Quality of Life and Natural Resources
 5. F. Protect Human and Natural Assets
6. Appendices

Toward a Sustainable Narragansett Bay Region

1. A Shared Vision and Commitment

We envision a sustainable Narragansett Bay Region that is beautiful, diverse, productive and interconnected; where our cities and towns are compact and livable, defined by open space and regional character; where our rivers, watersheds and estuaries support healthy native ecosystems and safe, diverse human uses; where our lands and waters support abundant local food production and recreation; and where robust and restored natural assets and human capital generate a prosperous economy and high quality of life. Together, we commit to work collaboratively to achieve this vision for the benefit of present and future generations in the Narragansett Bay Region.

Goals for the Narragansett Bay Region:

- Watershed Lands for Human and Ecological Needs: 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.
- Restore and Protect Water Resources: High fresh and salt water quality throughout the Narragansett Bay Region, available in sustainable quantity to meet human and ecological needs such as fish and wildlife habitat, recreation, drinking, irrigation, commerce and industry.
- Protect and Restore Vital Habitats: Healthy, intact and diverse habitats providing ecosystem services and capable of adapting to climate change, throughout the Narragansett Bay Region, protecting core undisturbed habitat while preserving and enhancing *valuable* habitats in developed areas.
- Sustain and Restore Fish and Wildlife: Fresh and salt water fisheries and aquaculture operations throughout the Narragansett Bay Region sufficient to provide food, recreational enjoyment and economic benefits while fully supporting ecosystem functions provided by native fish and shellfish populations.
- Restore Prosperity while Preserving Quality of Life and Natural Resources: A prosperous Narragansett Bay Region that generates high-value economic activity and water-dependent uses while preserving, restoring and enhancing our regional environment and quality of life.
- Protect Human and Natural Assets: 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.

Our Shared Principles:

1. Recognize human uses and needs for resources as well as ecological needs
2. Ensure transparent and inclusive decision-making
3. Promote stewardship and public participation
4. Manage resources on a watershed basis
5. Base decisions on sound science
6. Promote use of low impact design, water conservation and green infrastructure practices
7. Support use of green economic principles in creating regional prosperity
8. Build coordinated, collaborative networks for implementation to encourage equal participation by Massachusetts and Rhode Island agencies and organizations
9. Assess and measure progress toward goals

2. The Narragansett Bay Region

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--mystery. 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 that we call the Narragansett Bay Region (NBR), extending from Westerly, R.I., to Worcester and Taunton, Mass. [insert NBR map]. Four major river systems—the Wood-Pawcatuck, 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 NBR 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 NBR 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, NBR 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 home rule gives communities control of many environmental decisions—but makes large-scale planning and prevention of suburban sprawl difficult. Our pride of place fosters preservation—but means that even beneficial change can be wrenching.

Our Shared Future is intended to help all stakeholders—state, federal and municipal agencies, non-governmental organizations, businesses, schools, and individuals—address *key* challenges, and more. Working together, we believe 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.

Sidebar: The Narragansett Bay Region, by the Numbers

Narragansett Bay is an estuary—a semi-enclosed body of water connected to the ocean at its mouth or entrance, and connected to the land by rivers, streams and groundwater. Less tangible but no less real from the perspective of human use and management, are its social or political connections—to the states, cities, towns and neighborhoods which manage, use and affect Narragansett Bay and its natural resources.

In order to consider all these influences on the environment of Narragansett Bay, this report establishes the Narragansett Bay Region, or NBR, as its geographic scope. NBR encompasses Narragansett Bay, its drainage basin or watershed in Rhode Island and Massachusetts, and the adjacent estuaries and watersheds of the Wood-Pawcatuck river system and Rhode Island's coastal Salt Ponds.

NBR is 2066 square miles in area, of which 1028 square miles (50%) are in Massachusetts, 984 square miles (48%) are in Rhode Island, and 57 square miles are in Connecticut. The Narragansett Bay estuary is 192 square miles in area, of which 95% are Rhode Island waters, with only nine square miles in Massachusetts (at the eastern end of Mount Hope Bay). Narragansett Bay's watershed is 1707 square miles, of which 1028 square miles (60%) are in Massachusetts, with 677 square miles in Rhode Island.

3. Purpose of this Plan

The purpose of **Our Shared Future** is to present a realistic, priority-driven plan for achieving a common vision for a sustainable future for the Narragansett Bay Region. This will be done by developing a comprehensive set of goals, objectives and actions, broadly shared among stakeholders, that will guide a collective effort toward that vision. By developing consensus among state, federal and municipal agencies, non-governmental and grassroots organizations; businesses, academic institutions, and individuals, **Our Shared Future** will provide a collaborative framework to apply ecosystem-based management principles (see sidebar on page x) for planning and action, increasing the effectiveness of our efforts to manage, protect and restore ecosystem resources.

There is no shortage of laws, regulations, plans and policies intended to protect and improve the environment of NBR. 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 current approaches alone are not enough to address the challenges we face.

The jurisdictional complexity of NBR—two states, each with its own environmental laws and policies, and 100 unique sets of municipal land-use regulations—demands an overarching approach that recognizes this regional set of 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, accelerated biological invasions and changes in fish and wildlife migrations.

The plan presents a broad, consensus-based vision, with supporting goals and actions, for the entire Narragansett Bay Region, developed by stakeholders and experts in Rhode Island and Massachusetts. This results-oriented plan asserts that we can restore our environment and our economy—using the region's exceptional natural assets as a foundation for sustainable economic growth.

The vision and goals presented in *Our Shared Future* will be translated into action in a several ways. Priorities identified in this document will be used to guide the Narragansett Bay Estuary Program's annual workplans as well as to inform the interagency planning efforts of the seven Rhode Island state agencies represented on the R.I. Bays, Rivers and Watersheds Coordination Team. Through NBEP's interstate activities and through the members of its Management Committee, *Our Shared Future* will help guide the actions of Massachusetts state agencies, regional planning organizations and non-governmental organizations, as well as federal agencies such as NRCS, NOAA and EPA. As an element of the R.I. State Guide Plan, the document will be consulted in the development of municipal comprehensive plans throughout Rhode Island and for other state and local planning efforts.

This integrated, ecosystem-based approach is intended to improve coordination among government agencies, as well as between governmental and non-governmental organizations. Indeed, the authors of this plan seek to foster effective collaboration among all institutions, organizations and individuals with a stake in the future of the Narragansett Bay Region. By defining measurable results and establishing a

system for tracking their accomplishment, the plan will *increase accountability and allow us to assess progress toward common goals.*

Sidebar: Ecosystem-based Management

Ecosystem-based management (EBM) is an integrated approach to management that considers the entire ecosystem and recognizes that humans and their activities are integral parts of this system. This approach addresses the need to incorporate communities' social and economic needs into environmental management.

The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need. Ecosystem-based management differs from current approaches that usually focus on a single species, sector, activity or concern; it considers the cumulative impacts of different sectors.

Specifically, ecosystem-based management:

- *emphasizes the protection of ecosystem structure, functioning, and key processes;*
- *is place-based in focusing on a specific ecosystem and the range of activities affecting it;*
- *explicitly accounts for the interconnectedness within systems, recognizing the importance of interactions between many target species or key services and other non-target species;*
- *acknowledges interconnectedness among systems, such as between air, land and sea; and*
- *integrates ecological, social, economic, and institutional perspectives, recognizing their strong interdependences.*

Source: McLeod, K. L., J. Lubchenco, S. R. Palumbi, and A. A. Rosenberg. 2005. Scientific Consensus Statement on Marine Ecosystem-Based Management. Signed by 221 academic scientists and policy experts with relevant expertise and published by the [Communication Partnership for Science and the Sea](#).

This plan presents a comprehensive set of goals for a sustainable Narragansett Bay Region, as follows:

- Manage Watershed Lands for Human and Ecological Needs
- Restore and Protect Water Resources
- Protect and Restore Vital Habitats
- Sustain and Restore Fish and Wildlife
- Restore Prosperity while Preserving Quality of Life and Natural Resources
- Protect Human and Natural Assets

For each, we present an overarching goal for that aspect of the environment, descriptive information, a summation of the management responses intended to address these problems, a table of priority objectives and strategies, proposed environmental or performance indicators, and implementation actions [to be added].

This integrated 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. 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 *Our Shared Future* will empower stakeholders in Rhode Island and Massachusetts to create—together—a more prosperous and sustainable future for communities throughout the Narragansett Bay Region.

Sidebar: Development of an integrated plan for the Narragansett Bay Region

In 1985, Narragansett Bay was designated as an estuary of national significance by the U.S. Congress and became one of the first estuaries in the federal National Estuary Program with a charge to create a bi-state stakeholder-based conservation and management plan for the bay and watershed. That plan was issued in 1992. EPA requirements for an NEP require periodic updates to the plan; this new stakeholder-based ecosystem plan will meet the Clean Water Act requirement for plan update.

The R.I. Bays, Rivers & Watersheds Coordination Team (RIBRWCT), created by the R.I. General Assembly in 2004, produced a R.I.-focused environmental plan (the RIBRWCT Systems Level Plan) with water-related economic elements in 2008. The Systems Level Plan establishes goals and priorities for the management of Rhode Island's bays, rivers and watersheds and provides actions to be carried out by the Team member state agencies. The RIBRWCT has the charge of coordinating the projects, plans and activities of the Team member state agencies in implementation of the Systems Level Plan.

The R.I. Statewide Planning Program is charged with preparing and maintaining the R.I. State Guide Plan – a plan that articulates the state's goals and policies on land use, economic development, environmental management and other state interests. In 2009, the R.I. Statewide Planning Program embarked on an effort to restructure and update the current State Guide Plan which will include an overarching watershed management element. The three organizations agreed to work together to develop an integrated plan that addresses the requirements of their programs and draws from stakeholder input throughout the entire Narragansett Bay Region, including the more than 60% of the Bay watershed in Massachusetts. This review draft reflects the work of the integrated plan workgroup to this point.

4. Priorities for Near-Term Action

[to be developed with writing team, MC etc.]

Notes for this section from IP workgroup; Jan. 27, 2011

1. Many recommended actions address more than one of the identified problems
2. Need to address funding issues related to priorities
3. Might be a good place for the Governance/Management Responses section

Include a section that discusses the integrated plan in the context of existing state and local plans. (CZM, SAMP, state land use, local comprehensive plans, hazard mitigation plans, 1992 CCMP, RIBRWCT Systems Level Plan, R.I. watershed plans in both R.I. and Mass., state invasive species plans, etc.)

Separate Governance Section:

Objective: Use a watershed ecosystem-based management approach that promotes cross jurisdictional and regional cooperation and collaboration

Policies:
 A. *Develop interstate and regional mechanisms to better integrate planning, data and actions on watershed ecosystem issues.*
 B. *Convene regional mgmt. and technical expertise to better identify priority bay and watershed science issues, needs and solutions*

	Revise state programs to include application of ecosystem based management principles at the watershed level to address cumulative and climate change impacts of development.	RIDOP, Mass Regional Planning, NGOs, RIDEM, MADEP, MADCR, MACZM, RICRMC
	Examine feasibility of establishing a mechanism to assess development impacts at regional and bi-state scale	State Legislatures, RIDEM, MADEP, RICRMC, MACZM, RIDOP, Mass Regional Planning, NGOs
	Develop a watershed-wide monitoring program, linked to ecological indicators, to assess conditions, prioritize investments and evaluate management actions.	RIDEM, MADEP, RICRMC, MACZM
	Develop and expand grants and technical assistance mechanisms to build capacity of watershed groups and municipalities	State Legislatures, RIDEM, MADEP, RICRMC, MACZM, universities, NGOs
	Determine feasibility of development of water management districts to address stormwater, water supply, septic system performance	State Legislatures, RIDEM, MADEP, RICRMC, MACZM, municipalities, URI Cooperative Extension

- Include info on declining state investment in environmental protection; highlight that we are making choices/tradeoffs

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.

Problem Statement: 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. Human demands can often take precedence over 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.

Status & Trends:

Land consumption and transportation patterns in the NBR are such that land has been developed at a rate several times greater than population growth. This is a departure from the region's historic patterns of dense urban centers. This trend is significant because it increases impervious surfaces that alter the flow and quality of water in the NBR (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 storm water 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 NBR. 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.

Restoration of the quality and functions of the NBR's watersheds 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.

Climate Change Implications

Climate change presents increasing risks to the people and ecosystems of the NBR. Events such as the historical flooding of March 2010 are reminders of climate change impacts that we could face. Rising temperatures, more extreme weather and flood events and the erosion of the coastlines by storms, storm surges and rising sea levels are in our future. Such changes will endanger coastal human populations and infrastructure, as well as fisheries, seagrass, and marsh ecosystems. The increased risks need to be addressed through revising building codes, improving and updating emergency plans, prioritizing adaptation actions, and planning for such in on-going land development, transportation systems and infrastructure investments in the NBR.

Manage Land for Human and Ecological Needs

1. Implement low impact development			
<u>Policies:</u>			
A. <i>Implement R.I. and Mass. stormwater requirements and land use management plan elements particularly those for on-site stormwater infiltration and reuse of rainwater for existing and new development</i>			
1.1.	Provide technical assistance to municipalities to identify and implement green infrastructure and LID techniques for local use	RIDEM, MADEP, RICRMC, MACZM, EPA, universities, NGOs	
1.2.	Municipalities should adopt LID ordinances for new and redevelopment projects.	R.I. & Mass. municipalities	
1.3.	Municipalities should adopt ordinances for land redevelopment that require retrofitting of drainage systems to reduce impacts	RIDEM, MADEP, RICRMC, municipalities	
1.4.	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			
<u>Policies:</u>			
A. <i>Use regional and bi-state strategies (biodiversity mapping, science-based land acquisition and protection, wildlife corridors, state park policies, etc.) for protecting green spaces and natural and cultural resources.</i>			
B. <i>Coordinate interstate planning to create a NBR-wide network of green spaces and, planned in concert with urban growth and development.</i>			
2.1.	Map and scientifically prioritize areas for protection and restoration; target acquisition of priority areas	RIDEM, MADCR, land trusts	
2.2.	Identify and create a designation process for the protection of scenic vistas in the NBR	RIDEM, MADCR, municipalities, NGOs	
2.3.	Provide technical assistance and grants to expand use of conservation development designs and ordinances	RIDEM, MADCR, RIDOP, Mass. Regional Planning	
2.4.	Permanently protect areas that are now under non-permanent protection status (time-limited development rights, etc.)	RIDEM, MADCR, RIDOP, Mass. Regional Planning	

3. Concentrate development and growth in identified urban and suburban growth centers

Policies:

- A. *Implement state land use policies on growth centers and LID through state permitting and funding programs*
- B. *Facilitate the development of regional and or municipal structures to administer transfer of development rights (TDR) programs Facilitate the development of regional and or municipal structures to administer transfer of development rights (TDR) programs*
- C. *Give priority in grants and state investments to the preservation of habitat and greenways that link natural, historic, and cultural resources and / or provide recreational resources*
- D. *Require local plans to implement requirements for development and redevelopment that support the concept of compact, walkable communities*
- E. *Plan and develop intermodal transportation systems that reduce greenhouse gases and other pollutants and limit impervious areas; retrofit transportation systems to these standards, where feasible*

3.1.	Prioritize and redevelop Brownfields sites for industrial, commercial and waterfront development; publicize and promote incentives for Brownfield development	RIDEM, MADEP, state economic development agencies	
3.2.	Work with NBR municipalities to identify and assess areas for viability as new mixed use growth centers.	RIDOP, Mass. Regional Planning, municipalities	
3.3.	Provide technical assistance to municipalities to develop performance standards for water-dependent industrial waterfront uses.	RIDOP, Mass. Regional Planning, RIDEM, MADEP, RICRMC	
3.4.	Target grant funds and state investments for infrastructure improvements and/or added capacity to developed lands (in R.I., to state-designated urban service boundary and growth centers).	RIDOP, Mass. Regional Planning, MAEEOEA, RIDEM, MADCR	
3.5.	Target grant funds and state (R.I. & Mass.) investments in "natural" infrastructure and environmental improvement projects to actions aligned with state and regional ecosystem goals.	RIDEM, MADEP, RICRMC, MAEEOEA	

4. Increase and maintain regional recreational opportunities and public access to shorelines and waterfronts

Policies:

- A. *Require public access in development and redevelopment projects that abut bay and river shorelines*

4.1.	Develop and maintain NBR recreational maps that identify recreational areas and culturally significant sites.	RIDOP, Mass Regional Planning, NGOs, municipalities	
4.2.	Maintain, map, expand and inform the public about public rights-of-way to rivers and shorelines.	RCRMC, MADCR, municipalities	
4.3.	Develop walking/equestrian trail systems in the NBR including signage, public awareness programs, trail maps, parking areas and ADA access.	RIDEM, MADCR, NGOs	
4.4.	Develop and install signage to promote awareness of important NBR features.	NGOs, municipalities	
4.5.	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	
4.6.	Improve funding for RI CRMC coastal rights-of-way designations (assessment, signage, mapping); update and	R.I. General Assembly, federal	

	publish CRMC public access document	agencies	
4.7.	Provide improved parking near public access sites where feasible	RICRMC, MADCR, state legislatures, municipalities	
4.8.	Designate water trails and low-impact boating access areas; support efforts such as R.I. Blueways to help accomplish this work	RI Blueways, RIDEM, MADCR, NGOs, water use interests	
5. Improve science and information to support effective land use management			
Policies:			
5.1.	Assess and map sensitive environmental areas including critical headwater parcels in the NBR.	RIDEM, MADCR, RIDOP, Mass Regional Planning, RICRMC, MACZM	
5.2.	Monitor, map and track extent of impervious surfaces in the NBR.	RIDEM, MADCR, RIDOP, Mass Regional Planning, RICRMC, MACZM	
5.3.	Use technical stakeholder processes and special commissions to evaluate effectiveness of existing state and regional programs in making progress toward ecosystem and economic goals.	RIDEM, MADCR, RIDOP, Mass Regional Planning, RICRMC, MACZM	
5.4.	Develop an effective impervious surface indicator for more accurate assessment and implementation actions.	RIDEM, MADEP, universities, NGOs, EPA	
5.5.	Work with municipalities to develop community asset maps for RIGIS data catalog and use in development reviews.	RIDOP, Mass Regional Planning, NGOs, municipalities	
5.6.	Develop outreach programs to increase awareness of impact of impervious surfaces on watershed resources.	NGOs, RIDEM, MADEP, municipalities, universities	
6. Build capacity of watershed organizations and municipalities to serve as critical partners in watershed management			
Policies:			
6.1	Support bi-state cooperative work by nongovernmental organizations like the Blackstone River Coalition and others	Federal/state agencies; regional planning agencies; major NGOs	
6.2	Support the continued existence and work of the Blackstone River Valley National Heritage Corridor Commission to enhance interstate collaboration and cooperation on both ecological and economic development issues	Federal/state agencies; regional planning agencies; major NGOs	
6.3	Support Taunton River Wild & Scenic River status through implementation of recommended actions	Federal/state agencies; regional planning agencies; major NGOs	
6.4	Support effort to designate the Wood-Pawcatuck River as a federal Wild & Scenic River	Federal/state agencies; regional planning agencies; major NGOs	

Management Responses to Identified Problems

Section referencing ongoing and planned land use initiatives in both R.I. and Mass. areas of the NBR. Includes R.I. Land Use 2025 plan, local community plans, Mass. Community Preservation Act, Mass. regional planning efforts, special areas management plans, watershed-oriented efforts regarding land use practices and low impact development, state requirements to reduce impacts of land use development/redevelopment, etc.

Indicators of Progress

- Percent of watershed with managed impervious cover
- Percent of watershed with protected lands and water resources
- # of Public Access sites
- # of Recreational Facilities

Restore and Protect Water Resources

Goal:

High fresh and salt water quality throughout the Narragansett Bay Region, available in sustainable and sufficient quantity to meet human and ecological needs such as fish and wildlife habitat, recreation, drinking, irrigation, commerce and industry.

Problem Statement: Pollutants from point and nonpoint sources and alterations of flow are having negative impacts on water resources.

Wastewater discharges from treatment plants, cesspools and on-site waste treatment systems and stormwater runoff from suburban and urban landscapes result in bacterial contamination, streambed erosion, degraded habitat, low dissolved oxygen and nutrient enrichment in the rivers and estuary of the NBR. 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, Newport and Fall River discharge untreated wastewater after rain events, impacting urban rivers and Narragansett Bay. 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.

Status & Trends: Fresh Water Quality

The fresh waters of the Narragansett Bay Region—rivers, streams, lakes, ponds and ground water—are a critical natural resource, providing habitat for fish and wildlife, drinking water for about two million people, and exceptional opportunities for recreational boating, fishing and swimming. On average, more than two billion gallons of fresh water enter Narragansett Bay daily from its drainage basin or watershed—through major rivers such as the Blackstone, Taunton and Pawtuxet; smaller streams such as the Ten Mile and Hunt; and through ground water. These flows deliver fresh water to the Bay and also carry pollution from the watershed to coastal waters.

Water quality in NBR's major rivers is affected by diverse sources of pollution, while smaller streams and lakes are affected primarily by stormwater discharges and nonpoint runoff from developed landscapes. During the past half century, suburban sprawl throughout NBR has resulted in a redistribution of population. As people move from urban centers to rural areas, infrastructure follows and the accompanying roads, houses, schools and businesses affect water quality and stream flow. Long term water quality trends in New England fresh waters during the twentieth century also reflect the shift from agriculture to urban and suburban landscapes. Chloride levels, for example, have risen in lakes and ponds due to the widespread use of salt for de-icing roads in winter.

In 2008, RIDEM and MADEP used available data and determined the following with respect to freshwaters:

- Of waterbodies assessed, approximately 45% of the river and stream miles indicated one or more water quality impairment (failed to meet water quality criteria).
- Pathogens (fecal coliform or enterococci) were the leading cause of impairment in rivers and streams, with 40% of R.I. river miles and 52% of Mass. river miles impaired, and 4% of RI lakes and 0.2% of Mass.lakes impaired.

- Excess nutrients (Phosphorus in fresh water) were the main cause of impairment in 4% of R.I. river miles and 25 % of Mass. river miles, while 15% of RI lakes and 6% of Mass. lakes were impaired.
- In 2007 the RIDOH Beach Monitoring Program reported beach closures at 8 of 50 freshwater beaches for a total of 27 days. This probably understates the problem because to date Rhode Island has minimally funded freshwater beach monitoring.
- Biological monitoring revealed impairments due to reduced biodiversity in many rivers and streams. This indicates a state of degraded ecological condition caused by a number of stressors including various pollution sources as well as changes in hydrology, for example stream depletion and reduced groundwater quantities.
- Low-level metals, typically lead, copper and cadmium cause of impairment in rivers and streams, especially those within more urbanized watersheds.
- Reflecting a regional problem, where tested, tissue from fish in R.I. rivers and lakes often reveal contamination at unacceptable mercury levels, mostly due to atmospheric sources.
- Aquatic invasive plant species were the largest cause of impairment in freshwater lakes and ponds (some of which may be associated with excess phosphorous loadings).

There are continuing gaps in information. In Rhode Island, for example, RIDEM determined that data were insufficient to assess water quality in 51% of the state's river miles. Fish tissue contamination is another area for which significant information gaps exist.

Status & Trends: Salt Water Quality

Narragansett Bay exhibits a pollution gradient along its north-south axis, linked to the location of major cities and populations. A majority of pollution enters Narragansett Bay from its the upper reaches through wastewater treatment facilities (WWTFs), stormwater drains, and combined sewer overflow (CSO) points which discharge into upper Narragansett Bay and its major tributaries. Pollution decreases as one moves down the Bay, due to tidal flushing and dilution by cleaner ocean water. Similarly, sediments in the upper Bay tend to be more contaminated as a result of historic industrial activity such as metals production, once concentrated in the Providence/East Providence area. Exceptions to these patterns are 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 and local hydrodynamics.

The major impacts on the uses of coastal and estuarine waters are caused by bacterial contamination, low dissolved oxygen and nutrient enrichment. The major sources of pollution in estuarine waters are wastewater discharges, including combined sewer overflows, stormwater discharges and loadings from cesspools and on-site wastewater treatment systems. In addition, thermal discharges affect Mt. Hope Bay and the Providence River, while atmospheric deposition is a significant source of mercury.

Nutrient loads (nitrogen in salt waters) exceed the assimilation capacity of the upper half of Narragansett Bay. As a result, significant areas of upper and mid- Narragansett Bay are designated by RIDEM as impaired due to hypoxia, or low oxygen conditions. Monitoring data shows that over a third of the total Rhode Island area of Narragansett Bay, including the Providence and Seekonk Rivers, Greenwich Bay, and Mt. Hope Bay, is subject to hypoxia (low oxygen conditions) during the warm weather months. Hypoxia appears most severe and persistent in Greenwich Bay, the Seekonk and Providence Rivers and portions of the upper Bay/ upper West Passage.

Hypoxia has also been documented in some salt ponds as well as areas of the Pawcatuck River. RIDEM currently lists 22 coastal water areas as impaired by pathogens, with elevated levels of pathogens causing 21% of the state's shellfishing grounds to be closed permanently or conditionally. Estuarine waters generally meet swimming standards, with 10% designated as impaired for this use at certain beaches due to stormwater bacterial impacts. Of Rhode Island's 69 licensed saltwater beaches, 20 are at high risk for pollution, with beach closures closely linked to pathogen contamination from nearby stormwater discharges.

Status & Trends: Freshwater Flow

The Narragansett Bay Region is fortunate to have abundant, high quality fresh water resources—on the surface and underground—which are essential to the region's quality of life and economic prosperity. NBR's rivers powered the American industrial revolution, and even today, most of our communities bear the footprint of the compact villages which clustered around the mill dams.

Today, NBR's reservoirs and aquifers provide water for residential, industrial and agricultural use, through public water suppliers as well as private wells. Lakes, rivers, ponds and streams provide important recreational opportunities—swimming, fishing, paddling—and add immeasurably to the beauty of the region. Freshwater recreation is also a significant contributor to local and state economic activity. Wetlands are among our most important wildlife habitats—where the connection between surface and ground water is most apparent. In urbanized areas, rivers and floodplain wetlands are often the only relatively natural areas remaining on the landscape, serving as vital habitat corridors for fish and wildlife.

Fresh waters in NBR are subject to natural seasonal fluctuations. Rivers tend to flood, and groundwater tends to rise, in the spring and fall. River flows and ground water levels are typically at their annual minimum during summer. NBR's ecosystems are adapted to these cycles. Migratory fish, for example, move upstream during high spring flows, while many wetland plants require periodic flooding or soil saturation to survive.

These natural patterns can be disrupted in several ways. Many rivers and streams throughout NBR exhibit excessively low flows during summer as a result of water withdrawals. Similarly, water tables can be depressed by withdrawals from large wells. These changes dry up wetlands and deprive native fish and wildlife of water necessary to survive. Conversely, streams in urbanized areas often exhibit unnaturally high flows following rainstorms or snowmelt. Developed landscapes prevent rain and snowmelt from soaking into the ground, shunting water through storm drains directly into stream channels, causing river flows to spike in elevation and velocity. In other words, present patterns of land use and water consumption increase high flows and reduce low flows in NBR's surface and ground waters—leading to degraded habitats and increased occurrences of damaging floods. The extent of the problem is not fully known, however, as many rivers and streams are not assessed for impacts to flow.

Principal factors affecting NBR's stream flow and groundwater levels include:

- **Precipitation Patterns:** Variable precipitation patterns, particularly in summer months. Natural patterns of precipitation vary; climate change impacts also will have an effect.
- **Land Use Patterns:** Suburban and exurban development have increased population in areas which rely on wells, while reducing groundwater supply and quality through expansion of impervious surfaces. A 2003 report estimated that the development of 96,000 acres in Rhode Island between 1961 and 1995 reduced the available water supply by somewhere between 10 and 23 billion gallons a year – enough to serve 250,000 – 600,000

residents. As growth continues, additional demand for water will continue to alter flow and habitat in rivers and streams throughout NBR.

- Impervious surfaces. Low and peak flows are both exaggerated by impervious surfaces, which prevent rain and snow from seeping into the ground and recharging groundwater supplies. Instead of filtering through the earth, this water flows over the surface at increased volumes which erodes stream banks, roads and hillsides as it rushes downstream. During periods of low precipitation, the absence of groundwater recharge causes low flows in streams, and can deplete drinking water aquifers.
- Interbasin transfer of fresh water: In many areas, water is withdrawn from one watershed and consumed or discharged in another. Waste water treatment facilities also have a role in this exchange. In Massachusetts, for example, Stump Brook in Halifax, Mass., suffers from altered stream flows because water is withdrawn from its source, Monponsett Pond, and transferred to Silver Lake in Kingston, which serves as the water supply for Brockton. In South County, R.I. towns withdraw drinking water from the Pawcatuck River basin and discharge it as waste to Narragansett Bay.
- Water withdrawals. Water withdrawals can deplete stream flow. These impacts vary over time with precipitation patterns, demand and season. For example, in 2005 in the Hunt-Annaquatucket-Petaquamscutt (HAP) watershed, withdrawals for the Town of North Kingstown, Kent County Water and the Quonset Development Corporation have resulted in record low flows and record high demand. In the Taunton River watershed, the Canoe River has experienced severely reduced stream flow due to municipal withdrawals which resulted in extreme water temperatures. Freshwater mussels were killed near the Norton Town well downstream of the Newlands Street Bridge in 1999.
- Stormwater management. Traditional development patterns allow stormwater to travel across roads, parking lots, and other impervious surfaces into sewers and detention areas. LID techniques keep stormwater local and prevent it from becoming contaminated have been developed, including local infiltration to vegetative areas and rain gardens.
- Aging and leaky water supply. Water supply infrastructure can leak water into the ground through cracks in the pipes that would otherwise send water to users. The resulting increase in demand for water can stress streams and rivers.
- Climate change will have an increasing affect on stream flows. In the New England region, precipitation has increased 4 percent from 1895 to 1999. However, Rhode Island has seen an even larger increase in precipitation than the rest of the region – of 27 percent during the same time period In addition, there has been an 88 percent increase in the frequency of extreme precipitation events in Rhode Island since 1948, the largest increase of any state in the United States.
- Water supply fee structures: In Rhode Island, most rate structures consist of a uniform usage rate plus a flat fee. A few Rhode Island systems, notably Jamestown, have increasing block rate structures to reduce excessive water use. Even though there is state policy to require it, most Rhode Island water rate structures do not encourage conservation or increased water use efficiency, even those regulated by the PUC. Recent filings before the PUC are exploring new rate structures that could encourage or provide incentives for increasing water use efficiency. **(need Mass. info here)**
- Lack of conservation measures: Although requirements for lower-flow plumbing fixtures were implemented during the 1980's and 1990's, many new water-saving technologies are available which are not widely used in NBR, largely because there are few incentives or requirements to conserve. Broader use of high-efficiency plumbing fixtures, rainwater capture systems and irrigation systems result in minimized water use could greatly reduce demand for drinking water throughout NBR.

Sidebar: The Clean Water Act

In 1972, Congress passed the Federal Water Pollution Control Act—commonly called the Clean Water Act—to “restore and maintain the chemical, physical, and biological integrity of the Nation’s waters.” Almost 40 years later, CWA remains the foundation for federal and state management of fresh and salt waters and their associated resources. Under CWA, the federal government and the states regulate “point source” or localized discharges such as factories and wastewater treatment plants as well as “nonpoint” or diffuse sources of pollution such as stormwater runoff. CWA requires the state to establish water quality goals for all state waters, and report on the attainment of the goals. It also provides for wetland regulations and created the National Estuary Program. Drinking water is managed under a separate federal law (the Safe Drinking Water Act, enacted in 1974). The Clean Water Act has been largely successful in controlling point-source pollution and in slowing the pace of wetland destruction in the U.S. Non-point source pollution is, by nature, more difficult to monitor and control, and continues to present significant management challenges throughout the country.

Restore and Protect Water Resources *[IPWG note - need to address need for WQ standards that look at aquatic life use]*

1. Reduce pollution from point sources			
Policies:			
<i>A. Improve coordination between state and municipal sewer infrastructure planning and programs</i>			
1.1.	Issue and implement revised EPA New England permits for nutrient controls at WWTF's located in Mass. portion of the Blackstone River and Ten Mile River watersheds	RIDEM, MADEP, WWTFs	
1.2.	Implement nutrient reductions at prioritized WWTF's via consent agreements and other means including 2004 R.I. state mandate for 50% reduction in total nitrogen discharges (May to October) from WWTF's discharging into Narragansett Bay or its major tributaries	RIDEM, MADEP, WWTFs	
1.3.	Identify and complete needed CSO abatement projects in the NBR	RIDEM, MADEP, WWTFs	
1.4	Develop and implement cost-effective urban green infrastructure programs and practices that can reduce cost of CSO abatement	RIDEM, MADEP, WWTFs	
2. Reduce pollution from non-point sources			
Policies:			
<i>A. Implement effective nutrient management BMPS in sensitive areas and areas designated as priorities in state and local plans</i>			
<i>B. Expand the use of a watershed approach in water management programs like Sect. 319, TMDLs and other pollution abatement efforts</i>			
<i>C. Plan and develop intermodal transportation systems that reduce greenhouse gases, nutrients, particulates and other pollutants and limit impervious areas; retrofit transportation systems to these standards, where feasible</i>			
2.1	In sewerred areas, require connections to existing sewer lines	RIDEM, MADEP, WWTFs, municipalities	
2.2.	Provide technical assistance to municipalities to implement Phase 2 stormwater requirements	RIDEM, MADEP, NGOs, universities	
2.3.	Continue to develop and implement prioritized TMDLs; monitor and provide the public with ongoing reports on TMDL implementation progress	RIDEM, MADEP	
2.4.	Adopt a more aggressive approach for cesspool phase-out than current OWTS management and regulatory practices allow.	R.I. General Assembly, RIDEM	
2.4	RIDEM should incorporate mandatory connections with order of approvals.	RIDEM	
2.5.	Evaluate and ensure performance of residential and commercial Onsite Waste Treatment Systems (OWTS) through wastewater management plans that include education, inspection, prioritized areas, financial assistance programs and provision of adequate maintenance for advanced treatment systems.	RIDEM, RICRMC, WWTFs, RICWFA, MADEP, MA local boards of health	

2.6.	Develop and implement state and municipal beach restoration strategies to reduce pathogen contamination and provide additional recreation opportunities especially for urban populations	RIDEM, RICRMC, NGOs	
3. Manage stream flow to balance human and ecological needs			
Policies:			
<i>A. Base water management/ permitting decisions on the sustainable yield of the watershed and sub-basins, accounting for anticipated land development impacts</i>			
3.1.	Develop adequate streamflow standards for ecological integrity and effective streamflow triggers for drought management plans.	RIDEM, MADEP, EPA	
3.2.	Develop and apply technical criteria to identify and assess areas experiencing flow stress	RIDEM, MADEP, EPA	
3.3.	Assess transfers of drinking and wastewater discharges between watersheds; identify ways to manage or desist transfers to sustain hydrologic functions and increase recharge	RIDEM, RIWRB, MADEP, Mass. water suppliers	
3.4.	Use existing regulatory authorities (RI wetland permits, RI Water Resources Board water allocation authority and MA Water Management Act permits, Clean Water Act) and other opportunities to restore stream flow in areas that experience flow stress	RIDEM, RIWRB, MADEP, Mass. water suppliers	
3.5.	Create an information and decision-making framework that accounts for flow standards and water allocation plans	RIDEM, RIWRB, MADEP, Mass. water suppliers	
4. Improve funding for water quality and quantity improvement and for resource assessment/ monitoring			
Policies:			
<i>A. Seek increased federal SRF and other federal funding for water and wastewater infrastructure and stormwater</i>			
4.1	Increase the federal and state funding available to state DOTs to support construction of prioritized stormwater retrofits using LID practices as identified in state stormwater manuals.	RIDEM, MADEP, RICRMC, MACZM	
4.2	Develop funding mechanisms at the state and local level (especially consider utility districts) to support prioritized onsite wastewater treatment and stormwater infrastructure	RIDEM, RICWFA, Mass. Revolving Fund	

5. Improve information, analysis and management practices necessary to restore and protect NBR's fresh and salt waters.

Policies:			
5.1.	Develop a watershed-wide monitoring program, linked to ecological indicators, to assess conditions, prioritize investments and evaluate management actions.	RIDEM, MADEP, RICRMC, MACZM	Also in Governance
5.2.	Support and develop volunteer monitoring programs, building on programs like the Blackstone River volunteer monitoring effort; ensure resulting data helps fill gaps and has adequate QA/QC to be used for state purposes	RIDEM, MADEP	
5.3.	Continue to identify and assess the extent and impacts of personal care products, pharmaceuticals and endocrine disruptors	RIDEM, MADEP, universities, federal agencies, RIDOH, MADOH	
5.4.	Provide easy access for users to existing water quality monitoring data; make data accessible online and through other mechanisms	RIDEM, MADEP, universities, RIDOP, Mass. Regional Planning	
5.5.	Create R.I. state lake management program that includes requirements for lake management plans that address water quality and invasive species.	RIDEM	
5.6.	Develop numeric nutrient criteria adequate to protect aquatic ecosystem health for all NBR fresh and salt surface waters; base water quality management and permitting decisions on criteria	RIDEM, MADEP, MACZM, RICRMC, NBEP	
5.7.	Work with universities and federal agencies to improve scientific knowledge of flow issues including climate change implications; integrate new findings into management schemes	Universities, RIDEM, MADEP, RI Sea Grant - CRC	

Management Responses to Identified Problems

(INSERT section re. existing management actions related to these priorities)

Clean Water Act

In 1972, Congress enacted the Clean Water Act (CWA) in order to “restore and maintain the chemical, physical, and biological integrity of the Nation’s waters.” Generally speaking, CWA requires the U.S. Environmental Protection Agency (EPA) and the states to establish “fishable, swimmable” conditions in most fresh and salt waters. More than 30 years after passage of CWA, nearly half of the Narragansett Bay Region’s rivers and streams fail to meet state goals, while beaches and shellfish beds throughout Narragansett Bay and NBR’s coastal ponds are subject to periodic or permanent closures due to water quality concerns.

Under CWA, “point sources” of pollution such as wastewater treatment plants and factories have been greatly reduced. Land use patterns (runoff or “nonpoint sources”) remain a major contributor to water pollution. Further action to reduce both point and non-point sources of pollution are needed to restore the beneficial uses of the region’s waters and ecosystems for present and future generations. Restoring and maintaining water quality is essential to the ecological health of Narragansett Bay, other coastal waters, and the entire region’s tributary rivers and watersheds.

State Responses

[Insert R.I. and Mass. management responses to water quality problems]

Indicators:

- Beach closures
- Flow
- Dissolved Oxygen
- Phosphorus
- Nitrogen
- Turbidity
- (others to be developed)

Protect and Restore Vital Habitats

Goal:

Healthy, intact and diverse *ecosystems, providing desired ecosystem services* and capable of adapting to climate change, throughout the Narragansett Bay Region, protecting core undisturbed habitat while preserving and enhancing *valuable* habitats in developed areas.

Problem Statement: Pollution, landscape changes, hydro-modifications and invasive species are having negative impacts on NBR habitats.

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 steep declines in fish and wildlife populations. Principal factors affecting ecosystems include:

- Direct physical alteration: A byproduct of urbanization is the “replumbing” of natural watersheds—replacing wetlands and watercourses with pavement and pipes. Deforestation, 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—preventing or reducing the ability of these areas to support native fish and wildlife.
- Water pollution: Discharges of nutrients and toxics have all but eliminated more sensitive species from urban rivers and upper Narragansett Bay, while large areas of the Bay are subject to chronic pollution impacts—for example, low dissolved oxygen which reduces biodiversity throughout upper Narragansett Bay.
- Fragmentation: NBR's road network creates small islands of habitat which may appear natural, but are incapable of supporting many native species which require movement among habitats, or genetic mixing, to survive.
- Invasive species: Humans have been introducing—accidentally and intentionally—alien plants and animals into NBR for hundreds of years. Invasives replace native species, degrading food webs and reducing biodiversity. With globalization, the pace of invasion has increased.

Habitat protection and restoration offer means of addressing some of these impacts.

Status & Trends:

Biodiversity is short for “biological diversity.” At its simplest, it refers to the variety of organisms, at the species level, that are found in a particular area. Biodiversity is also sometimes used to refer to the genetic diversity within a species, or the diversity of habitats in an area, each habitat being a geographical space with a characteristic combination of physical features and organisms surviving and interacting there. Biodiversity is a component of ecological integrity, which can be thought of as the ability of an area to support plants and animals and the natural processes necessary to sustain them over the long term.

The Narragansett Bay Region is losing this integrity, both on land and in our water bodies. This loss occurs through direct alteration of aquatic and terrestrial habitats, through the secondary effects of development and climate change, and through cumulative impacts from these and other stressors that weaken resiliency and increase vulnerability to invasive species. And as we lose key habitats, we also lose the species – the biodiversity -- that rely on them as well as the values, functions, and services those habitats and species provide. Land use and development are among the most immediate causes of biodiversity loss on land, but ecological integrity is equally challenged by the *modification* of our landscapes and the loss of biological and hydrological connectivity within and among watersheds and habitats. In water bodies, additional

stressors include fishing pressure on commercially valuable species and bycatch, the physical destruction of bottom and vegetative habitats by dredging, filling, and scouring, and changes in temperature, salinity, and flow.

Rhode Island's Conservation Stewardship Collaborative has data showing that half of the state is one football field length from a road, and 90% is within a quarter mile of a road. No place in the state is far from a building (206 meters is the average distance between them) or a residential development (220 meters). Mass Audubon has developed a model to assess ecological integrity of lands and waters across relatively large geographic areas, and thus to estimate ecological impacts of development. Its model shows that for each acre developed in Massachusetts, another three acres loses significant ecological integrity --- and the state is developing land at the rate of 22 acres/day. Further, hot spots for that development are in the Blackstone, 10-Mile, Narragansett, and Taunton River watersheds.

As on land, Narragansett Bay and the rivers and streams of its watersheds also have changed profoundly. The region's coastal, marine and freshwater habitats include salt marshes, sea grass beds, rivers, streams, lakes, brackish marshes, freshwater marshes, swamps, vernal pools, benthic, inter-tidal, and water column habitats. They support a variety of flora and fauna and provide important ecological services that support a multi-billion dollar tourism and outdoor recreation industry, and *provide significant economic benefits through* commercial and recreational fisheries. Further, these habitats perform critical ecosystem functions such as flow and groundwater regulation, infiltration, and nutrient processing. Rivers in particular are the link between terrestrial and other aquatic ecosystems, and form an important part of our ecological infrastructure. Yet despite their exceptional ecological and socio-economic values, all these aquatic habitats have been altered, degraded, and destroyed by human development and resource consumption since the early 1600's. Wetlands and salt marshes have been diked, ditched, and filled. Dams and impoundments generated hydropower, enabled water-based transportation, and controlled flooding, but in the process destroyed access to spawning areas for migratory fish, valued not only in their own right, but also as key elements of the aquatic food chain. 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.

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. In freshwater systems, aquatic macrophytes such as variable water-milfoil and curly pondweed are spreading in lakes and ponds. A survey of Rhode Island lakes in 2007 found AIS in 78% of the locations inspected. 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.

The results of these assaults on the region's natural biological systems can be stark: a study by NatureServe in 2002 ranked both Rhode Island and Massachusetts low on the scorecards for diversity. 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. Both states were high in risk to mammals -- 8th and 12th place respectively. And though birds in that survey seemed relatively safe in our states, the 2009 "State of the Birds" report by the North American Bird Conservation Initiative found that coastal and ocean birds are especially vulnerable and forest birds face an uncertain future. The 2003 Massachusetts report, *Living Waters*, concluded that

freshwater biodiversity had reached a critical junction, for native as well as rare and endangered species. The Rhode Island Natural Heritage Program is currently inactive and, at this time, there are no plans to update a state list of endangered, threatened or special concerns species. In its last 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.

For many species, reports consistently point at human activities, primarily *land-consumptive* development that degrades or eliminates critical habitats, as the chief cause of jeopardy. And looming over immediate man-made changes in the physical environment is the impact of climate change. Not only do its effects ripple through the landscape and ecosystem directly and indirectly, but the scale of these changes calls into question the long-term viability of current efforts to restore habitat and ecosystem health – raising the key question of “what are we restoring to?”

Protect and Restore Vital Habitats

1. Conserve existing natural landscapes that have been and will be adversely affected by development, climate change, and invasive species			
Policies:			
A. <i>Design and implement a natural infrastructure framework of hubs, spokes, and corridors to maintain watershed functions and reduce habitat fragmentation</i>			
B. <i>Continue to focus resources and enhance land protection efforts by conservation agencies and organizations on less-developed areas, particularly areas threatened by new sprawl development</i>			
C. <i>Improve rivers protection regulations to protect habitat (including riparian buffers) and water quality</i>			
1.1.	Review existing efforts to integrate "pan-New England" land conservation and priority-setting across state boundaries and the public and private sectors; select most promising effort to support and implement	RIDEM, MADCR, TNC, RIDOP, Mass Regional Planning	
1.2.	Identify, map 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, MADCR, TNC, RIDOP, Mass Regional Planning	
1.3.			
2. Restore degraded or lost habitats and habitat functions			
Policies:			
A. Improve integration of habitat restoration and fisheries management, e.g. through Essential Fish Habitat efforts			
2.1.	Remove dams, upgrade culverts and create structural fish ways to restore free-flowing rivers and anadromous fish passage; implement state fish passage plans	RIDEM, MADCR, RICRMC	
2.2.	Identify and map priority coastal and riparian restoration sites; implement restoration at these sites	RIDEM, RICRMC, MADCR, universities, NGOs	
3. Monitor, control and prevent land and aquatic invasive species			
Policies:			
3.1.	Develop and implement programs for monitoring and assessment of invasive species and impacts throughout NBR	RIDEM, MADEP, RICRMC, MACZM, NGOs, universities	
3.2.	Develop criteria to evaluate and prioritize risk of aquatic and terrestrial invasive species as part of an effort to coordinate R.I. and Mass. in regional invasive species planning efforts	RIDEM, MADEP, RICRMC, MACZM, NGOs, universities	
3.3.	Develop programs to educate key constituencies on identifying and preventing the spread of invasive species: marina operators, nurseries, aquarists, pet stores, bait stores, fishing and wildlife organizations, etc.	RIDEM, MADEP, RICRMC, MACZM, NGOs, universities	
3.4.	Develop an early detection and rapid response strategy with participation by state, local/NGO and federal actors to control or abate invasive species	RIDEM, MADEP, RICRMC, MACZM, NGOs, universities	

4. Improve science and information to guide management of habitats and biodiversity

Policies:

4.1.	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, MADEP, RICRMC, MACZM, NGOs, universities	
4.2.	Restore/re-fund Rhode Island Natural Heritage program	RIDEM, RI General Assembly	
4.3.	Develop incentives for private property owners to participate in habitat restoration projects	RIDEM, RICRMC, MADEP, MACZM, NGOs	
4.4.	Examine science and assess need for additional land and water protections, e.g., ACECs, etc., to meet conservation goals	RIDEM, MADCR, NGOs, RIDOP, Mass Regional Planning	
4.5.	Plan coastal habitat restoration efforts taking sea level rise into account in project design	RIDEM, RICRMC, MADEP, MACZM, NGOs	

5. Build capacity to implement ecological restoration at state (particularly in R.I.) and local levels and improve interstate coordination

Policies:

- A. *Improve integration of water quality improvement, stormwater measures and physical restoration*
- B. *Work with state, federal and university officials to improve science and regulation pertaining to river restoration and dam removal*
- C. *Create a coordinated restoration strategy for riverine and wetlands habitat between both watershed states*

5.1.	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	
5.2.	Support and expand R.I. Coastal and Estuarine Habitat Restoration Trust Fund funding, the Mass. Wetlands Restoration Program, NGO-based restoration efforts and federally funded restoration programs (NRCS, USFWS, NBEP, etc.)	RIDEM, RICRMC, MADEP, MADCR, NGOs, federal agencies	
5.3.	Maintain and expand state-wide and NBR mapping of critical habitats and use data to support restoration, conservation planning, and enhanced enforcement	RIDEM, MADEP, RICRMC, MACZM, NGOs, universities	
5.4.	Develop a continuing seagrass mapping program in R.I. and Mass. coastal waters	RIDEM, MADEP, RICRMC, MACZM, NGOs, universities	
5.5.	Establish a comprehensive set of NBR status and trends indicators for critical habitats to assess habitat changes, impacts, and conservation and restoration progress.	RIDEM, MADEP, RICRMC, MACZM, NGOs, universities	
5.6.	Undertake biodiversity hotspot mapping throughout NBR that integrates R.I. mapping with existing Mass. biodiversity and wetlands mapping.	RIDEM, MADEP, RICRMC, MACZM, NGOs, universities	
5.7.	Create a R.I. Habitat Restoration program, similar to the Mass. Wetlands Restoration Program, with dedicated, full time staff to support project implementation, work on needed restoration policy, and integrate agency actions	RIDEM, RICRMC, NGOs, universities	
5.8.	Provide technical assistance and expand grant programs to protect and restore riparian buffers and wetlands, particularly in urban watersheds.	RIDEM, MADCR, RICRMC, MACZM	
5.9	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	In WQ too

Management Responses to Identified Problems

(INSERT section re. existing management actions related to these priorities)

- Federal
- State
- Non-governmental

Indicators

- Invasive species
- Anadromous fish runs (extent)
- Undammed watercourses (or, conversely, dams and other impediments to fish and wildlife passage)
- Population-level indicators TBD
- Acres of coastal/freshwater wetlands restored

Path Forward

- Implementation plans TBD

Sustain and Restore Fish & Wildlife

Goal:

Fresh and salt water fisheries and aquaculture operations throughout the Narragansett Bay Region which provide abundant production for food, recreational enjoyment and economic activity while fully supporting ecosystem functions provided by native fish and shellfish populations.

Problem Statement: Current fisheries management practices, pollution, fishing pressure and loss of habitat are affecting regional fisheries.

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. However, the region's fisheries are not always fully compatible with preservation and restoration of fresh and salt water habitats. Salt water commercial fisheries, through fishing pressure and habitat impacts, have contributed to the decline of once-common species, caused a reduction in the size of individual fish, and led to changes in the composition of fish and shellfish species. In response, the region's commercial fisheries have moved progressively offshore as inshore species were depleted and boats became more powerful

Fresh water fisheries in the Narragansett Bay Region are based largely on non-native species in created habitats. Large- and smallmouth bass were probably introduced from upstate New York in the late 19th century, but are now popular gamefish 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. European 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.

Status & Trends:

Fisheries are one of the oldest and most important uses of the water resources of the Narragansett Bay region. For millennia, the environment of NBR has provided a biological foundation for productive and valuable fisheries. Over the past several centuries, the fisheries have exerted a significant reciprocal effect on the ecosystem, dramatically altering the biology of NBR's fresh and salt waters.

The history of marine fisheries in NBR begins with inshore fixed gear and moves progressively offshore. Improved capture technology such as otter trawls and diesel engines allowed stable or increased overall catch as inshore and individual species were depleted by fishing, pollution, habitat destruction, and climate change. Since 1960, the composition of marine fish and shellfish populations in Narragansett Bay has changed significantly. Resident demersal fish species such as winter flounder, which historically comprised an important part of the Bay biomass, have declined, while decapod crustaceans such as lobsters and spider crabs, and warm-water migrants such as scup, have increased.

NBR's fresh water fisheries have also changed dramatically over time, due to habitat changes and the introduction of non-native species. NBR's large river systems once supported significant populations of anadromous fish such as Atlantic salmon, American shad, blueback herring and alewives. During the 18th and 19th centuries, all of NBR's large rivers except the Taunton were dammed along their mainstems, leading to local extirpation of these species. Today, more than 600 dams in Rhode Island alone prevent the movement of native riverine species—including spawning migrations. 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 European 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.

Aquaculture in NBR has also evolved significantly over time. During the early 20th century, Narragansett Bay supported a large oyster grow-out industry; around 1910, nearly a quarter of Bay bottom (20,000 acres) was leased for oyster production, which peaked at 1.4 million bushels. The industry declined for various reasons during the post-war era but was rekindled in the 1970s. The value of aquaculture operations in Rhode Island waters has steadily increased to about \$1.8 million in 2009, primarily shellfish.

Commercial and recreational 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.

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.

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. In Rhode Island and Massachusetts, a further difficulty is caused by the fact that landings data do not distinguish between fish caught within vs. outside of NBR; from estuaries vs. open water; or among the several estuaries in NBR. The commercial fisheries of NBR, therefore, are not necessarily reflective of NBR's ecosystem, since many of the most valuable species landed, reported and sold in NBR are caught far offshore.

Sustain and Restore Fish & Wildlife

1. Preserve and restore fresh and salt water populations, habitats and ecosystems			
<i>Policies:</i>			
A. <i>Incorporate adaptive management principles into fisheries regulations to improve management of unanticipated short-term events or circumstances</i>			
1.1	Orient fresh-water fishery management to emphasize restoration of native species over stocking of hatchery fish	RIDEM, MADEP	
1.2	Link habitat restoration activities to fishery management objectives through Essential Fish Habitat or other means – see recommendations in Habitats chapter	RIDEM, MADEP, RICRMC, MACZM	
2. Reduce ecological impacts of commercial and recreational fisheries in fresh and salt water			
<i>Policies:</i>			
2.1	Assess and implement technologies for reducing ghost fishing and solid waste from nets, traps and fishing gear	RIDEM, MADEP, universities, commercial fishing interests, Commercial Fisheries Research Foundation	
2.2	Promote education and implement mandates for recreational fishers to reduce catch-and-release mortality; partner with nongovernmental organizations to reach key audiences	RISAA, RIDEM, MADEP, universities, Commercial Fisheries Research Foundation	
3. Manage species for commercial, recreational, cultural, and ecological value			
<i>Policies:</i>			
3.1	Support development of revised state wildlife plan that identifies and addresses important species by RIDEM and RI-TNC	RIDEM, MADEP	
3.2	Support and implement the Mass. State Wildlife Conservation Strategy	MADEP, Mass. Regional Planning, TNC	
4. Improve science and information to guide fisheries management			
<i>Policies:</i>			
A. <i>Incorporate adaptive management principles into fisheries regulations to improve management of unanticipated short-term events or circumstances</i>			
B. <i>Monitor ecologically important fish species as well as commercially important species monitored for management purposes</i>			

4.1	Track commercial landings by geographic sector	RIDEM, MADEP, universities	
4.2	Working with commercial fishermen, NBNERR, universities, angler associations and other community and technical stakeholders, examine potential for additional protected areas in Narragansett Bay and other coastal waters.	<i>RIDEM, RISAA, NBNERR, fishing interests, universities, RISG, MACZM, MADCR</i>	
4.3	Building on existing state efforts to implement a stakeholder process (fisheries roundtable) to provide recommendations regarding balancing the interests of Narragansett Bay recreational and commercial fisheries in relation to shared fisheries such as menhaden	RIDEM, MADEP, universities, fishing interests	
4.4.	Improve fish contamination studies and consumption advisories, particularly as pertains to urban and ethnic communities and populations at risk.	RIDEM, MADEP, universities	

Management Responses to Identified Problems

(INSERT section re. existing management actions related to these priorities)

- Federal, State, Non-governmental

Indicators

- TBD

Path Forward

- Implementation plans TBD

Restore Prosperity while Preserving Quality of Life and Natural Resources

Goal:

A prosperous Narragansett Bay Region that generates high-value economic activity and water-dependent uses while preserving, restoring and enhancing our regional environment and quality of life.

Problem Statement: Regional economic planning and initiatives need to build, attract and retain economic activities that provide high-quality jobs while protecting and maintaining the quality of life values that are a key part of that attraction.

NBR's compact built environment, high-quality water resources, and strategic location within the Boston Metro economy offer compelling prospects for sustainable economic development. Moreover, together with their watersheds, the marine and fresh water ecosystems of the Narragansett Bay Region are the green infrastructure of ecological services and human uses that provide the foundation for a diverse array of economic activities: high-tech industries, some related to marine sector spin-offs; boatbuilding and repair; marine and fresh water fisheries and aquaculture; shipping, transportation, and port operations; agriculture; energy development; and water-based tourism and recreation, both consumptive and non-consumptive. The regional economy around these water-reliant and ecologically based uses generates billions of dollars in annual revenues and is critical to the region's current and future prosperity.

At the same time, these activities face significant challenges. Changing demographics and industries contend with traditional waterfront and water uses; further inland or upstream, the capacity to sustain direct human and ecological needs is stressed by growing residential, commercial, and industrial demand. Fragmented management and lack of economic information, including difficulty in parsing data, hinder our ability to fully understand trends and opportunities related to this essential sector of the region's economy. And impacts of climate change, both from direct sea-level rise and from increased storm activity, are already being felt and will surely affect the mix and success of future use decisions.

Status and Trends:

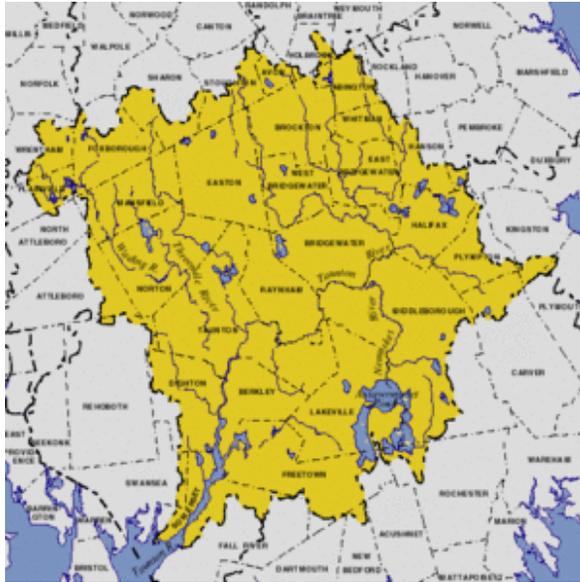
Ecology

The Narragansett Bay Region is dominated in Rhode Island by the Bay itself, but 60 percent of its watershed is in Massachusetts, from Worcester in the north to Brockton in the east. Its two major rivers – the Blackstone and the Taunton – connect the two states and serve as primary freshwater sources to the estuary and preserve remnant anadromous fish runs currently stymied by dams and other obstructions. Both states share similar legacies of the impacts of industrial development (A 1990 report sponsored by the EPA described the Blackstone River "*the most polluted river in the country with respect to toxic sediment*") and sprawl outpacing population growth, as well as the benefits and disadvantages of the strong tradition of local home rule. Of the 20 towns with the highest rate of development in Massachusetts, a dozen border Rhode Island in adjoining watersheds. Nutrients, especially as contributed by stormwater, are a common and growing problem. And despite projections that climate change will leave New England wetter and stormier than most of the rest of the country, both states face increasing episodes of drought and declining water availability, both as base flow and as drinking water supply.

Managing the supply and delivery of freshwater is critical for both states, even as demand strains the capacity of existing systems. In the Taunton watershed, 73 percent of subwatersheds have a recharge

deficit compared to natural conditions; 69 percent have a deficit even when surface water discharges and withdrawals are accounted for. Stressed systems in Rhode Island, such as the Hunt River, are well-documented.

Economics



The Narragansett Bay Region shares two metropolitan areas as defined by the census: Providence-New Bedford-Fall River (1.6 million, 32nd in the country) and Worcester (770,000, ranked 62nd), both serving as bedroom communities for Boston, and both squeezed by pressures for development from outside the region, Providence to the south, Worcester from 495. Those pressures are exacerbated by the individual decisions of 39 separate municipalities in Rhode Island, 67 in the Taunton and Blackstone watersheds, all strongly committed to local autonomy and freedom of action.

A key issue in the regional economy is the shift from manufacturing and more traditional resource-based activities. Where once fishing, farming, and “making things” dominated the economy, employment and growth today are steadily migrating to the service sector broadly defined, which includes both highly technical and professional industries (health care, education, government, finance) and industries such as food, recreation, accommodations, and entertainment.

Several studies in both states have attempted to follow this trend in an effort to anticipate impacts and shape a more proactive response to changing demographics and industries. An early study by EPA’s National Center for Environmental Economics summarized economic activity for each NEP based on 1998 data, including Narragansett Bay. For the Narragansett Bay Region, which included Bristol, Norfolk, Plymouth, and Worcester in Massachusetts, and Bristol, Kent, Newport, Providence, and Washington in Rhode Island, the study found that wholesale trade, a diverse sector category, stood out as the top output sector with over \$11 billion in sales; state and local government (education) ranked as the top for employment numbers. In response to the increasing reliance on tourism in local economies, however, the study also produced a “tourism GDP” for the area. The U.S. Department of Commerce has defined tourism industry ratios as expressing the proportion of sector output that is consumed by travelers more than 50-100 miles from home. For the Narragansett Bay Region, tourism-related industries at that time produced in

the aggregate over \$2 billion in output, employed over 40,000 individuals, and ranked as the 10th largest employment sector.

Complementing analyses of economic output, several more recent reports, such as the Rhode Island Systems Level Plan (SLP) and the states' updates to their comprehensive economic development strategies (CEDs), have confirmed the migration of employment numbers away from resource-based industries. In its 2004 employment statistics, for example, the Massachusetts Office of Labor and Workforce Development showed that for the Worcester metropolitan area, the highest average monthly employment (almost 35,000) was in the health care and social assistance sector, followed by manufacturing, retail trade, and educational services. In 2008, the Massachusetts Southeast Regional Planning & Economic Development District (SRPEDD), which stretches from Wareham in the east to Seekonk on the border of Rhode Island, also found the health care and social assistance and retail trade sectors were the highest percentages of employment, followed in their region by utilities. Similarly, Rhode Island's Department of Labor and Training found that 2008 statewide employment was led by health care and social assistance, followed closely by retail trade and manufacturing; by 2018, however, Rhode Island projects that employment in manufacturing will drop from third to sixth place, falling by 13.7 percent, and that employment characterized under "agriculture, forestry, fishing, and hunting" will remain essentially flat (declining from 782 to 778). (References at end of report.)

These shifts are taking place in the context of a cultural and ecological region keenly aware of the unique sense of place endowed by its iconic landscapes and traditional occupations --- and the economic value provided by those landscapes and occupations as well. For example, aquaculture and farming have been expanding as a percent of economic output; especially in Rhode Island, the number of farms has increased by 42 percent since 2002, the second highest increase in new farms in the country. In 2006, commercial fishery landings in Rhode Island were estimated at nearly \$100 million, with recreational fishing estimated to contribute another \$120 million to the state's economy in 2008. New Bedford has retained its crown as the top fishing port in the U.S. as measured by dollar earnings --- \$241.3 million in 2008 according to the National Marine Fisheries Service, primarily from the opening to scallop dredging of previously closed areas. Moreover, recreational fishing and boating, "locavore" and fresh food – based operations, and outdoor and cultural attractions contribute not only to their conventionally assigned industries, but also serve as elements of the growing sectors of tourism and recreation, and the "quality of life" activities that enable the Region to attract and attach technology and knowledge-based industries. The question before the Narragansett Bay Region is how to support viable iconic industries while retaining flexibility and resources to seize new opportunities and industries as they emerge.

1. Develop a regional economic platform to collaborate on and encourage sustainable industrial, technological, and commercial development

Policies:

- A. *Facilitate (technical assistance, incentives, grants, data, etc.) consistent development and management of renewable energy technologies where the region has greatest potential; i.e., wind, hydropower, and possibly landfill methane recovery*
- B. *Reconcile potentially conflicting goals for river restoration (e.g., restoring fish runs and habitat) and renewable energy (e.g., dam repairs to enable local hydropower) both within each state and across state lines*
- C. *Expand support for marine spatial planning at the state and regional level*

1.1	Identify "green" industrial technologies that enable cost-effective and environmentally sound operations; support and expand collaboration among the region's academic and knowledge-based institutions to address this task	MAEEOEA, RIEDC, universities, private sector, RISG	
1.2	Create an economic development program to support and expand collaborations and shared business infrastructure among the wide range of businesses and facilities that generate tourism as a major regional industry	MAEEOEA, RIEDC, universities, private sector, state and regional tourism councils, RISG	
1.3	Invest in technologies and tools that promote shared data and information, such as GIS, aerial photography, and environmental process models	Multiple agencies in both states	
1.4	Increase capacity of economic and planning agencies in both states to be able to better collect and analyze economic data to inform economic development strategies	MAEEOEA, RIEDC, private sector, universities	

2. Plan infrastructure as a region for long-term economic and ecological resiliency

Policies:

- A. *Collaborate in comprehensive statewide and regional planning for transportation, natural hazards, and wastewater and water supply management, including development of regional financing mechanisms and potential trading solutions*
- B. *Maximize benefits from current public investments in environmental infrastructure such as CSO tunnels, brownfield cleanups, and stormwater management, while also considering long-term needs for appropriate replacement and adaptation*

2.1	Update the existing study of NBR's existing ports -- Providence, Quonset, Newport, Point Judith, and Fall River -- for public investments as appropriate, including maximizing complementary, recreational and/or creative uses.	Port Authorities, RIEDC, Mass. econ devel, municipalities, RIPEC, universities	
2.2	Determine feasibility of regionalization of key infrastructure services	RIDOT, RIDOP, MADOT, Mass. Reg'nl. Planning, RIWRB, Mass & RI water suppliers, WWTFs, RICWFA, Mass. SRF, RIDEM, MADEP	
2.3	Establish regional planning capacity in Rhode Island and consider supporting a bi-state planning organization	RIDOT, RIDOP, MADOT, Mass. Regional Planning, RIWRB, Mass. SRF, RIDEM, MADEP	
2.4	Manage the supply and delivery of fresh water by investing in system inter-connections and the development of adequate reserve supply to increase system reliability.	RIWRB, RI and Mass water suppliers, RIDOP, Mass Regional Planning	
2.5	Establish sediment quality standards in both R.I. & Mass. to enable beneficial uses of dredged material and consistent treatment of sediment in impoundments and dam removals.	RIDEM, MADEP	

3. Preserve the region's natural, cultural, and quality of life assets as advantages that improve its business climate and promote sustainable economic development

Policies:

- A. *Develop economic strategies that build on existing economic sectors where the region has resources, expertise, networks, and business infrastructure (e.g., health, finance)*
- B. *Create economic and demographic analytical capacity at the state and regional level to provide better information to inform economic development strategies and anticipate change*

3.1	Convene an economic roundtable of economists, business and labor interests, economic journalists, and other observers of business cycles to identify economic development needs (both data and management) to improve the regional economy	RI and Mass economic planning authorities, RISG, Universities	
3.2	Develop a regional assessment and strategy for redevelopment of historic mill villages and other urbanized areas that addresses transportation, housing, recreation, energy, economic development and environmental needs.	RI and Mass economic planning authorities, Smart Growth advocacy organizations	

4. Sustain and improve economic value provided by commercial and recreation fisheries and aquaculture.

Policies:

- A. *Improve value and marketing of commercial fisheries products*
- B. *Create state-wide and regional mechanisms for cooperative management with industry that emphasize efficient fishery operations, consistent with biological objectives*

4.1	Assess feasibility of offshore aquaculture opportunities that do not have negative water quality impacts in conjunction with future wind farm operations	RIDEM, MACZM, RIEDC, Mass Econ. Devel., Fisheries Councils, Fishing interests, RISG	
4.2	Expand shallow water shellfish aquaculture in relation to CRMC/MFC endorsed strategic planning.	RIDEM, RICRMC, MACZM, RIEDC, Mass Econ. Devel., Fisheries Councils, Fishing interests, RISG	
4.3	Assess feasibility of establishment of legal depuration of shellfish as in Mass. (depuration plants) and Connecticut (permitted private depuration) to establish production from closed areas.	RIDEM, MACZM, RIEDC, Mass Econ. Devel., Fisheries Councils, Fishing interests, RISG	
4.4	Working with commercial fishermen, Sea Grant programs, and the R.I. Seafood Marketing Collaborative, identify options for local/sustainable or "green seal" labeling and marketing to add value to local products.	RIDEM, MACZM, RIEDC, Mass Econ. Devel., RSG, Fisheries Councils, Fishing interests	
4.5	Support development of local cooperative marketing for R.I. seafood, as is underway in Mass.	Sea Grant, Fishing interests, state economic development agencies	

Management Responses to Identified Problems

(INSERT section re. existing management actions related to these priorities)

State Responses

[Insert R.I. and Mass. management responses to economic recommendations]

Indicators:

In 2007, the Economic Monitoring Collaborative of the Rhode Island Bays, Rivers, and Watersheds Coordination Team drafted a preliminary draft of an inaugural economic monitoring report. The report was intended as a baseline from which to track changes in a key suite of water-based industries (known as the “water cluster”) and to identify areas needing more intensive study. It was also expected to serve as a source of information for shaping bay and watershed policy, and to that end, the report proposes a scorecard of 28 indicators deemed to offer insight into components of the Narragansett Bay economy.

TBD

The Path Forward

TBD

Protect Human and Natural Assets

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.

Problem Statement: Protecting human and natural assets from the effects of increases in sea level rise, storm intensity and precipitation as well as temperature change affects on natural systems are challenges we face due to climate change.

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 watershed development. Native ecosystems are also threatened by climate change. Challenges include:

- Sea level rise will lead to greater storm surges 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 NBR'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.
- 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 (earlier blooms, longer mosquito seasons) have implications for species changes and human health

Status and Trends:

Throughout history, the communities of the Narragansett Bay Region have periodically experienced severe natural hazards. The Hurricane of 1938, for example, killed several hundred people in Rhode Island and Southeastern Massachusetts, destroyed more than 2,000 houses, and flooded coastal towns and cities with several feet of water. Improved forecasting has greatly increased our ability to protect lives from storms and floods; however, the prospect of climate change will likely increase the vulnerability of public and private property, as well as native ecosystems, to these types of hazards. Aging infrastructure and existing land use patterns exacerbate the situation.

Effects of climate change are evident in NBR. 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. Average precipitation 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 is also clearly increasing, although the variability is such that a figure cannot be given. Sea level rise at Newport has increased by ten inches over the past century. 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.

River Flooding

We may already be seeing the effect of climate change on storm intensity—for example, the record-breaking floods in Southern Rhode Island in March, 2010. Whether or not this event was “caused” by climate change, it highlighted the vulnerability of NBR’s infrastructure and land use to extreme weather events.

Hundreds of homes and businesses were flooded in the Pawtuxet River basin; in Warwick, Cranston and West Warwick, R.I., most of the flooding occurred in historic flood plains which were filled and developed during the 1950’s and 1960’s. Where it crosses the Pawtuxet River, Interstate 95 acted as a dam, increasing flooding to the west; once the highway was overtopped, it interrupted traffic along the principal East Coast interstate route. Wastewater treatment plants along the Pawtuxet were flooded, causing the release of raw sewage and leading to months of reduced treatment. In the Pawtuxet and Wood-Pawcatuck river basins, several small dams failed, washing out roads.

The impacts of the flood were greatly exacerbated by existing patterns of development and inadequate infrastructure design and protection. Impervious surfaces associated with urban and commercial development increase flooding by preventing infiltration into groundwater, while development in the floodplains has placed dwellings and businesses in harm’s way.

Sea Level Rise and Coastal Storms

The effects of coastal storms are evident along Rhode Island’s South Shore. Beaches in this area are subject to 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. The Matunuck area in South Kingstown has lost hundreds of feet of beach front since the 1930’s; today, coastal erosion threatens businesses, the main road and water line. One proposal calls for construction of a multi-million dollar sea wall which would protect the road at the expense of the beach and natural shoreline. These problems are exacerbated by sea level rise.

While Matunuck is perhaps most vulnerable to sea level rise for a variety of reasons relating to exposure and sand supply, similar trends are underway along most of NBR’s coastal shorelines. As sea level rise continues, more calls for sea walls and “hardened shorelines” can be expected to protect coastal property, particularly in low-lying Rhode Island communities such as Wickford and Portsmouth’s Island Park. Most of NBR’s energy infrastructure, including electrical generating plants and fuel distribution facilities, is located along the shorelines of upper Narragansett Bay and Mount Hope Bay, creating the potential for severe disruption of regional energy production and distribution, including home heating oil and gasoline, as a result of coastal storms.

Infrastructure and Development

Existing coastal and riverine infrastructure, facilities, and development in general were not designed to accommodate extreme rainfall events, sea-level rise and increased storm surges. Culverts, bridges and many dams are inadequate and millions of dollars could be needed to retrofit access routes that would otherwise be flooded at high tide and during storm events. Coastal setbacks, based on average annual erosion rates, are intended to protect homeowners and public infrastructure for a limited span of time—

usually about thirty years. Properties built thirty or more years ago in compliance with previously established erosion setbacks are at particular risk.

Despite the prospect of increased flooding and storm hazards caused by climate change, coastal and floodplain development continues throughout NBR. The effect is an increase in the value of public and private property in harm's way, and, when an event occurs, an increase in the cost of recovery. To better protect life and property, improved siting and design standards are needed for new or redeveloped public infrastructure, commercial facilities, and housing situated in expanding coastal and riverine floodplains. Improved storm-surge modeling and high-resolution topographic data is currently being used to update floodplain maps and to predict and prepare for impacts of storms and floods.

Dams

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. Some of the larger dams serve water supply; many provide recreational or aesthetic value. Most of the region's dams, however, have outlived their original purpose of providing mill power, and are essentially unmanaged—indeed, many are entirely unmaintained. 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.

Federal, state and local organizations are collaborating to remove or modify dams on rivers and streams throughout the Narragansett Bay Region; however wetland regulations, legacy sediments, historic resource requirements and local concerns greatly increase the cost of these efforts (a small dam on the Pawcatuck River, for example, was recently taken down at a cost of more than \$1 million) while funding for such projects is limited. Greatly increased funding coupled with significant policy and regulatory changes will be required to fully address the risks and costs presented by NBR's aging dams. Culverts and bridges should also be assessed for flooding vulnerabilities and modified as necessary.

Ecosystem Impacts

Terrestrial and aquatic ecosystems are also subject to climate change impacts. Increased average seasonal water temperatures in Narragansett Bay appear to have caused changes in fundamental biological processes (plankton bloom patterns) as well as the Bay's fish communities—leading to loss of cold-weather adapted species such as winter flounder and increased prevalence of southern migrants such as fluke. Increased atmospheric temperatures and atmospheric carbon appears to benefit aggressive terrestrial invasives such as Japanese knotweed and Eurasian bittersweet as well as the native poison ivy.

NBR's coastal wetlands are vulnerable to rapid changes in sea levels. Salt marshes here have evolved since the last ice age through a process of sediment accumulation or accretion. This process may not be able to keep pace with more rapid sea level rise, leading to inundation and loss of marsh habitat. Land development adjacent to marshes can exacerbate this situation by preventing landward migration of the marsh in response to sea level rise. An increased rate of wetland loss due to climate change would cause significant loss of habitat for fish, shellfish, birds, and other wildlife.

Protection of Human & Natural Assets

1. Maximize preservation and restoration of green infrastructure to increase coastal and floodplain resilience			
<i>Policies:</i>			
A. 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.			
B. Protect and restore watershed and riverine natural resources like wetlands and riparian areas so that they can continue to provide cost-effective protection.			
1.1.	Remove dams where practicable; where dams must be retained, ensure that high and moderate hazard dams are fully maintained	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies	
1.2..	Develop and improve dam condemnation mechanisms for purposes of removal in R.I. and Mass.	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies	
2. Improve public and private infrastructure to withstand anticipated impacts			
<i>Policies:</i>			
A. Guide future development away from high hazard areas			
B. Ensure that redevelopment and reconstruction minimize future hazards			
2.1.	Improve dam inspection and maintenance requirements and enforcement	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies	
2.2.	Develop and implement natural hazard mitigation and adaptation plans for publicly-owned facilities	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies, RISG	
2.3.	With transportation departments, develop programs to examine flood capacity of bridges and other public structures; begin planning and funding for improvements	RIDOT, MADOT, RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies	
2.4.	Reduce vulnerability of communities to flooding through implementation of stronger flood plain management policies including setbacks, elevation, construction and utility requirements, etc.	state emergency mgmt. agencies, RISG	
2.5.	Incorporate advancements in coastal hazards science into state and local policies. Adopt more stringent building standards, flood ordinances, permitting processes, and best practices to improve resilience of private structures in coastal flood zones	RIDEM, RICRMC, MADCR, MACZM, municipalities, RISG	
2.6.	Update state building code freeboard requirements and design life standards as new scientific information becomes available	RIDEM, RICRMC, MADCR, MACZM, municipalities, RISG	

2.7.	Design stormwater treatment facilities and green stormwater infrastructure to have adequate capacity for increased, intensified flow resulting from climate change	RIDEM, MADEP, RICRMC, MACZM, municipalities	
2.8	Assess the effects of salt water intrusion on coastal onsite wastewater treatment systems	RIDEM, RISG, URI-CE, Mass. universities	
3. Ensure adequate disaster mitigation and response planning to protect life and property			
<i>Policies:</i>			
3.1.	Develop and update local natural hazard mitigation plans (floods and coastal storms), increase the capacities required to implement them, and to improve local responses to coastal and inland flooding events	Emergency mgmt. agencies, municipalities, RIDOP, Mass Regional Planning, RISG	
3.2	Develop a pre-disaster checklist for municipalities in order to facilitate federal disaster funding	Emergency mgmt. agencies, municipalities, RIDOP, Mass Regional Planning, RISG	
4. Develop funding mechanisms for improved preparedness and response			
<i>Policies:</i>			
4.1.	Develop additional funding for dam inspection, maintenance and removal—examine development of fees on existing reservoirs to create dam management fund	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies	
4.2.	Develop/leverage funding for acquisition of properties most vulnerable to climate change impacts	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies, RISG	
4.3.	Develop funding mechanisms for infrastructure retrofits for affected utilities and structures.	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies	
5. Improve science and information necessary for preparedness and response			
<i>Policies:</i>			
A. <i>Revisit science and identify research needs to better assess sea level rise and precipitation rates</i>			
5.1.	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 emergency mgmt. agencies, RISG	
5.2.	Continue to develop accurate inundation models for coastal and riverine floodplains	RIDEM, RICRMC, MADCR, MACZM, municipalities, state emergency mgmt. agencies, RISG	

6. Ensure that coastal habitat restoration efforts take sea level rise into account			
<i>Policies:</i>			
6.1	Develop adaptation plans for wetland migration to include protection of adjacent upland areas	RIDEM, RICRMC, MADCR	
6.2.	Support/expand as practicable Living Shorelines program	RIDEM, RICRMC, MADCR	

Management Responses to Identified Problems

(INSERT section re. existing management actions related to these priorities)

- Federal, State, Non-governmental

Indicators

- TBD

Path Forward

- Implementation plans TBD