THE RHODE ISLAND BAYS, RIVERS, & WATERSHEDS COORDINATION TEAM

Bays, Rivers, and Watersheds Systems-Level Plan: 2009-2013

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BRWCT Strategic Planning Work Group

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Ethical stewardship of Rhode Island's aquatic resources and environments, which the present generation never possesses solely for its own purposes, demands full recognition of the complex relations between our present social, environmental, and economic interests and values, and the future interests and values of subsequent generations. The essential question of government entails not only how should we balance and channel the demands of current interests but also, what are our obligations to future generations and how may we best fulfill them?

VISION AND GOALS

In the future, Rhode Island's waters and coasts are fishable, swimmable, prosperous, and resilient, and state and local environmental and economic development policies are well-managed, integrated, and cost-effective.

Numerous socio-economic uses and values are thriving, including commercial and recreational fishing, recreational boating, renewable energy generation, ocean and bay monitoring, water-dependent transport and industry, maritime technologies, recreation and tourism.

State and regional governance of Rhode Island's waters and watersheds fully incorporates systems perspectives, particularly the principles of ecosystem-based management, and is based upon world-class programs in monitoring, research, education and outreach, and strategic planning and evaluation.

A high level of biodiversity and a wide range of marine, estuarine, and freshwater habitats are protected, restored, and managed holistically. Development along shorelines, waterfronts, and floodplains is designed to mitigate the risks of coastal storm hazards and sea-level rise, and increase community resilience. Rhode Island's bays, rivers, and watersheds are widely perceived as desirable, attractive places to live, work, and play, with clean water, exceptional beaches, abundant public access, thriving living resources, and vital harbors and waterfronts.

Bays, Rivers, and Watersheds Systems-Level Planning and Evaluation Goals

- *Develop and apply ecosystem-based management principles to protect and restore Rhode Island's fresh, estuarine and marine waters and watersheds, and the human and economic values that derive from them.*

- *Guide the development of Rhode Island's "water-reliant economy" so that natural resources, including renewable energy are utilized sustainably, and enhanced in their utilization*.

Systems-Level Goals: 2009-2013

Waterfront and Coastal Development: *Rhode Island's shorelines and waterfronts will be characterized by balanced, well-designed development that accommodates marine-related industry, transportation, recreation, housing, and conservation.*

Watersheds: *Rhode Island's watershed ecosystems will be healthy and their natural functions maintained.*

Rhode Island's Water-Reliant Economy: *Rhode Island businesses that rely upon aquatic resources and/or waterfronts will thrive and have the opportunity to grow sustainably.*

Natural Hazards: *Human life, property, infrastructure, and natural resources will be protected against the hazards of storms and floods.*

Freshwater Supply: *Rhode Island will have ample, reliable safe fresh water supplies for the future.*

Water Quality: *Rhode Island's fresh, estuarine, and marine waters will support aquatic habitats, biological diversity, and their traditional and emerging human uses.*

Biodiversity: Aquatic Habitats and Invasive Species: *Rhode Island's freshwater, coastal, estuarine, and marine habitats will support healthy aquatic ecosystems for native fish and wildlife*.

Fisheries and Aquaculture: *Rhode Island will maintain sustainable and vital freshwater and marine fisheries, as well as a diverse, thriving aquaculture industry.*

Education, Training, and Technical Assistance for Local Governments: *Training, technical assistance, and continuing education will enhance how local and regional governments, citizens, and non-profits utilize, protect and manage aquatic resources and the economic values that derive from them.*

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List of Acronyms

AIS	Aquatic Invasion Species
ANS	Aquatic Nuisance Species
AR4	Fourth Assessment of UN Intergovernmental Panel on Climate Change
ASMFC	Atlantic States Marine Fisheries Commission
BMP	Best Management Practice
BRWCT	RI Bays, Rivers and Watersheds Coordination Team
BRW SLP	RI Rhode Island Bays, Rivers and Watersheds Systems-Level Plan
CAD	Confined Aquatic Disposal
CPUE	Catch per Unit Effort
CRMC	RI Coastal Resource Management Council
CRMP	RI Coastal Resource Management Program
CSO's	Combined Sewer Overflow
CSSLP	Community Septic System Loan Program
CTP	Coastal Training Program
CWFA	RI Clean Water Finance Agency
CWP	Center for Watershed Protection
DEM	RI Department of Environmental Management
DOH	RI Department of Health
DOT	RI Department of Transportation
DOP	RI Department of Administration, Division of Planning
EBM	Ecosystem-Based Management
EDC	RI Economic Development Corporation
EPA	US Environment Protection Agency
FEMA	Federal Emergency Management Agency
GWPC	Groundwater Protection Council
IC	Impervious Cover
IPCC	Intergovernmental Plan of Climate Change
LIDAR	Light Detection and Ranging, a precision airborne topographic survey technology.
LID	Low Impact Development
MFC	Marine Fisheries Council
MGD	Million Gallons per Day
MSY	Maximum Sustainable Yield
NEANS	Northeast Aquatic Nuisance Species Panel
NEFSC	National Marine Fisheries Service Northeast Fishery Science Center
NBC	Narragansett Bay Commission
NMFS	NOAA National Marine Fishery Service
NOAA	National Oceanic and Atmospheric Administration
NROC	Northeast Regional Ocean Council
OSPAR	RI Oil Spill Planning, Administration, and Response Fund
OWTS	On-site Wastewater Treatment Systems
RICWFA	RI Clean Water Finance Agency
RIDFW	RI Department of Environmental Management's Division of Fish and Wildlife

RIEDC	RI Economic Development Corporation
RIEMA	RI Emergency Management Agency
RIGIS	RI Geographic Information System
RIGL	RI General Law
RIRC	RI Rivers Council
SAFIS	Standard Atlantic Fisheries Information Systems
SAMP	CRMC Special Area Management Plan
SLP	RI Bays, Rivers, and Watersheds, Systems-Level Plan
SNE	Southern New England
SSO	Sewer System Overflow
TMDL	Total Maximum Daily Loading Assessment (water quality restoration plan)
UCG	Upper Coastal Greenway
USFWS	U.S. Depart. of Interior's Fish and Wildlife Services
USGS	U.S. Geological Survey
URI	University of Rhode Island
WAPAC	Water Allocation Program Advisory Committee
WWTF	Wastewater Treatment Facility

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PURSUING RHODE ISLAND'S STEWARDSHIP ETHIC

Rhode Island is blessed with abundant, healthy waters and watersheds. Rhode Island's maritime culture, development patterns, and major sectors of its economy stem from its estuarine geography and abundant fresh waters. Rhode Islanders identify deeply with their waters and watersheds. Our marine coast means far more than rocky shorelines, delectable shellfish, ocean beaches, marinas, commercial ports, fishing wharves, and exquisite summer homes. We understand that the coast and the watersheds that run to it are all of these and more, that the sum is far greater than its parts; that the slender boundary between land and sea that we live within offers and sustains extraordinary resources, unparalleled ecological diversity, and irreplaceable socioeconomic and cultural values. It is land and ocean, fresh water and salt. It is a place of manifold connections. What we introduce into the rivers, streams, and groundwater of our coastal watersheds flows inexorably into Narragansett Bay and the salt ponds. In turn, our rivers and streams are endowed with spawning and nursery habitats for marine fish that migrate offshore and along our seaboards.

Rhode Island's physical and social intimacy with its aquatic environs offers vital lessons in environmental governance, renewable resource economics, and the management of diverse aquatic ecologies; lessons for living sustainably *within*, not simply *on* the coast. We are still teaching ourselves these lessons. Protecting and restoring waters and watersheds, and managing the use of common property resources such as marine fish is technically challenging, time-consuming, and expensive. We would like to do more, and as this plan demonstrates there is a lot of clarity and good ideas on what more we can do. But in this first decade of the new millennium, we are struggling to retain and acquire the necessary funds and expertise, and the risks of non-action or inadequate action seem to be intensifying. Our governmental, non-profit, business, research, and educational networks incorporate an extraordinary array of interests and topics whose reach and impact span generations. That a diversity of interests is better recognized is commendable; but the resulting complexity of government and economic decision-making often seems to stymie innovation, experimentation, and leadership.

In government and in our economy, we must continue to improve how we address, balance and over time integrate the positions and priorities of resource users, environmentalists, business interests, seasonal residents, and local communities. Such an ecology of governance requires a systems approach to policy, organization, and regulation as engendered in ecosystem-based management.

Today, many Rhode Islanders are skeptical about government's accomplishments in pollution control, water supply management, public access, habitat restoration, greenspace protection, and public infrastructure investment. And little can be said definitively about how, together, these efforts produce ecological well-being and long-term economic vitality.

Nevertheless, there is abundant evidence in Rhode Island's long history that the protection and sustainable development of our waters, watersheds, and their abundant,

resilient ecologies have been among our great passions. That passion for the state's natural and built environments has produced some extraordinary results. In continued pursuit of its stewardship ethic, Rhode Island must build upon its accomplishments in land-use planning, pollution control and prevention, shoreline conservation, and habitat restoration. Rhode Island must embrace democratic, systems-based environmental governance. And we must with courage and determination invest in new ideas for sustaining and expanding our water-reliant economy.

In terms of environmental quality, many observers believe that our natural waterbodies are stressed and vulnerable to rapid, deleterious alterations in their function and qualities. On August 20, 2003, five years prior to the issuance of this Plan, Greenwich Bay experienced a large fish kill consisting of about one million juvenile menhaden, but also hundreds of small crabs, blackfish, horseshoe crabs (DEM, 2003). That summer also produced numerous saltwater beach closings due to pathogen contamination. These events galvanized public and political attention upon Narragansett Bay. In the fall of 2008, Governor Donald L. Carcieri launched the Governor's Commission on Narragansett Bay and Its Watershed. This Commission issued a "Phase I Report" containing numerous recommendations on how Rhode Island should work to reduce the hypoxia in Greenwich Bay which was the direct cause of the fish kill and to improve water quality at Rhode Island's treasured saltwater beaches. Many of those recommendations have been acted upon in the ensuing years. In addition, the Rhode Island General Assembly passed several key pieces of environmental legislation including creation of the RI Bays, Rivers, and Watersheds Coordination Team (BRWCT). The BRWCT's creation was the General Assembly's direct response to numerous calls for better governmental coordination and systems management approaches. For example, DEM's 2003 report on the causes of the 2003 Greenwich Bay fish kill and the beach closings, articulated the widely-held view that:

> *We actually have a relatively good understanding of what happened [in Greenwich Bay] and what must be done. Three things must happen to make us collectively more effective. First, we must allocate adequate resources to programs with key responsibility, both at the state and local level. Several state programs, including marine fisheries, water quality restoration and enforcement are struggling to meet their mandates. Local initiatives, for example to deal with poorly functioning septic systems or storm water, are frustrated by lack of resources or available expertise. Second, to make these programs more effective and make the best use of limited resources, we must coordinate and integrate them better, at and between all levels. We need a statewide, if not watershed-wide, mechanism by which we pool our resources, share, use and disseminate information, develop and implement joint strategies, and avoid wasteful duplication. And finally, we need better accountability, a structure and transparency for our efforts, so they can be evaluated on a regular basis, by a range of experts and by the public.*

Through systems-level planning, implementation, and evaluation, it is the mission of the BRWCT to pursue these three critical tasks of increased resources, better coordination, and learning-based evaluation. As discussed below the imperatives for this work are only growing.

THE CHALLENGES WE FACE AND HOW WE WILL MEET THEM

Since the arrival of European immigrants to its shores four hundred years ago, Rhode Island has confronted and frequently surmounted considerable challenges in developing, sustaining, and restoring this region's aquatic and watershed resources. But those historic challenges pale in comparison to what we face now.

Climate Change:

- Mitigate and adapt to the environmental and economic consequences of climate change including sea-level rise, intensifying coastal hazards, ambient water temperature increases, alterations in precipitation patterns and quantities, and alterations to terrestrial and aquatic ecosystems, habitats, and living resources.

Waterfront, Riparian, and Coastal Development:

- Ensure that future coastal waterfront development and re-development upholds state interests in marine economic vitality, public access, and the protection and restoration of critical habitats and environmental qualities.

- Ensure and cultivate high-quality public access to Rhode Island's shorelines and coastal waters.

- Redevelop waterfront brownfields and urban coastlines to eliminate historical legacies of industrial contamination and restore their recreational, environmental, and economic functions and values.

- Enhance the functions, resiliency, and productivity of Rhode Island's ports and related maritime industries, including dredging and dredged materials management.

Watersheds and Water Quality and Supply:

- Protect Rhode Island's world-class freshwater resources, surface and groundwater to maintain the well-being of freshwater ecosystems and ensure adequate, affordable, high quality drinking water supplies for Rhode Islands' citizens and businesses.

- Implement watershed-based systems approaches to managing and controlling pollution.

Water-Reliant Economies:

- Develop ocean renewable energy resources in a balanced manner that accommodates and promotes existing uses of Rhode Island's marine waters and submerged lands such as fisheries and recreation.

- Achieve and sustain the economic viability and ecological well-being of commercial and recreational fisheries.

- Encourage aquaculture in Rhode Island waters while balancing its development with other uses.

Habitat Restoration and Aquatic Invasive Species:

- Protect and restore freshwater, estuarine, and marine habitats, boosting their biodiversity and resilience to anthropogenic and environmental stressors.

- Prevent or mitigate the effects of aquatic invasive species and their impacts upon habitat quality, native species, and biodiversity.

From climate change to economic globalization, these challenges entail multiple environmental, socio-economic, and cultural factors that interact synergistically. They pose substantial risks and costs to the future well-being of Rhode Island, New England, and the United States. Their socio-economic impacts are multiplying and their solutions will require significant public and private investments and difficult alterations to social and individual behaviors and life-styles.

We must address these challenges acknowledging their synergies and their diverse, cumulative impacts. If we don't invest in their quality and functional capacity, Rhode Island's aquatic environments and resources will decline, allocation and access disputes among multiple interests will intensify, and the capacity of our socio-economic and environmental systems to adapt to future change will decline. To simply maintain current levels of environmental quality (natural and built) and social well-being, Rhode Island must cultivate the resiliency of its aquatic systems to unprecedented environmental change at multiple scales.

Climate Change

Climate change encompasses all climatic, hydrological, ecological, and socio-economic consequences of rapid and accelerating increases in temperature in atmospheric, terrestrial, and oceanic systems due to global atmospheric emissions of greenhouse gases from anthropogenic activities globally, the majority of which stem from energy generation from fossil fuel and biomass combustion. What is truly sobering is that the impacts of climate change will intensify in the coming decades regardless of how much and how rapidly we reduce greenhouse gas emissions. In addition to the enormous economic and social transformations inherent to reducing greenhouse gas emissions, the degree to which Rhode Islanders act now to prepare for, mitigate, and adapt to the impacts of climate change will strongly determine the level of human suffering and resource degradation we will endure in the future.

Rhode Island's aquatic and terrestrial ecologies are already changing rapidly due to planetary greenhouse warming. The United Nation's Intergovernmental Panel on Climate Change Fourth Assessment (AR4), 2007, identifies with high confidence (80% likely) that the following consequences of climate change are occurring globally:

- Warming of lakes and rivers is altering thermal structure (stratification) and water quality.
- Earlier timing of spring events, such as leaf-unfolding, bird migration, and egg-laying; earlier greening of vegetation in spring that is linked to longer thermal growing seasons.
- Poleward shifts in ranges in plant and animal species.
- Shifts in ranges and changes in algal, plankton, and fish abundance in high-latitude oceans.
- Range changes and earlier migrations of fish in rivers.

The AR4 identifies with medium confidence (50% likely) that the following effects of temperature increases are occurring globally:

- Effects on agricultural and forestry management and alterations in disturbance regimes of forests due to fires and pests.
- Increases in heat-related human mortality, infectious disease vectors, and allergenic pollen.

The AR4 projects that for higher latitudes annual average river runoff and water availability will increase by 10-40% by 2050 and major precipitation events will increase in frequency, exacerbating flood risks.

Ecosystem resilience will be diminished by an

> *unprecedented combination of climate change, associated disturbances (e.g., flooding, drought, wildfire, insects, ocean acidification), and other global change drivers (e.g., land-use change, pollution, over-exploitation of resources).*

Furthermore,

> *net carbon uptake by terrestrial ecosystems is likely to peak before 2050 and then weaken or reverse, thus amplifying climate change."*
>
> *Finally, about "20-30% of the plant and animal species assessed to date . . . are at increased risk of extinction if increases in global average temperature exceed 1.5-2.5°C.*

In New England, over the next several decades average winter air temperatures are projected to increase by 2.5-4ºC (4-7ºF), and average summer air temperatures by 1.5-3.5ºC (2.7-6.3ºF) (Frumhoff et al. 2007). Correspondingly, Rhode Island coastal water surface temperatures since 1990 have increased by about 1.7ºC in winter and 1ºC in summer (Nixon et al. 2003). These ambient temperature increases are altering species community composition and inter-species relationships in estuaries, freshwater systems, marine waters, wetlands, planktonic communities, fisheries, and the benthos. For example, water temperature increases are altering the timing of fish and planktonic life cycles (Nixon et al., 2007, Oviatt, 2004). As Rhode Island is located within the boundary zone between northern and mid-Atlantic ecological regimes, it will experience major species habitat shifts and heightened vulnerability to aquatic invasive species.[1]

These transformations of marine and freshwater aquatic ecosystem structure and function will result in significant, unpredictable changes in the living resources that

[1] See discussion of climate change impacts from the Narragansett Bay Estuary Program's Status and Trends Assessment Project.

provide irreplaceable socio-economic values to humanity. Climate-driven changes in precipitation intensity and seasonality will alter the magnitude and nature of stormwater pollutant loads. The Northeast U.S. has experienced the largest increase in extreme precipitation events in the country. New England as a whole has experienced a 61% increase in such storm events over the past 59 years, while Rhode Island has witnessed an 88% rise over the same period (Madsen and Figdor, 2007). Continued increases in rainfall depth as recently projected may mean that current stormwater control infrastructure is under-sized by as much as 35%.

The Rhode Island coast is highly vulnerable to sea-level rise. In the coming decades, sea-level rise, driven by polar ice melting, thermal expansion of oceans, and land subsidence, will accelerate and storm-induced erosion will intensify. The Rhode Island Coastal Resources Management Council (CRMC) has approved a new Coastal Resources Management Plan Section (145) that projects a 3-5 foot rise in average sea-level along the Rhode Island coast by the year 2100. The latest scientific findings indicate that a five-foot rise by 2100 is the more likely scenario. On the basis of these findings regarding sea-level rise, CRMC will "proactively plan for and adapt to climate change and sea-level rise."

Each stakeholder will respond distinctly according to how they perceive the effects of climate change upon their activities and values.

Architects & Builders: want green building codes, nationally.
Big Business wants agreement on the cost of carbon.
Clean Tech Sector wants to power the earth with new energy.
Environmentalists want the planet & people protected from harm.
Governors want a hand in shaping national climate law.
Hunters & Anglers want habitats, flyways & waterways unspoiled.
Investors want to start the low carbon gold rush.
Mayors want federal help to fight global warming.
People of Faith want to protect the poor and God's creation.
Scientists want climate policies based on the facts.
The Military wants the end of petro-politics.
Young People want a sustainable tomorrow.

From: *http://solveclimate.com/*

Sea-level rise over the coming decades will expand coastal floodplains inland. Salt marshes will be blocked by topography and/or development from migrating inland and may be drowned diminishing estuarine species diversity and abundance, and reducing resilience to aquatic invasive species. Saltwater intrusion into shoreline aquifers will increase, degrading drinking water resources, breaking down on-site wastewater treatment processes, and increasing soil salinities. Coastal infrastructure from roadways to sewage treatment plants will need to be relocated to higher land or redesigned and rebuilt. These direct and cascading impacts of sea-level rise and climate change will thus trigger a host of ecological and socio-economic alterations and losses leading to degraded ecosystems, coastal human population displacement, permanent losses of economic wealth, and infrastructure destruction.

Energy resource development and utilization will be increasingly governed by legal requirements to significantly reduce carbon emissions from energy facilities. The

ensuing changes to how energy is generated and utilized, with attendant increases in energy costs, will in turn powerfully affect how we use and protect aquatic resources. In its multi-faceted response to climate change, Rhode Island must aggressively pursue the development of renewable energy resources, increase the resilience and adaptability of systems that provide and utilize energy, and promote energy conservation at all levels of the state's and region's economy.

The impacts of climate change will be felt throughout Rhode Island's aquatic environments and water-reliant economy, including watershed and river systems and communities. Agencies and individuals in state, local and federal government face unprecedented policy and regulatory challenges in collaboratively, strategically, and rapidly responding to climate change in order to prepare Rhode Island and Rhode Islanders for what lies ahead.

Controlling and adapting to climate change, sea-level rise, and the intimately related issues of energy resource development, generation, and consumption, necessitates a systems approach to aquatic and coastal resources management, protection, and sustainable development.

The Bays, Rivers, and Watersheds Coordination Team

> *Adaptability and transformability depend on the capacity of people to maintain or change the social-ecological system in which they live. Adaptability to upcoming challenges depends on human choices being made now. Better choices are likely if evolving changes are faced clearly and collaboratively, with minds open to the surprises to come.*
>
> - Walker & Salt, 2006

To help meet the challenges we face, Rhode Island's state agencies must develop coordinated, systems approaches to coastal, marine, and watershed management, and the sustainable development of Rhode Island's water-reliant economy. This is the mission of the Rhode Island Bays, Rivers, and Watersheds Coordination Team (BRWCT) (RIGL 46-31). The General Assembly concluded that:

The formation of an [state executive] interagency group for the coordination of the functions, programs, and regulations that affect the bays, rivers, and watersheds is the most effective way to transcend the limited responsibilities and jurisdictions of each agency, address complex issues using an ecosystem-based approach, and provide for continuity over time.

The BRWCT member agencies are:

- Coastal Resources Management Council
- Department of Environmental Management
- Department of Administration's Division of Planning
- Economic Development Corporation
- Narragansett Bay Commission
- Rivers Council
- Water Resources Board

(See Appendix I for a detailed overview of the BRWCT member agencies.)

"**Networked governance**" describes the evolution of public executive strategy and function in response to the confluence of four major trends transforming government worldwide:

Third-party government*: the increase in using private firms and non-profit organizations to deliver services and fulfill policy goals.*

Joined-up government*: multiple government agencies, even multiple levels of government, to join together to provide integrated service.*

The digital revolution*: the recent technological advances that enable organizations to collaborate in real time with external partners in ways not previously possible.*

Consumer demand*: citizen demand for more control over their own lives and more choices and varieties in their government services.*

(Goldsmith & Eggers, 2004)

In the pursuit of their respective missions, these state agencies interact continually with each other and other agencies and branches of Rhode Island government. Given the pluralistic federalist system of government in the U.S. (Colt, 1994), coordination is widely recognized as fundamental to effective executive agency administration, planning and management.

For example, responding to a hurricane, flood, or nor'easter requires centralized control and command systems that facilitate massive, rapid and effective responses by state and federal emergency response, public safety, and law enforcement authorities. The heavily-criticized governmental responses to Hurricane Katrina in 2005 underscored the importance of interagency planning and coordination for effective leadership in coastal emergency response and recovery.

In contrast to centralized command and control structures required for emergency response, marine and fresh water policy and management domains are relatively decentralized, and the problems and challenges they face are 'squishy' (difficult to characterize and assess), 'trans-scientific' (may be defined in scientific terms, but resist resolution via empirical observation and engineered solutions), and 'wicked' ("complex all the way through").

Thus the BRWCT's purpose does not entail the centralization of control and operations via the imposition of a hierarchical, centralized command structure. Rather its mandate is to develop and implement an ecosystem-based management approach to water and watershed management and water-reliant economic development that acknowledges and functions within contemporary networks of environmental governance, economic development, and, increasingly, energy management.

Ecosystem-Based Management

Under RIGL 36-41, the BRWCT must utilize "ecosystem-based management" (EBM) to "address complex issues" and "provide for continuity over time". Ecosystem-based management is a set of planning and management principles that has emerged over the past thirty years from the ecological sciences, systems theory, and policy analysis. As a management approach it:

- Integrates ecological, social, and economic goals and recognizes humans as key components of the ecosystem.
- Considers ecological- not just political- boundaries.
- Addresses the complexity of natural processes and social systems and uses an adaptive management approach in the face of resulting uncertainties.
- Engages multiple stakeholders in a collaborative process to define problems and find solutions.
- Incorporates understanding of ecosystem processes and how ecosystems respond to environmental perturbations.
- Is concerned with the ecological integrity of coastal-marine systems and the sustainability of both human and ecological systems.

(Communications Partnership for Science and the Sea)

EBM presumes that a holistic view of social-ecological systems is required to manage and govern them effectively. Systemic health, productivity, and resilience are considered essential to ensuring the provision of the ecological services and natural resources that humanity values and needs.

Despite its ambitiousness, in light of the enormous future changes to our aquatic environments and economies that we anticipate, there is little doubt among managers and scientists as to the importance of successfully implementing an EBM approach if Rhode Island is to protect its aquatic environment and resources, and manage credibly and equitably their multiple human uses and values. Appendix II discusses the foundations and purpose of EBM in greater detail.

Strategic Planning, Coordination and Ecosystem-Based Management

By statute, the BRWCT shall develop and implement the Bays, Rivers, and Watersheds Systems-Level Plan (BRW SLP) to foster interagency coordination, advance EBM of estuarine and fresh water resources, and foster development of the water-reliant economy. The SLP is to "include a strategy for attaining goals and delineate specific responsibilities among agencies" (RIGL 46-31-5).

Through BRW SLP implementation, the BRWCT will strengthen and expand state agency relations with federal and municipal entities, as well as with stakeholders in academia, business, and the non-profit sector.

Bays, Rivers, and Watersheds Systems-Level Plan Development

An Ad Hoc Strategic Planning Work Group comprised primarily of state officials, the chairs of three of the BRWCT's four standing subcommittees, and the BRWCT Chair were responsible for producing the BRW SLP, with significant contributions from a variety of state officials. A "Public Review Draft" was issued in March 2008 for public review during the spring of 2008. Ensuing changes to the BRW SLP led to the issuance of a Final Draft in late June 2008. A second, briefer round of public review was conducted for the Final Draft, with the BRWCT finalizing the BRW SLP: 2009-2013 in late July 2008.

The Planning Work group recognized that strategic planning for public institutions must "accept and build on the nature of political rationality" (Byron, 1995); that political decision making centers upon issues and that issues by definition entail conflict between different interests and values. Politically acceptable programs and policies emerge from efforts to resolve conflicts inherent to issues. And hence, "more general policies may be formulated to capture, frame, shape, guide, or interpret the policies and programs developed to deal with the issues" (Byron, 1995).

The BRW SLP is thus organized by eight major "issue domain" sections.

- Waterfront and Coastal Development
- Watersheds
- Rhode Island's Water-Reliant Economy
- Natural Hazards
- Freshwater Supply
- Water Quality

- Fisheries and Aquaculture
- Aquatic Habitats and Invasive Species

Each of the following sections summarizes key concerns and uncertainties for basic issues such as “Water Quality”, “Watersheds”, and “Natural Hazards.” Each section concludes with a Strategy Table summarizing objectives, strategies, and actions for each issue domain to be pursued in the next four to five years. Agency leads for each action are identified, along with important partners including agencies and programs in addition to the seven BRWCT agencies. Detailed commitments to implementation will be made in the BRWCT Annual Work Plans. The BRW SLP’s concluding section discusses the responsibilities and priorities of the BRWCT.

The Planning Work Group determined that the BRW SLP should capture, frame, and interpret the policies and programs developed to address key issues through previous strategic planning and management efforts. The BRW-SLP distills and builds upon previous consensus-building efforts and agency-based strategic planning. Thus, many of its recommendations have already been collaboratively agreed to and are re-affirmed by the BRWCT’s own planning effort.

During development and public review of earlier drafts of the BRW SLP, the question of how detailed or quantitative the goals, objectives, strategies, and actions should be was discussed extensively. The Planning Work Group and the BRWCT concluded that it did not wish to “lock-in” to quantitative objectives that could quickly become infeasible given significant uncertainties regarding the staff and operational resources available in the future to the BRWCT agencies.

Similarly, the BRWCT decided to forego incorporating implementation cost estimates into the BRW SLP. Concrete performance measures and specific needs for implementation will be delineated subsequently by the BRWCT and the Planning Work Group in conjunction with other stakeholders. The Strategy Tables do establish “Timeframes” for pursuit of the recommended actions. *However, effective pursuit of many of the recommended actions in the allotted timeframes will require additional operational funding and staff.*

The BRW SLP: 2009-2013 represents the first step in the development of an interagency strategic planning cycle comprised of planning, implementation, evaluation, and plan refinement. Each of these steps is critical to the BRWCT’s core mission of improving interagency coordination, establishing EBM for Rhode Island’s waters and watersheds, and integrating environmental and economic development priorities and programs.

Some observers criticize comprehensive strategic planning for environmental and economic management because plan implementation rarely achieves the ideals articulated during the planning process. This criticism largely misses the point that the essential value of a strategic planning cycle is as a collaborative learning process that enables environmental and economic development leaders to gain greater insight into the complex decision environments that they function within, and cultivates appreciation

and insight on the part of political leaders, NGO's, user groups, and the general public on what it truly takes to achieve the goals that most citizens intuitively embrace for aquatic environmental management and sustainable economic development.

WATERFRONT & COASTAL DEVELOPMENT

For the purposes of the BRW SLP, waterfront and coastal development encompasses all forms of construction and alteration stemming from human habitation, transportation, flood control, economic activities, or recreation situated within or along estuarine, riverine, lakefront, or coastal shorelines. (Land use and development throughout the region's coastal watersheds are addressed in the section on Watersheds.)

Coastal Development

Despite the cyclical downturn of the region's real estate market beginning in 2007, and the scarcity of undeveloped coastal sites available for new development, coastal and urban waterfront development continues at a strong pace in Rhode Island. Development pressure upon existing open space, marginally buildable lots and protected areas such as coastal wetlands, remains strong and shows no indication of abating in the future, even as other factors come into play, such as higher property insurance rates and sea-level rise.

> "People are turning South County's beach cottages into seaside estates at a staggering rate. Statistics show that this area – which includes the coastal towns of North Kingstown, Narragansett, South Kingstown, Charlestown and Westerly – has seen more of these projects than any other region in Rhode Island.
> With most all oceanfront land in the area either built upon or protected from development, those wishing to own large beach houses are left with few options other than buying an old saltbox and rebuilding. Out-of-state buyers also have fueled this boom in coastal remodeling projects. Though property values in the Ocean State continue to rise, buyers continue to flock from other Northeastern states – namely Connecticut, Massachusetts and New York – where oceanfront homes are generally more expensive.
> "People are buying these summer cottages basically for the land," said Grover J. Fugate, of the R.I. Coastal Resources Management Council, which has jurisdiction over all development within 200 feet of the state's coastal features.
> Since 1970, the CRMC has granted about 11,500 coastal building permits in South County's five coastal towns – more than any other five coastal towns in the state. The permits are for projects ranging from remodeling cottages to expanding docks.
> During the past 20 years, the council has seen its number of annual assents for coastal "rehab" projects jump from about 200 to more than 700.
>
> - R. McBride
> Providence Business News

Since the mid-1980s, the Rhode Island Coastal Resources Management Council (CRMC) has observed a decrease in permit applications for new subdivisions and homes, and an increase in permit applications for redeveloping existing sites (Figure One).

This trend in permits reflects the "intensification" of existing coastal and shoreline development as seasonal cottages are rebuilt as year-round residences.[2] This trend should continue as members of the baby boomer generation retire in greater numbers over the next decade.

[2] Another consequence of the conversion of seasonal properties to year-round residences may be the decrease in summer rental properties along the Rhode Island coast.

Redevelopment projects on individual residential lots in densely developed suburban areas rarely meet expansion thresholds that trigger CRMC's buffer zone regulations. This has resulted in significant numbers of redevelopment projects and increases in "intensity of use", with little overall gain or investment in environmental restoration or protection as compensation or mitigation.

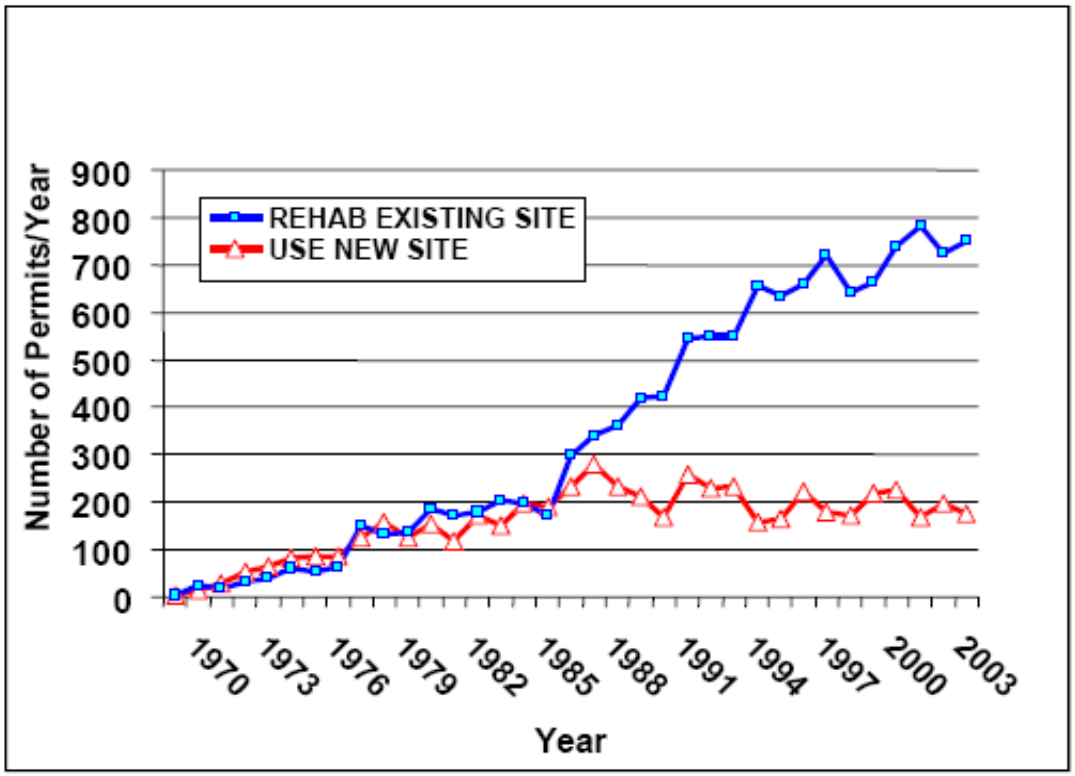

Figure 1: Annual Trends in CRMC Permits for Coastal Development, 1970 – 2004.
(Robadue, CRMC Marine Resources Development Plan, 2006)

CRMC utilizes buffer zone regulations and water type designations to guide and regulate development. The recently established Urban Coastal Greenway (UCG) Policy for the Metro Bay (upper Narragansett Bay) area provides a framework for urban waterfront redevelopment by establishing a specialized coastal buffer zone program for urban development and redevelopment projects. The UCG policy, if implemented fully and in a timely manner will increase shoreline public access, improve storm water management, and reestablish vegetated buffer zones for urban waterfronts in the upper bay. Application of UCG policies and requirements will be governed by the rate of waterfront property turn-over in the real estate market.

Urban Waterfront Redevelopment

In upper Narragansett Bay, numerous urban waterfront redevelopment projects are in planning or under construction. In the Providence metropolitan region, including Providence, East Providence, Pawtucket, and Cranston, there is strong interest on the part of municipal governments and private developers to refurbish under-utilized commercial and industrial spaces, including the reclamation of waterfront brownfield

areas for residential and light commercial uses in order to increase long-term the value and utility of municipal lands and development.

From a municipal perspective, the property tax revenues derived from high-end residential development are significantly greater than from other uses such as industrial or commercial developments. For instance, a 2007 analysis of available parcel data indicated that the assessed value of coastal residential lands were about three times greater than that of coastal industrial lands[3].

Although waterfront residential development would generate property tax revenues for the municipalities of the Providence metropolitan region, and possibly foster greater public access and recreation along these waterfronts, traditional maritime uses of statewide importance may be crowded out of the urban waterfront. In 2006, Provport maritime activities generated $178.8 million in total economic value, accounting for 939 direct jobs and $16.3 million in state and local taxes.[4] There is little possibility of relocation for the majority of Provport maritime activities due to their dependence on deep-water port channels and existing port infrastructure.

The Rhode Island economy retains robust "water-dependent" industrial sectors (those firms that depend on their close proximity to the water for their economic viability) in marine trades, commercial and recreational fishing, and maritime defense, and the skilled workforce needed to support and grow these sectors. Rhode Island's water-dependent sectors represent 6,500 direct jobs and approximately $279 million in employee wages. The Rhode Island Economic Monitoring Collaborative estimates that these sectors are growing on average about 2.6 times faster in Rhode Island than they are nationally.

With critical mass in marine trades, defense and fishing, Rhode Island has the potential to attract companies in these industries. However, for reasons discussed above, available industrial waterfront land is scarce and may be developed for other uses such as residential and commercial development. If industrial waterfront is rezoned for other uses, particularly residential, Rhode Island will lose vital waterfront infrastructure required to support and grow key industrial sectors that would contribute to a high-wage economy. Thus, Rhode Island has a strong interest in preserving industrial waterfront land in order to foster growth in industries that require it. The BRWCT Economic Monitoring Collaborative has summarized the issues of urban waterfront development as follows:

- Develop new ways to generate local government revenues so that municipalities are not tied to promoting land uses that generate the most property tax at the least municipal cost.

- Distinguish between those land and water uses which directly conflict with each other and those for which new design or management solutions have good potential to mitigate use conflicts.

[3] BRWCT Economic Monitoring Collaborative, FY 2007 Report.
[4] BRWCT Economic Monitoring Collaborative, FY 2008 Report.

- Making the necessary investment in transportation infrastructure (maritime, rail, transit and road) to support new growth.

- Plan for sea-level rise and possibly more intense storm events due to climate change.

As municipal governments pursue the development of urban waterfronts with a greater mix of residential, commercial and industrial uses, the demand for waterfront industrial sites remains strong. Other water-dependent uses (water-borne transportation, recreation) also continue to grow. The competition of interests in urban waterfront redevelopment is governed by numerous factors including market forces at a variety of scales, CRMC Water Type designations (water use zoning), DEM water quality classification zones, and local land use zoning.

State agencies should work with Rhode Island municipalities and maritime and real estate business leaders to ensure that waterfront lands currently zoned industrial are maintained. Rhode Island should continue to invest in innovative means for remediating waterfront brownfields. Waterfront brownfields could help meet high demand for developable waterfront property. Correspondingly, state and municipal governments could harness the demand for waterfront property to drive the remediation and restoration of brownfield sites.

Riverfront Development

Rivers such as the Blackstone, Pawtuxet, and the Ten Mile provide critical open space and recreational corridors in Rhode Island's urban areas (Figure 2). The Wood-Pawcatuck watershed also offers tremendous recreational opportunities with over fifty miles of canoe-able waterways. (This watershed also functions as a sole source aquifer supporting the drinking water needs of southern Rhode Island.) The recreational, open space, and drinking water values supported by Rhode Island's rivers are also impacted by development along riverfronts and throughout their watersheds. River-based recreation, wildlife habitat, and drinking water supply all require the best possible water quality, which in turn is attainable only if bordering freshwater wetlands and "riparian buffers" are protected and restored to the maximum extent possible. Riparian buffers are defined as:

> *a complex assemblage of plants and other organisms in an environment adjacent to water. Without definitive boundaries, it may include stream banks, floodplain, and wetlands, as well as sub-irrigated sites forming a transitional zone between upland and aquatic habitat. Mainly linear in shape and extent, they are characterized by laterally flowing water that rises and falls at least once within a growing season.* (Lowrance, Leonard, and Sherida, 1985)

Figure 2: The Blackstone River at Central Falls Landing: an important urban open space and aquatic recreational corridor. (DEM Urban Environmental Design Manual, 2005)

River-bordering development, whether commercial, residential, or industrial, must proceed in a manner that preserves and restores freshwater wetlands or riparian buffers. Implementing low-impact development standards will become more central to attaining this policy goal by minimizing site alterations and the degradation of riparian buffer values, and maximizing the treatment of stormwater on-site. The forthcoming Rhode Island Stormwater Manual, in concert with more focused policies such as CRMC's urban coastal greenways policy, will provide important means to guide and regulate riverfront development in order to protect and restore riverine water quality and habitats.

Sea-Level Rise

In the coming decades, Rhode Island marine and estuarine waterfront development, including activities along tidal rivers such as the Seekonk, Woonasquatucket, and Moshassuck, will need to accommodate for accelerating sea-level rise. [5] Data from the Newport tide gauge (1930-2006) indicates a relative rate of sea-level rise equal to 10.1 inches (± 1.2-inches) over the last century in Rhode Island. However the period of 1989-2007 indicates an accelerated rate of sea-level rise at the Newport tide gauge, equaling approximately 0.16 inches per year. Recent advancements in ocean and climate change models indicate that the annual rate of sea-level rise will continue to accelerate for at least several decades, with the possibility that major losses of the Greenland and

[5] Material from this section has been drawn from the Metro Bay SAMP Chapter on Natural Hazards, 3/11/08 Draft.

West Antarctic ice sheets will pose worst-case scenarios for sea-level rise that will greatly exceed current projections.

Sea-level rise will cause coastal floodplains to migrate and expand inland, impacting waterfront areas that currently are not considered to be located in high hazard flood zones. Some waterfront facilities are already experiencing the effects of sea-level rise during spring tides, particularly with strong onshore winds.

The hazards posed by intense storm events such as nor'easters and hurricanes will intensify due to sea-level rise, increasing substantially the number of people, resources, and facilities located along Rhode Island's coasts threatened by hurricanes and floods. The densely settled and developed coastal shorelines and floodplains of upper Narragansett Bay endured significant losses of both life and property from the Hurricane of 1938 and Hurricane Carol in 1954. The cities of the Providence Metropolitan region are beginning to work together on evacuation issues through the Metro Bay SAMP in recognition that the risks posed by hurricanes to the upper bay are intensifying due to sea-level rise and climate change. It is clear to emergency management planners in local, state, and federal government that serious public safety risks exist. The Federal Emergency Management Agency (FEMA) has identified the upper Narragansett Bay region as the "Achilles' heel of the Northeast" due to its vulnerability to flooding (Vanderschmidt, 2005). According to existing models, storm surges as high as 21 feet could strike upper Narragansett Bay in the event of a direct strike by a hurricane to the southern New England coast.

Nevertheless, the Rhode Island Economic Development Corp. (EDC) estimates that more than $1.5 billion in redevelopment along the waterfronts of the Providence metropolitan region is planned, underway or recently completed. Therefore, the upper bay's waterfront infrastructure must be designed to accommodate sea-level rise in the coming decades and to maximize their coastal hazard mitigation capacities.
In January 2008, the CRMC adopted a new Section 145 of the Coastal Resources Management Plan entitled Climate Change and Sea-Level Rise which will powerfully influence coastal and waterfront development in Rhode Island in the coming decades. It states that

> *it is the Council's policy to accommodate a base rate of expected 3 to 5 foot rise in sea level by 2100 in the siting, design, and implementation of public and private coastal activities and to insure proactive stewardship of coastal ecosystems under these changing conditions. It should be noted that the 3-5 ft. rate of sea level rise assumption embedded in this policy is relatively narrow and low. The Council recognizes that the lower the sea level rise estimate used, the greater the risk that policies and efforts to adapt sea level rise and climate change will prove to be inadequate. Therefore, the policies of the Council may take into account different risk tolerances for differing types of public and private coastal activities. In addition, this long term sea level change base rate will be revisited by the Council periodically to address new scientific evidence.*

In June 2008, CRMC Director Fugate stated,

> *All of the data [CRMC is] looking at right now is lining up at the worst-case scenario. With sea level rise along the shore, we [anticipate] increases in erosion, groundwater contamination by sea wate,r and [on-site wastewater treatment system] failures. [Rhode Island is] also going to be more susceptible to storm damage.*
>
> *Some possible ways to manage sea level rise are to accommodate it – build structures at a certain height above expected sea level rise (free board); retreat from it; or protect ourselves from it by protecting infrastructure and services and nonstructural areas like beaches and vegetated sites. Climate change has to be systematic throughout [the CRMC Coastal Management] program now. We're going to have to consider out-of-the-box ideas.*
>
> CRMC-URI Climate Change Workshop, June 18, 2008.

While CRMC undertakes initiatives to address the impacts of future sea-level rise upon coastal and waterfront development, other state agencies working on water quality management, wetlands protection and restoration, on-site wastewater treatment, stormwater, riparian buffer protection and restoration will also have to plan for sea-level rise. Projected increases in precipitation rates due to climate change may interact with sea-level rise to exacerbate flooding risks in freshwater systems. Coastal and brackish wetlands will be severely threatened without substantial measures to permit their migration inland. Finally, Rhode Island will have to monitor closely and respond to the impacts of a migrating shoreline upon living resources such as finfish, shellfish, and eelgrass.

In sum, stormwater control measures, industrial, commercial, and residential waterfront and coastal development, living resource protections, storm hazard mitigation, and coastal infrastructure re-investment will all have to accommodate sea-level rise and climate. This will require both unprecedented action and coordination by Rhode Island state and municipal government. CRMC's SAMP process serves as an important mechanism for such major collaborations and ongoing SAMP initiatives are prominently featured in the following Strategy Table 1. However, additional coordinating mechanisms, especially ones that draw upon the resources and capabilities of the federal government, will be required. Of particular urgency in the near-term is the development of seamless topographic-bathymetric maps through advanced survey technologies such as LIDAR for the Rhode Island coast. Such surveying and mapping projects cannot be carried out with substantial assistance from the federal government.

Table 1: Waterfront and Coastal Development Strategies

Goal: *Rhode Island's shorelines and waterfronts will be characterized by balanced, well-designed development that accommodates marine-related industry, transportation, recreation, housing, and conservation.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
Sufficient quantity and quality of industrial waterfront lands to foster marine and waterfront economic development.	Expand municipal government utilization of zoning tools such as performance standards to encourage appropriate development of industrial waterfront sites.	Complete updating of the RI Industrial Land Use Plan and incorporate it into the update of the Div. of Planning's Economic Policies Plan.	**DOP**, EDC	1-2 years
		Promote remediation of waterfront brownfield sites to help fulfill future demand for mixed-use redevelopment, and to support Rhode Island's maritime sector.	**DEM**, EDC	Ongoing
	Develop clear policy statements regarding the state's interests and goals for marine transportation and the maintenance and development of key port facilities.	Identify those activities which are determined to be of regional benefit and demonstrate how state legal authority will ensure that these activities are not unreasonably excluded by local government action from locating in the coastal area.	**DOP**, EDC, CRMC	Ongoing
	Adapt current and design future waterfront infrastructure to accommodate sea-level rise.	Communicate with municipalities and maritime companies on the need to adapt infrastructure to sea-level projections over the coming decades. Develop polices and regulations to ensure investments in current and future waterfront infrastructure made in accordance with official state sea-level rise projections.	**CRMC**, EDC, DOP	1-4 years

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Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
Waterfront, riverine, and coastal developments that incorporate design standards sensitive to the environmental and cultural values of their surroundings.	Support and advance Special Area Management Planning for critical coastal regions in accordance with the goals for SAMP development established in the 2006 Marine Resources Development Plan.	Work with municipal and private sector stakeholders to update, revise, and implement the Metro Bay SAMP.	**CRMC**, DEM, DOP, EDC	Ongoing
		Complete development of the Aquidneck Island SAMP.	**CRMC**	Ongoing
		Spearhead revisions to the Greenwich Bay SAMP.	**CRMC**	1-2 years
		Pursue development and implementation of the Ocean SAMP, linking it to planning and policy development for the terrestrial components of ocean renewable energy development.	**CRMC**, DOP, DEM, RI Office of Energy Resources	2-3 years
	Ensure that SAMP goals and actions and DEM's water quality TMDL plan recommendations (see Water Quality section below) are adequately reflected in state and local planning, zoning and related by-laws.	Update and enforce local development requirements in conformity with relevant SAMP and TMDL mandates.	**CRMC**, DEM, DOP	Ongoing

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Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
	Promote revision of community development standards to ensure application of Low Impact Development (LID) standards and techniques in re-development and development projects along freshwater and estuarine waterfronts.	Provide education, training, and assistance to local governments to adopt LID for coastal and waterfront sites.	**DOP**, DEM, CRMC	Ongoing
Timeframes: For many listed actions additional funding will be required for successful completion.	<u>Ongoing</u>: Action is currently being pursued by one or more agency. Additional funding may be required for completion.	<u>1-2 Years</u>: With adequate funding, action should be completed within 1-2 years. <u>2-3 Years</u>: With adequate funding, action should be completed within 2-3 years		

WATERSHEDS

> *A watershed is the area of land that drains to the outlet of a lake, stream, river, estuary, or other body of water. All land is in one watershed or another. The Watershed Approach organizes management and planning around watershed boundaries. It brings people together—local watershed residents, businesses, town officials, and state and federal government representatives—to envision and create the future of their watershed area.*
>
> - RI Watershed Approach Framework, 1999

> *Land use is about how we manage our communities to meet our needs. Land-use policies will dictate much about how we and our children will live. We must be deliberate in deciding how best to use our land, a limited and precious resource in Rhode Island.*
>
> - Division of Planning
> *Land Use 2025*

A watershed is defined as the land area that collects and conveys water to a particular point along a waterway (CWP, 2000). A watershed may span hundreds of square miles and include multiple jurisdictions. The Narragansett Bay Watershed encompasses 1,820 square miles, approximately 60% of which lies in Massachusetts. Major watersheds are broken down into many smaller units called sub-watersheds. Sub-watersheds typically have a drainage area of two to 15 square miles and comprise the majority of the headwater streams.

Land use and development patterns powerfully influence watershed functioning and well-being, and the health of Rhode Island's fresh and marine waters (CWP 2007). If we wish to maintain and restore the quality and functions of Rhode Island's watersheds and waters we cannot continue recent development patterns. We must prevent additional water quality and habitat degradation by improving land use controls via a state-wide watershed management framework.

Contemporary development trends in Rhode Island continue to follow a low-density, scattered pattern of "sprawl". Historical development patterns were comprised of small house lots, a mix of housing types, and interconnected street networks that dispersed motor vehicle traffic. These patterns were superseded by development that prioritizes large house lots, one dominant housing type (single family), the separation of industrial, business, and civic land-uses, and roads with fewer interconnections and traffic concentrated on collectors and arterials. It took 330 years to develop the first 20% of Rhode Island's land area, but just over 25 years to develop the next 10%.

A 1999 report entitled the *Rhode Island Watershed Approach Framework* proposed a framework and a means for organizing "management and planning around watershed boundaries." As a report and collaborative process involving numerous stakeholders, the Rhode Island Watershed Approach is a major predecessor to the BRWCT. Its history subsequent to 1999 should be assessed closely by the BRWCT as many of its recommendations remain valid today and many observers are

concerned about the lack of progress made toward the Watershed Approach's recommendations by state and local government over the past ten years.

To mitigate the consequences of sprawl development, and inspire new development patterns that incorporate ecosystem considerations, Rhode Island state and local government has sought since the 1960's to advance better approaches to land use and watershed management, such as those engendered in the Rhode Island Watershed Approach. These efforts continue to be hampered by insufficient resources for training for local public officials, inadequate capacity in state and local governments to implement comprehensive land use planning frameworks and processes, subdivision ordinances that do not incorporate protections for water resources, and well-intended but deficient state-wide mechanisms for cultivating "watershed governance".

While Federal and State agencies have important roles to play, local governments are the key to incorporating watershed management goals and strategies into land-use planning. Since Rhode Island's cities and towns retain primary authority over land uses within their jurisdictions, their future growth decisions and the degree to which those decisions reflect watershed management policies will determine whether we achieve Rhode Island's water quality and aquatic habitat protection goals. With more proactive planning and the use of environmentally sensitive development techniques and smart growth, it is possible to accommodate new development while preserving, protecting and restoring the state's waters.

In order for local communities to exert leadership and fulfill their responsibilities in managing watersheds and protecting water quality, they will require substantially more technical and financial assistance from state and federal government. A top priority for the BRWCT is to coordinate existing fragmented agency efforts and seek the funds necessary to bring forth comprehensive, watershed management for Rhode Island.

Impervious Cover

An important, readily available indicator of how well a watershed functions is impervious cover, the sum total of the spatial extent of hard, impermeable surfaces including paved roads, parking lots, sidewalks, and rooftops. The extent of a watershed's impervious cover strongly determines the impacts of land development upon watershed health.

Years of research conducted nationally has demonstrated how impervious cover (IC) impacts hydrology, water quality, and aquatic habitat quality and biodiversity (CWP 2000, Coles 2004, Morse 2003). Higher density development significantly reduces impervious cover at a watershed scale than low-density development, for the same amount of development, (EPA 2006). This suggests that the current trend of low-density development with segregated uses creates significantly more impervious cover than necessary to meet our growth needs.

Significant stream degradation occurs when the amount of IC exceeds 10% of total watershed area. At levels of below 10% IC, the associated stream or waterbody stream is considered to be protected, between 11-25% IC it is considered to be impacted, and with an IC of over 25% it is considered to be degraded. Even when best management practices are implemented to mitigate the impacts of IC, once the 10% IC threshold is reached, predevelopment water quality cannot be maintained (CWP 2000).

IC extent is measured and quantified on both a watershed and a sub-watershed basis. The Narragansett Bay watershed currently has an overall IC of 14%, which is not surprising since it is a densely populated estuary (over 1,000 people per square mile, almost two times the density of Buzzards Bay and five times the density of Chesapeake Bay). Fortunately, as shown in Figure 3, many of the Bay's sub-watersheds are still below the 10% IC threshold and are considered healthy. Therefore, the primary objective of state watershed management initiatives should be to focus on the sub-watersheds that are still healthy and to make every effort to minimize IC to protect headwater tributary streams from the negative impacts of future growth.

> A recent study in Chesapeake Bay determined that new development was increasing nutrient and sediment loads at rates faster than restoration efforts were reducing them. Developed lands within the Chesapeake Bay Watershed contribute less than one third of the Bay loading of pollutants, but would require approximately two thirds of the overall restoration costs. This study concluded that the most cost-effective approach to reverse the trend of increasing pollutant loads from new development was by forming strong partnerships with communities to encourage them to adopt and implement more environmentally sensitive development techniques. -EPA 2007

The increase in IC and loss of wetlands and riparian buffers affects not only the water quality of our urban rivers, but also exacerbates flooding in urban watersheds. Development and redevelopment projects provide opportunities for restoration of impaired and/or lost wetlands along Rhode Island's rivers and streams. Policies and regulations that control IC, encourage wetland restoration and promote greenspace along our waterways, as provided in Land Use 2025, will contribute to water quality improvements and reductions in flood hazards.

In addition to reducing impervious cover on a sub-watershed basis, it is also critical to control the proliferation of non-point source pollution.

> *The extent and seriousness of water pollution depends largely upon how land is developed. Land use activities that generate pollutants include accidental leaks, spills, fertilizer/pesticide leaching runoff, and runoff from impervious surfaces. Forests, wetlands and naturally vegetated riparian buffers retain, transform, or treat pollutants to surface and ground waters. Natural landscape features such as soil types, topography, and riparian buffers govern water flow and pollutant pathways to surface and groundwater.*
>
> - National Academy of Sciences, 1993

The strong relationships between watershed land uses and water quality are based upon comprehensive scientific studies of how aquatic pollutants are generated and move through the watershed landscape. Non-point source pollutants such as excessive nitrogen and phosphorous occur throughout a watershed. While a single source of fertilizer run-off may not be significant, the cumulative effects of numerous small non-point sources over time will seriously degrade water quality and permanently alter aquatic habitats.

Moreover, Federal and State regulations provide little authority for state agencies to regulate directly IC at a watershed scale, nor to control effectively many of the diffuse non-point pollution sources directly related to land use. Minimizing the increase of IC in undeveloped watersheds and protecting critical headwater streams should be important policies for Rhode Island state and local governments.

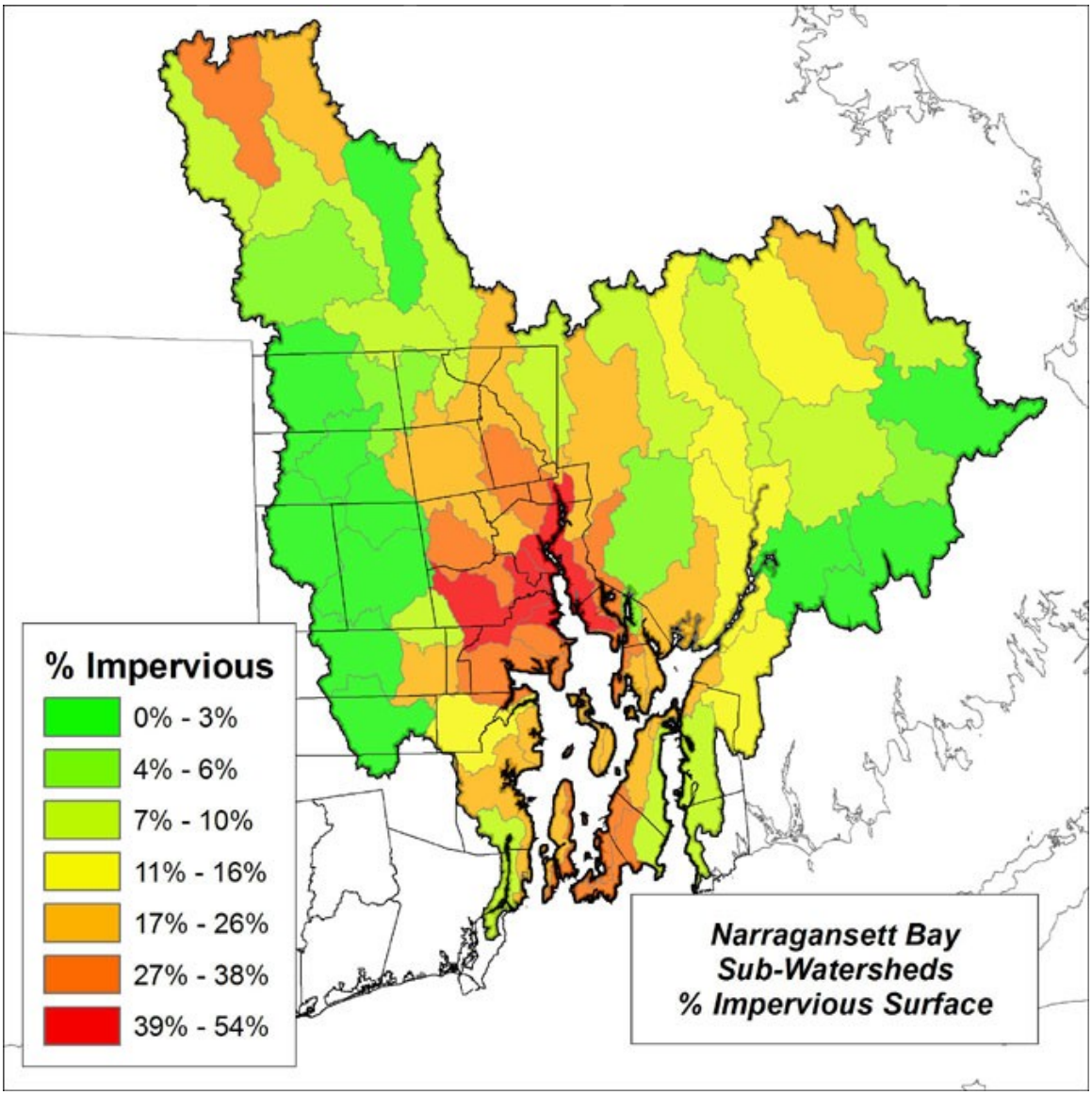

Figure 3: Narragansett Bay Watershed Impervious Cover *(DEM, 2007)*

Rivers, Lakes, and Ponds[6]

Rhode Island's rivers and their associated watersheds, including those of lakes, ponds, reservoirs, wetlands, and aquifers are vital resources. They supply drinking water. They provide critical habitat to support biological diversity. They are greenways of open space and support diverse recreational opportunities. The quality of life in Rhode Island depends on its river systems.

From a global perspective, Rhode Island is a small metropolis, an urban place of approximately a million people. Although much open space exists, all land has been fragmented, developed, or impacted by human activity; there is no wilderness. Agricultural and industrial uses of rivers have declined and the principal contemporary uses of rivers are now water supply, habitat, open space, and recreation. Rhode Island's rivers no longer support a commercial fishery.

To understand Rhode Island's rivers, lakes, ponds, and estuaries, it is helpful not to look at them individually, but to consider how the overall system of rivers and watersheds functions. In order for Rhode Island's rivers and estuaries, and their watersheds, to continue to meet varied, important, and in some respects competing needs, what must be improved, preserved, and better managed is the overall system.

Rhode Island has three main river systems. The Pawtuxet River watershed contains the state's primary source of drinking water, the Scituate Reservoir. Through the Providence Water Supply system, it serves 60% of the state's population. The Big River offers a potential and important groundwater supply reserve.

The Wood-Pawcatuck watershed, with more than fifty miles of canoe-able waterways, is a major recreational resource. It is also a sole source aquifer; via municipal and private wells its groundwater provides drinking water to most of southern Rhode Island.

The Blackstone River Valley is the birthplace of the industrial revolution in the United States. Lakes and ponds, which were created to maintain water flow for industrial power in the western portion of the Blackstone River Valley watershed, have become places of recreation within urban and suburban neighborhoods. In the eastern portion of the Valley, these lakes and ponds serve as drinking water supplies for the cities of Woonsocket, Pawtucket, and Central Falls.

The streams in the rocky uplands of western Rhode Island that drain into Connecticut ‘s Quinebaug River have once again become pristine because of reforestation. The rivers in the East Bay area and the streams and ponds on the state's larger islands are important sources of water supply although limited in quantity and vulnerable to water quality degradation.

[6] Material for this section has been drawn from the Rivers Council’s Rivers Policy and Classification Plan.

In urban areas, rivers serve as vital corridors of open space and recreation (Figure 2). The recreation potential and open space value of the Pawtuxet, the Woonasquatucket, the Blackstone, the Runnins, the Ten Mile, and the Saugatucket Rivers, and their estuarine regions, are being explored and developed in a manner that will improve the health and amenity to the communities through which they pass. Habitat and fisheries restoration efforts are targeting these river systems with strong volunteer and technical support from local Watershed Councils.
River headwaters and tributaries connect watershed land uses to the rivers. Headwater streams, which are short and often so narrow that a child can straddle them, are often overlooked because most are not mapped or named, and they often flow intermittently. However, it is critical to protect these small streams (CWP, 2007). Approximately 60-75% of the stream miles that connect to Narragansett Bay (introducing about 2 billion gallons of fresh water daily into the Bay) are headwater streams. Inventory and prioritization of these headwater streams remain critical state-wide tasks. The Water Resources Board has identified the importance of mapping perennial and inter-annual streams and in 2004 USGS developed a proposal to do. This is still an important assessment project awaiting funding.

The protection of headwater streams is essential to achieve water quality objectives in the larger rivers they feed, and in Rhode Island's coastal waters. These headwater streams are extremely vulnerable to direct and indirect impacts of land use and many are located in areas that are experiencing high rates of growth. Headwater streams are less likely to be adequately protected from new growth by Federal, State and local regulations than larger stream and river systems (CWP, 2007).

Land-Use Planning to Protect Watersheds and Freshwaters

The1992 Narragansett Bay Land Use and Water Quality Management Report stated:

> *Given the twin postulates that: (a) land use significantly affects water quality and that (b) land use is determined by zoning, it is apparent that local land use both in statute and administration, will play a critical role in protecting or failing to protect the Narragansett Bay Watershed.*

In the sixteen years since this report, state agencies such as the Department of Environmental Management (DEM) and the Division of Planning have provided local governments some assistance and guidance to strengthen local land-use management. But there has not been a comprehensive effort to provide the community land use assistance that was recommended by the Narragansett Bay Project. Since most of the vulnerable headwaters are located in areas of the state that have experienced significant growth, it is reasonable to assume considerable increases in water quality and habitat impairment problems due to development that has occurred throughout the state since 1992. Rhode Island's water quality impairment problems are assessed in the section on Water Quality.

Local communities must protect rivers and their watersheds by guiding growth to those landscape areas most suitable for development, and steering growth away from landscapes whose geological and hydrological characteristics will result in non-point source pollutants being transported unmitigated to surface and ground water. Strategies such as Low Impact Development (LID) and Conservation Development have been developed and piloted in Rhode Island first through the efforts of DEM's Sustainable Watersheds Branch, and more recently CRMC's waterfront development policies, both with important support from Grow Smart Rhode Island. These strategies are based upon improved understanding of the associations between specific development patterns, geomorphologic characteristics and water quality and habitat degradation.

In order to help communities and developers make informed land use decisions, the Rhode Island Geographic Information System (RIGIS) provides maps of many of the areas that entail a high non-point source pollution risk. These maps are an important tool for communities that wish to use their land use authority to guide future growth. Rhode Island should invest in their creation and dissemination for communities that still lack them. [7]

Relatedly, the State Guide Plan for land use, *Land Use 2025*, directs the State and communities to concentrate growth inside an Urban Services Boundary and within locally designated centers in rural areas. It further directs communities to pursue significantly different land use and development approaches for urban and rural areas to reduce pressure on farms, forests, green fields and thus helping reduce impervious cover.

Despite the emergence of sprawl development patterns over the last decades, *Land Use 2025* states that:

> *The distinction between Rhode Island's historic urban centers and neighborhoods and their rural natural surrounding areas is still strong. It remains the most important feature of the state's land use pattern.*

Land use 2025 emphasizes that "achieving a sound policy for appropriate growth in urban areas will allow us to preserve more of our rural landscape. "Encouraging and re-directing new development into areas located within the "urban services boundary" (Figure 4) will not only preserve Rhode Island's rural landscape, it will also enable us to attain in the most cost-effective manner watershed management goals regarding riparian buffer protection, impervious cover controls, and stormwater management. Land Use 2025 establishes 25 objectives and over 90 strategies, under the goals for sustainability, green space, community design, infrastructure and implementation. That the following "priority objectives" of *Land Use 2025* align closely with watershed management and river protection goals demonstrates the growing integration of comprehensive evaluation and strategic planning processes

[7] The USGS in an extensive national review concluded that land use and landscape characteristics could reliably be utilized to identify areas on a given parcel of land that presented the highest risk of contamination from development (Nolan et al. 1997).

for development, land resources, and aquatic environments being pursued by the BRWCT agencies:

- Sustain Rhode Island's unique character through use of the Urban Services Boundary, rural centers, and holistic approaches to planning.
- Permanent Greenspace throughout the rural, urban, and waterfront areas.
- Development concentrated in well-designed centers, neighborhoods and special places.
- Public infrastructure maximized and coordinated with development.
- Reform of the property tax system in a manner that supports this plan.
- Excellent land use information and technology systems.

Overall, through the combined efforts of DEM, Statewide Planning, CRMC, and the Water Resources Board, Rhode Island needs to develop science-based land use management techniques and development standards and support and compel their implementation by municipal governments. It is essential that local land use authorities have access to the information and assistance they need to plan responsibly, make informed decisions, and implement watershed protection strategies (Groundwater Protection Council, 2007) in conjunction with the goals established in *Land Use 2025*. Without such resources, any attempt to mandate improved watershed and land-use management by local government will falter. In Rhode Island, and throughout the Narragansett Bay watershed located in Massachusetts, the day-to-day decisions that affect watershed health are typically made by dedicated, but insufficiently trained, volunteers on local planning and zoning boards, who turnover rapidly. Well-intentioned local decision makers may wish to consider fully the potential impacts of a proposed land use activity to water quality, but do not always use or fully understand the technical and resources data needed to delineate and generate support for resource protective decisions; decisions often perceived as inhibiting or blocking development proposals that are fiscally attractive and, hence, politically popular.

Rhode Island must expand community outreach by state and federal entities and partnerships. Achieving water quality and habitat goals for Rhode Island's waters and watersheds will require much better linkages between local decision-makers and state and federal sources of development planning and technical expertise and support.

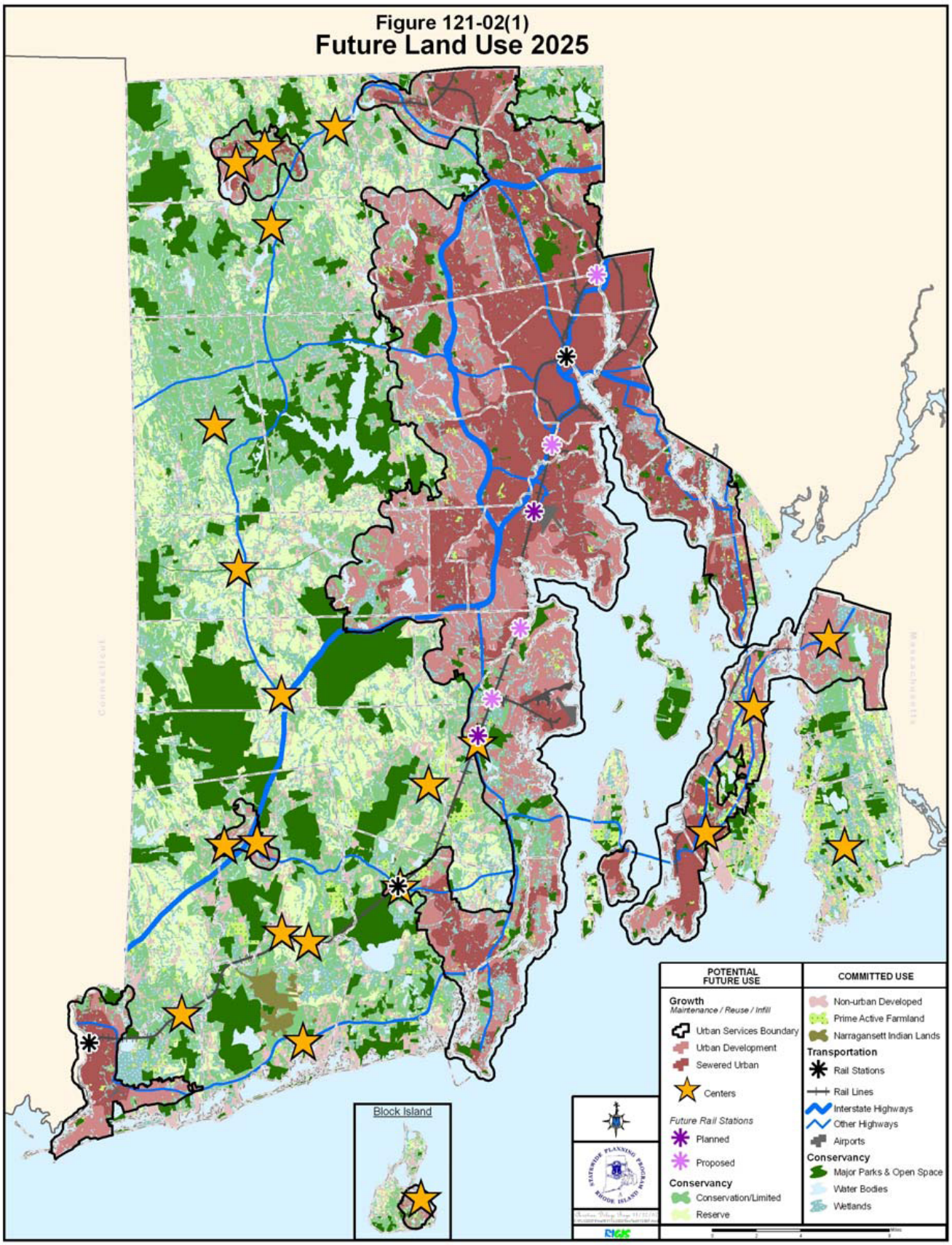

Figure 4: Land Use 2025 Vision for Future Land Use. (Best if viewed in color.)

There are currently millions of state and federal dollars available as low-interest loans through federally and state-financed revolving loan funds for wastewater treatment facilities located on Narragansett Bay and its watersheds. In contrast, woefully inadequate funds are available to fund the significantly more cost-effective and environmentally sound watershed protection measures. In contrast to Rhode Island, Massachusetts has invested over $17.5 million to provide technical and financial assistance for community land use planning activities since 2000. In particular they have allocated $3.5 million in smart growth technical assistance grants to help municipalities improve their land use practices to achieve consistency with Massachusetts Sustainable Development Practices (Kurt Gaertner, Director of Land Use Policy MA EOEA, 2007 personal comm.). Currently, no single agency or organization in Rhode Island has the staff, resources or statutory mandate to lead an effort similar to that in Massachusetts. In particular, the lack of a clear mandate is a key reason why this issue has not received the attention required.

However, it will be very challenging to enhance such state/local partnerships given historical and continuing decreases in state agency staff and operational capacities, stagnant federal support for such programs, and the reluctance and fiscal inability of municipalities to contribute effectively to achieving state and regional water quality and habitat goals through the exercise of local land use authorities due to the absence of stronger state mandates and enforcement efforts.

Nevertheless, Rhode Island would be wise to heed the lessons learned in Chesapeake Bay, where billions of dollars have been spent on wastewater treatment facilities only to have the benefits of these investments negated by failing to manage subsequent watershed land uses.[8] The BRWCT considers it a top priority to facilitate State and local government partnerships to better manage watershed development patterns and to advocate at all levels of government for the technical, financial, and legal resources and capacities that Rhode Island needs to protect its watersheds, lakes, ponds, streams, and rivers by growing greener and smarter.

[8] For more on recent assessments showing little overall improvement in Chesapeake Bay water quality despite major point source control investments, go to: http://www.chesapeakebay.net/

Table 2: Watersheds Strategy

Goal: *Rhode Island's watershed ecosystems will be healthy and their natural functions maintained.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
Complete attainment of water quality standards and the prevention of water quality degradation for Rhode Island's rivers, streams, lakes and ponds.	Work with local governments to establish their most important priorities for protecting natural resources with strategies such as participation in a regional green space protection strategy.	Work with local governments to develop "community asset maps" that identify and prioritize natural, cultural, and recreational resources, including headwater tributaries and ground and surface water supplies.	**DEM**, DOP, CRMC	1-4 years
		Use community asset maps to educate communities on developing planning processes that consider natural, cultural, and recreational resources in comprehensive plans and development reviews.	**DOP**, DEM	Ongoing
		Integrate community asset maps into a single state GIS system.	**DOP**	1-5 years
	Establish and promulgate green development standards and land use techniques to protect fresh and marine water quality.	Expand technical assistance and seek additional financial support to help communities implement green development standards and land use techniques.	**DEM**, DOP, CRMC, RIRC	Ongoing
	Expand local and state-wide protection of riparian buffers, freshwater wetlands, brackish wetlands, and salt marshes.	Expand grants and technical assistance to protect and restore riparian buffers and wetlands, particularly in urban watersheds.	**DEM**, CRMC	Ongoing

Table 2: Watersheds Strategy

Goal: *Rhode Island's watershed ecosystems will be healthy and their natural functions maintained.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
	Increase the capacity and emphasis of state, federal, and non-profit land acquisition programs to protect critical headwater parcels.	Grant proposals should be assessed with greater consideration for land acquisitions that protect healthy headwater streams.	**DEM**, DOP	1-2 years
	Minimize impervious cover to prevent stormwater runoff from impairing water quality and habitat.	Work with municipalities to update zoning ordinances to allow for reductions in impervious cover.	**DOP**	1-4 years
Future land-uses and development that fully protect and restore watershed resources, habitats, and freshwater resources.	Develop incentives and requirements for local government permit reviews and land-use decision making to address cumulative impacts to water quality.	Evaluate and expand as necessary state authorities relative to gaps in local land use authority to prevent cumulative water quality impacts from growth.	**DEM**, CRMC, DOP, WRB	1-4 years
	Provide incentives for local governments to adopt compact growth techniques such as village centers and conservation development.	Target applicable grant funds for infrastructure improvements, recreation and housing needed to support compact growth. Streamline permitting processes for projects that bolster growth centers or incorporate conservation development techniques	**DOP**, DEM, WRB, DOH	1-2 years
	Maximize the utilization of existing infrastructure and developed sites in order to reduce development pressure on green fields and critical watershed areas.	Evaluate the capacities of existing infrastructure systems to support the planned and/or anticipated build-out at local and regional levels. Target grant funds for infrastructure improvements to local growth centers.	**DOP**, DEM, WRB, RIRC	Ongoing

Table 2: Watersheds Strategy

Goal: *Rhode Island's watershed ecosystems will be healthy and their natural functions maintained.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
	Ensure that future development occurs where there is adequate freshwater supply to support it.	Develop appropriate development review requirements to link development with available water supplies and educate communities on their use.	**WRB**	1-2 years
Timeframes: For many listed actions additional funding will be required for successful completion.	Ongoing: Action is currently being pursued by one or more agency. Additional funding may be required for completion.	1-2 Years: With adequate funding, action should be completed within 1-2 years. 1-4 Years: With adequate funding, significant progress on the action will require ongoing efforts over the next 4 years.		

RHODE ISLAND'S WATER-RELIANT ECONOMY

> *It is clear that in the years and decades ahead, those communities with a reliable water supply . . . , those that encourage dense development within urban growth boundaries surrounded by open space, healthy forests [and waterways, and productive natural resources]; those that develop diverse, locally distributed sources of energy: those communities are the ones that will flourish.*
>
> – Spencer Beebe, Ecotrust

Rhode Island's marine and freshwater resources have always been central to its economy, culture, and quality of life. From the birth in the early 1800's of the American industrial economy in the textile mills of the Blackstone River Valley, which relied upon water power and water-based transportation, to the substantial naval defense facilities and research and technology development centers of present-day Aquidneck Island, to commercial and recreational fisheries and aquaculture that contribute at least $170 million a year in direct value to the state's economy, to a multi-billion dollar tourism and recreation sector, Rhode Island's oceans, rivers, and groundwater are as important to Rhode Island's economy today as they were during the state's founding.

Broadly, Rhode Islanders recognize that numerous linkages exist between environmental quality and economic vitality in the state's contemporary knowledge and services economy. But, like many other states, Rhode Island does not assess and invest in environmental assets and economic development strategies in a holistic manner. Hence, as the RI Senate Policy Office pointed out six years ago with regard to the state's marine economy:

> *Resource managers and policy makers have insufficient guidance to fully coordinate the relationship between marine resources, the marine-related economy, and the overall economic development strategy of Rhode Island. As a result, Rhode Island's marine economy shows signs of neglect. The configuration of relevant government agencies is inadequate. Economic data and analysis are scarce. Underlying statutes are antiquated. Coordination among entities is poor.*

Rhode Island continues to make major investments to promote water-reliant economic development, such as improvements in wastewater treatment to maintain water quality essential for tourism, recreation, and fisheries, maintenance and upgrades to state piers that support the commercial fishing industry, the Providence River Channel Dredge Project, and upgrades in 2002-2004 to the state's commercial fisheries management regime. Nevertheless, marinas and port facilities are being squeezed on the waterfront by competing uses, and commercial fishermen struggle to keep their enterprises afloat in the face of exploding fuel costs.

Finally, Rhode Island will need to grapple with major challenges to its economy due to the inter-related consequences of climate change, sea-level rise, and intensifying worldwide demand for fossil fuel resources whose future global availability (and

resulting price increases) may become more restricted than presently assumed by government and industry. Together, climate change and higher fossil fuel prices may necessitate urgent economic and management reforms and infrastructure re-development investments in order to maintain and grow Rhode Island's water-reliant economy. Rhode Island's dense development patterns and compact geography should offer distinct advantages in a future with higher fossil fuel costs, if it invests in forms of public transit (including water-based transportation) that serve the needs of both commuters and visitors to the state (RI Economic Policy Council, 2008) and other energy conservation measures.

Rhode Island's water-reliant economy consists of three main components:

Water-dependent sector: This sector depends on waterbodies or their close proximity for its economic viability. It consists of the following subsectors: marinas; water transportation and related activities including sightseeing; boat dealers; fish/seafood wholesalers; ship & boatbuilding; seafood product preparation; fishing and aquaculture; water & sewer construction; and water & sewer systems management. This sector generates approximately 6,500 direct jobs and approximately $279 million in employee wages for the state. In Rhode Island is growing 2.6 times faster than the sector is on a national basis.

Water-related sector: Waterbodies are a contributing component (either direct use or indirect use such as aesthetics), but this sector could function without direct access to them. Components of this sector may also be tied to the water through historical legacy but over time their dependence on it has lessened. It consists of several subsectors: Navy bases and research centers, and supporting technology contractors; water-based tourism and recreation; real estate and real estate development; education, advocacy and regulatory activities, and marine trades. In Rhode Island, this sector generates approximately 16,000 jobs and payrolls in excess of $918 million. The defense industry is the primary driver of this sector, representing 12,400 jobs and $842 million in wages. The second largest component is coastal tourism associated with the summer season with 2,852 jobs and $51 million in wages. Comparisons to national or regional sectors are difficult within this sector because of the lack of comparable data for other states.

Watershed sector: While all human activities require a supply of fresh water, this sector is defined by industries that rely on particularly large volumes of fresh water for production– two or more times the median water usage per employee.[9] This sector generates approximately 14,500 jobs and approximately $636 million in direct wages. This sector is dominated by manufacturing firms; intensive water use manufacturing represents approximately 26% of the state's manufacturing employment and 28% of the manufacturing wage base. The largest and fastest growing component is companies with chemical and/or biological processing capabilities. The state's focus on developing the biotechnology sector could substantially increase this sector of Rhode Island's water-reliant economy.

[9] For additional details see the BRWCT Economic Monitoring Collaborative FY 2007 Annual Report.

Each main sector of Rhode Island's water-reliant economy will benefit in different ways from improved aquatic resource management and restoration, in terms of both enhanced environmental qualities and improved governance built upon EBM systems perspectives. Each sector in turn offers compelling economic justifications for investing in environmental and resource quality. There is little dispute at any level of government that the watershed sector will benefit directly from improvements in freshwater supply systems as discussed in the following section "Water Supply". The water-dependent sector relies as much upon wise, multiple use waterfront redevelopment and management as it does on high environmental quality, as discussed in the section "Waterfront and Coastal Development". The well-being of components of the water-related sector such as coastal recreation and tourism depend heavily on *perceptions* of environmental quality and "quality of place."

Two subsectors of Rhode Island's water-reliant economy deserve particular mention, Marine Trades and Coastal Recreation and Tourism.

Marine Trades

The Rhode Island Marine Trades sector is comprised of more than 7,000 employees working at over 700 companies. It presents multiple growth and employment opportunities as detailed in a variety of state economic development plans and job growth goals.

While many of the companies involved with marine trades do not have waterfront locations, they need ready access to facilities that are located on the water to perform the needed repairs, or to handle materials delivered through the ports. The importance of preserving existing industrial waterfront sites, and expanding industrial waterfront site availability through coastal brownfields redevelopment, has already been discussed in the previous section, "Waterfront and Coastal Development".

Broadly, there are three types of companies in Rhode Island's marine trades sector: boat builders, waterfront repair and service facilities and specialized marine service businesses that cater primarily to providing service and equipment for boats.

Currently, only a few of Rhode Island's boat builders are located on the waterfront, but as they move toward building larger, more profitable and labor intensive boats, the need for direct access to the water and launching sites will become more evident. Moving larger boats and other marine-related products such as masts over public roads is difficult and expensive.

As discussed previously, a major challenge to marine trades from residential and other types of non-marine waterfront development such as condominiums and resort hotels. While the boat slips may remain in place, the waterfront lands are no longer available for maritime uses such as boat repair. This forces the boat owner to move the boat to other facilities for service repairs and off-season storage. For example,

the proposed 1,500 slip Weaver Cove Marina in Portsmouth has very little land area devoted to marine service facilities.

The service and repair work generated both by boats moored here and boats that transit through Rhode Island's waters supports many of the high skill, high paying jobs offered by the marine sector. If Rhode Island's boat repair and services companies are to grow, affordable access to the waterfront sites will be vital. While smaller vessels may be serviced inland, it is not cost-effective or practical to move larger boats inland for service. Waterfront haul-out locations and near-by lay-down areas are vital to expanding marine service operations.

Given the expected continuation of strong demand for waterfront real estate, cities and towns will continue to seek property tax revenue growth by rezoning waterfront real estate to favor the types of development that increase property assessments. While for some waterfront sites this may be appropriate, the risk over the long run is that the rezoning to residential and mixed use may drive out water-dependent businesses due to conflicts over noise, light traffic etc. with neighboring property owners and the higher property values that come from residential uses.

Recreation and Tourism

Rhode Island's tourism industry and the assets that support it have become critical to the state's economy and a major basis for its unique quality of place. Rhode Island has long based its appeal to visitors on its extensive natural and cultural resources. Water-related resources and amenities are indispensable to the Ocean State's tourism industry. The sustainable development and utilization of these resources is a priority for the Economic Development Corporation's Tourism Division.

For the past several years the National Geographic Society has prominently advanced the concept of *geotourism*, which they define as "tourism that sustains or enhances the geographical character of a place - its environment, culture, aesthetics, heritage, and the well being of its residents." As so defined, geotourism captures how Rhode Island promotes and positions the state's natural and cultural assets; and there are numerous examples of public, public/private and private sector initiatives in Rhode Island that fit the geotourism definition. Rhode Island has long been a national leader in areas such as historic architectural preservation, land and coastal conservation, and cultivating and celebrating a rich cultural heritage.

A similar effort dedicated to what is referred to as "civic tourism" is underway, with support from the Blackstone Valley Tourism Council and other Rhode Island regional tourism councils. Civic tourism seeks to re-focus the economics of tourism on "place-based, restorative market policies" that help local communities re-develop without eroding or losing altogether their distinctive historic and natural qualities. Civic tourism targets tourists that embrace greater civic engagement with the communities they visit. And civic tourism calls for tourism practices and development that "invests

in the story" and upholds and restores those natural, civic, and historic values of places and regions that teach and revive their visitors.

Rhode Island is continuing to promote water-related activity through its "Jewels of the Bay" initiative, which links visitors and residents to hundreds of recreational activities and businesses. Dozens of small boat rental venders and dive shops offer equipment and instruction to thousands of visitors that seek a canoe or kayak experience. Well-known dive sites in Rhode Island's coastal and marine waters present unique and varied undersea encounters for undersea divers. Excursion boats feature tours, off shore educational expeditions, dinner cruises, as well as water taxi passages throughout Rhode Island's coastal waters. Water-based transportation systems that could commuters and tourists alike continue to be difficult to maintain without public subsidies. The popular high speed ferry service from Providence to Newport will expire after the 2008 season if federal funds that have supported it for the past several years cannot be replaced.

Newport, Providence, Warren, and Bristol are the ports of call for more than sixty passenger cruise ship arrivals annually. Several cruise ship companies originate their itinerary from Rhode Island locations. Nearly one hundred Rhode Island charter boats take visitors to the what are considered the finest off shore fishing locations in the Northeast U.S. Regularly scheduled party boat fishing excursions offer visitors a deep-sea fishing opportunities at affordable prices. Rhode Island shores are popular locations for surfcasters or recreational shellfish diggers.

An estimated 3 million beachgoers visit Rhode Island's public beaches annually. Rhode Island's strong reputation for fresh seafood continues to draw visitors to the state as the tourism industry increases efforts to promote the state's culinary assets, particularly local foods.

Nature-based tourism opportunities have emerged with assistance from URI, the Audubon Environmental Center of Bristol and Save the Bay of Providence. Rhode Island's rivers offer boating opportunities, such the Samuel Slater Canal Boat on the Blackstone River in Central Falls. The lighthouse keepers program at the Rose Island light in Newport draws hundreds of visitors to Rhode Island's waterfront.

A wide variety of regattas, boat races, and boating events such as tall ships, black ships, and waterfront boat events draw visitors from North America and abroad. In turn, they generate substantial business for Rhode Island's hotels, restaurants and other attractions. The state's pristine waters also attract sporting events such as the Iron Man competition, which begins with a swim in Block Island Sound. A variety of rowing competitions, including the state's greenway challenge, also are very popular.

Local communities continue to emphasize water-based events that attract both residents and tourists. *Waterfire*, the single most popular waterfront event in held in the state during the last decade, has attracted more than one million visitors to Providence and generated international attention for the city and the state.

National studies show that authentic natural and cultural assets continue to gain in popularity as determining factors in vacation decisions, particularly for well-educated travelers who are interested in "green" vacations and geotourism. The state's reliance on such visitors makes aquatic resource sustainability a key issue for its tourism and recreation industry.

Demand for new bay and river-related tourism and recreation is expected to grow. For example, visitors are seeking more "hands-on" experiences such as working with a commercial fisherman or on environmental restoration projects. As interest in aquaculture increases so does the curiosity of the traveling public. Nearly any place there is water there are opportunities to create tourism opportunities attractive to today's and tomorrow's "geo-tourist."

Beaches

Beaches, both salt and fresh water, are among the most heavily used recreational resources in the state. A 2002 survey of public recreational demand (see *Ocean State Outdoors: Rhode Island's Comprehensive Outdoor Recreation Plan*) disclosed that two-thirds of Rhode Island residents visit beaches for an average of 31 days annually. The same survey disclosed that almost 30% of those surveyed thought that Rhode Island was deficient in how well its salt and fresh water beaches met demand. When asked to rank 27 types of recreational facilities in terms of "unmet needs", salt water beaches ranked 4th and fresh water beaches ranked 6th. To further highlight the importance of this recreational resource, 97% of respondents said that providing public beaches was either a somewhat or very important service of DEM.

Public Infrastructure for the Water-Reliant Economy

Like much of the United States, Rhode Island's public infrastructure will require major rebuilding and renovation over the coming decades. Together, Rhode Island's state and municipal governments must design, finance, and implement renovations or expansions of infrastructure for water supply, wastewater and stormwater treatment, waterfronts, coastal shorelines, maritime navigation, and coastal roadways. The provision of infrastructure is one of the most important functions to be carried on by any government but infrastructure is not limited to state government responsibilities it also includes responsibilities shared among all levels of government and the private sector. The need for planning for infrastructure is increasing, as increasingly complex development applications require a systematic basis for standards and guidelines for evaluation and approval. Utilities, communities and state agencies have to respond to ever more complex regional water and air quality requirements and affordable housing obligations.

The term public infrastructure should be re-defined to include enhancements to "natural" or "ecological" infrastructure as manifested in habitat restoration and or wetlands protection. Certainly wetlands and riparian buffers provide important values

which, in their absence, perforce must be supplied by engineered systems. The water purifying, flood absorbing properties of wetlands exemplify important ecological infrastructure which must be replaced with human-engineered systems once they are degraded or eradicated.

Of course climate change and sea-level rise, will force DEM, CRMC, NBC, and the Division of Planning to identify and require infrastructure renovation and replacement designs that incorporate their expected impacts.

Dredging to maintain navigation

Adequate channel and harbor maintenance is essential to maintaining the vitality of Rhode Island's harbors, ports, and marinas. Rhode Island recently completed the re-dredging of the Providence River Channel and the development and operation of confined aquatic disposal (CAD) cells that provide affordable means for marina and harbor dredge maintenance projects to dispose of contaminated sediments.

With leadership from CRMC, a "State Dredge Team" consisting of regulatory officials from CRMC, DEM, and the U.S. Army Corps of Engineers meets regularly to review dredging needs and proposed projects, and serves as an excellent example of how interagency collaboration enhances permitting reviews and project implementation. Detailed information on dredging projects for federal navigation channels in Rhode Island is available from the Army Corps of Engineers New England District state updates.

Dredging activities in Rhode Island waters consist primarily of the improvement or maintenance of previously dredged areas. (There has been some creation of new dredged areas associated with terminal expansion in the Providence Port area made feasible by completion of the Providence River Channel Dredging Project.) Dredged materials management by state law must consider beneficial re-use as the first means of disposal. Unfortunately, most dredged materials produced in Rhode Island are high in silt content, limiting re-use opportunities. Rhode Island needs to move forward with plans for a land-side dredge material processing facility in Quonset that will enable storage of materials that are needed to mix with silty dredged materials in order to make beneficial re-use feasible.

Contaminated sediment disposal has been greatly facilitated by the Providence River confined area disposal (CAD) cells created when the Providence River Channel was re-dredged. The Providence River CAD cells provide essential disposal options for maintenance dredging for smaller and larger projects located in Rhode Island waters. At current rates of disposal of approximately 100,000 cubic yards annually, the capacity of the CAD cells will be exhausted approximately in 2011. Planning for additional CAD cells, potentially located closer to geographic centers for dredge activity, needs to begin immediately in order to ensure additional CAD cells are available in the future. (D. Goulet, 11/27/07 presentation to CRMC)

Offshore sediment disposal occurs at Site 69B located northeast of Block Island, a long-term dredge disposal site. It serves as a disposal option for large projects as material testing requirement costs average $100,000, thus generally limiting use of the site to projects with at least 30,000 cubic yards for disposal.

Developing a Database of Rhode Island's Expenditures on Water Infrastructure

Per its statutory mandate, the BRWCT Economic Monitoring Collaborative has provided an initial report on "public expenditures for infrastructure to support" the water-reliant economy which can be found in Appendix G of the FY07 Economic Monitoring Collaborative Report. In this initial attempt to collect data on public expenditures water infrastructure, the complexity and magnitude of this task became more apparent. The expenditures included in the FY 2007 report are capital expenditures and selected non-personnel operating expenses for state fiscal years 2005, 2006 and 2007. Expenditures were categorized for: water quality and availability improvements, recreational opportunities/access, and/or other economic development activities that directly support water-reliant economic activities. The process of collecting the data revealed important issues for consideration in future years of monitoring:

Data context is essential: Although limiting data collection to recent years was required to manage project scope, the resulting data generally could not reveal a full picture of an individual project's full cost, or how the funds were allocated compared to the amount of project funds requested. Further, the three year window of project costs collected could not reveal much regarding anticipated future costs, including required maintenance.

Difficulty of Isolating Federal, State and Local Expenditures: It is difficult to isolate Rhode Island's expenditures from related federal and local match expenditures. Further, it is difficult to collect data on municipal expenditures unless there was direct state match to which it was directly linked.

Potential Use of the Data: Public expenditure data and data analysis for infrastructure critical to Rhode Island's water-reliant economy may need to drill down first into specific program or project, with detailed project data then being collected and organized over time into a single database. A project orientated approach would enable the BRWCT Economic Monitoring Collaborative to specify the most appropriate types of expenditures to include and the time span to consider on a project basis. Aggregating available public expenditure data derived from executive agency records prevents or is insufficient for capturing important details necessary to appropriately frame future policy and funding decisions. On the other hand, data aggregation across projects will become more challenging with a more project-specific focus.

Opportunities

Whether we look at use of Narragansett Bay by vessels, development of coastal

land, or use of freshwater resources, we see an expansion of direct use by residents relative to use by industry. Although our bay and rivers are not primarily industrial, maritime companies still play important roles in job creation, diversifying Rhode Island's economy, and creating a more interesting waterfront. Policies pertaining to the use of coastal lands and water need to carefully consider how those policies influence Rhode Island's maritime economic sectors. In many cases, marine trades companies cannot exist without the water and shoreline access. How do we balance state interests in healthy, diverse maritime companies that contribute jobs and tax revenues with national demographic trends (baby boomer retirement) and local government needs that are driving the coastal real estate market? What are the tradeoffs needed to balance these diverse forces, and how should we execute such trade-offs as a state?

In addition, there are unmistakable opportunities for Rhode Island's water-reliant economy that we must consider and pursue:

Short Sea Shipping (S3): Short sea shipping (S3) entails the movement of goods (largely transported in containers) on barges or next generation high-speed coastal freighters/ferries. The principle objective of this is to reduce truck traffic on congested highways. The Boston, New York, Washington DC corridor is often cited as an attractive traffic corridor in which to deploy S3 technology given the roadway congestion, close proximity of cities, and major shipping centers. The growth of S3 could have substantial implications on Narragansett Bay and Rhode Island's ports and harbors.

Narragansett Bay, particularly Providence, could serve as the de facto terminal for Boston based on a superior logistics profile in terms of distance and time savings versus traversing the Cape Cod Canal to reach facilities in Boston. A study prepared by the National Ports and Waterways Institute for the Short Sea Cooperative Program identified Providence as a preferred location for Boston.

Although the permitting of a major container port in Narragansett Bay proved problematic, the location and operation of a S3 terminal would face significantly fewer barriers and potentially generate more vessel calls.

Growth of Aquaculture: In 2005, RI's aquaculture industry consisted of 25 farms representing 85 acres under cultivation. Farm gate value of aquaculture totaled $744,000. Since 2001, acres under cultivation have quadrupled from 30 to 123 acres.

All of RI's present aquaculture industry is based on cultivation of shellfish. There are no saltwater finfish farms in the area. However, with the anticipated growth in demand for seafood products, declines or lack of growth in wild fisheries, and a large downstream seafood processing industry still located in New England, at some point in the future saltwater finfish aquaculture may emerge. Opportunities to integrate offshore aquaculture with offshore windfarm development are currently being actively explored by aquaculture researchers (CRMC Ocean SAMP).

Ocean Renewable Energy Resources: Despite the historic presence of energy infrastructure on Rhode Island's coast, technology advancements inevitably create public controversy, as demonstrated by the Cape Wind project and the proposed liquefied natural gas terminal in Fall River. Both projects provoked political backlash and debate about potential economic dislocation for industries tied to marine navigation and recreation.

However, movement of fossil fuel energy products by water is a cost-effective way to move these products and New England will rely increasingly upon LNG to meet its future energy needs. Inherent to meeting future energy needs is siting major energy facilities (generation, storage, distribution, or conversion operations such as power plants and municipal-scale wind turbine generator fields (windfarms)) on or near coastal waters and developing the piers, berths, shore-side facilties, and other required support facilities. It may also require additional dredging of federal shipping channels.

Rhode Island's marine waters and shoreline show considerable promise as sources of renewable energy. Wind power has obvious potential in Rhode Island. Rhode Island's offshore waters offer the best sources for steady winds required to operate wind power facilities at maximum efficiency. A spectrum of technologies is being developed to harness tidal and wave energy. However, numerous generating technologies to develop ocean renewable energy sources exist already and their piloting and commercial-scale deployment is growing rapidly throughout the world's coastal oceans.

Deployment of these technologies has implications for marine fisheries, recreational activities, and maritime navigation. However, ocean renewables could become an important source of renewable energy which will grow in demand given rising oil prices and caps upon carbon emissions to combat climate change.

Successful pursuit over the next several years of CRMC's Ocean SAMP effort will be a critical step toward the development of Rhode Island's offshore ocean renewable energy resources. The Ocean SAMP's findings will need to be integrated with planning and management priorities for living and non-living marine resources impacted by ocean energy development, as well as shoreline and land-use management priorities with regard to required support facilities.

Managing potable water: Managing the supply and delivery of freshwater is a critical economic issue. While industrial and agricultural uses of water are declining, summertime residential use of freshwater has grown to the point that some important sources of supply are near capacity, and some, like the Hunt River, are over used, with observable impacts on stream flow and ecology. Tapping known supplies, for example with new well fields in the Big River, will allow pressure to be taken off stressed basins, like the Hunt, through interconnections between multiple water systems. The direct impact on Narragansett Bay of increased withdrawal and use of surface or groundwater anywhere in the watershed is a reduction in

freshwater input to Narragansett Bay which would directly impact estuarine waterbodies such as the south shore coastal lagoons.

A significant portion of Rhode Island's water supply infrastructure has aged beyond its 75-year projected service life and there is an estimated $800 million worth of infrastructure maintenance projects that will be required over the next twenty years. Investments also need to be made in system interconnections and the development of adequate reserve supply to increase system reliability.

If maintaining the water supply system is one side of the management challenge, managing demand (and checking its rate of growth in the summer) is the other. Creating a professional state-wide capability to manage demand offers a cost-effective means of assuring system reliability over time and meeting dynamic water needs. Rhode Island is a relatively water rich state and, with the right management structure, freshwater availability could become a major competitive advantage relative to other parts of the U.S.

Table 3: Rhode Island's Water-Reliant Economy Strategy

Goal: *Rhode Island businesses that rely upon aquatic resources and/or waterfronts will have the opportunity to thrive and grow.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
Recreation and Tourism: A thriving tourism industry based on world-class environmental and cultural assets. Diverse marine and freshwater recreational resources for RI's citizens and visitors.	Implement the National Geographic Geotourism Charter Principles for Sustainable Tourism.	Implement Charter via programming under development by RI EDC Tourism Division.	**EDC**	Ongoing
	Position RI's unique natural attributes and maritime history to attract national and international marine-related events and activities.	Inventory sites with sufficient dockage and moorings to support major boating events.	**EDC**, CRMC	1-2 years
	Develop alternative transportation schemes for moving people to and between coastal and watershed destinations.	Implement planned expansion of RI bike path system.	**DEM**, DOT, RIRC	1-4 years
		Promote the Blueways Alliance's Blueways program.	**DEM**, DOT	
	Maintain and expand public infrastructure for active and passive marine and freshwater recreational opportunities.	Implement DEM's "Pier-a-Year" Program. Implement RIEDC/DEM's "Jewels of the Bay" Program. Invest in the maintenance and improvement of saltwater and freshwater beach facilities and infrastructure.	**DEM,** EDC	1-4 years

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Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
	Compete nationally and internationally for large marine boating events. Promote such events as part of RI's Geotourism strategy.	Assess RI's capacity to attract major marine events, particularly current infrastructure and future infrastructure needs, marketing strategies, and in-state logistical and planning capacity.	**EDC**	1-2 years
		Connect major marine boating events to growth and well-being of boat-building, boat servicing, and boating related sectors.	**EDC**	1-4 years
		Promote Civic tourism, especially with regard to urban waterfronts and river corridors such as the Blackstone River Valley.	**EDC**	1-4 years
Boatbuilding, Shipbuilding, and Boating- Related Businesses: Ensure that Rhode Island continues to be a world leader in marine trades.	Ensure that dredging in suitable areas key to shipbuilding interests and other marine interests are done in a timely and cost-effective manner.	Begin planning for additional CAD cells in Rhode Island waters or other appropriate designated disposal sites to support dredge maintenance and improvement projects for Rhode Island's ports and harbors and navigational channels not designated as Federal.	**CRMC**, RI Dredge Team	1-2 years
		Review the need for CRMC water type revisions and related regulatory language.	**CRMC**, DEM, RIRC	1-2 years
	Support the development of marine industry sites on portions of the surplus Navy land on the Westside of Aquidneck Island.	Assist with the implementation of the Aquidneck Island West Side Master Plan.	**EDC**, DOP	Ongoing

Table 3: Rhode Island's Water-Reliant Economy Strategy

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Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
	Develop strategies to recruit new workers into marine related careers (ongoing)	- Implement workforce development strategies for all levels of employees to meet industry needs, utilizing RI EDC's industry skill gap analysis completed in Feb. 2008. - Increase industry awareness of training initiatives and the need to upgrade worker skills.	**EDC**	Ongoing
	Facilitate expansion of boat storage and marina capacity.	Support and facilitate the planning and permitting review of marina projects such as the Weaver Cover Marina Project.	**CRMC**, EDC	Ongoing
Water-based Transportation: Expanded, competitive water-based transportation of people and goods to, from, and within Rhode Island.	Comprehensive, state-wide planning and development investments for marine transportation that addresses local, state, and regional imperatives.	Develop a long-term plan for the development and maintenance of RI's marine transportation system.	**DOP**, EDC, DOT	1-2 years
		Promote water-based transportation for commuters and tourists.	DOP, EDC, DOT	1-4 years

Table 3: Rhode Island's Water-Reliant Economy Strategy

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Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
Commercial Fisheries & Aquaculture: Ensure viable businesses in commercial and recreational fishing, and in aquaculture. (See also Table 9: Fisheries and Aquaculture Strategy)	Develop creative uses for state ports and piers that provide commercial and recreational fishermen with needed infrastructure while maximizing complementary uses.	Assess present and future infrastructure needs for maintaining viable commercial fisheries.	**DEM**, EDC, DOP	1-2 years
	Assess marketing needs of RI's commercial fisheries and aquaculture industry.	Promote Rhode Island wild harvest, aquaculture, and seafood products.	**DEM,** CRMC	1-4 years
Timeframes: For many listed actions additional funding will be required for successful completion.	Ongoing: Action is currently being pursued by one or more agency. Additional funding may be required for completion.	1-2 Years: With adequate funding, action should be completed within 1-2 years. 1-4 Years: With adequate funding, significant progress on the action will require ongoing efforts over the next 4 years.		

NATURAL HAZARDS

Rhode Island is at significant risk for flooding events caused by coastal storms (nor'easters), tropical storms and hurricanes, and snow melt combined with heavy rains. It is also highly vulnerable as well to wind and wave damage caused by higher magnitude storms (nor'easters and hurricanes). Climatologists and oceanographers predict that global ocean temperatures will increase the intensity and frequency of storm events, but there is significant scientific debate as to how and whether this will occur. Indisputably, floodplain boundaries are steadily expanding due to shoreline filling and infill development, sea-level rise, increased stormwater runoff and shoreline erosion. In particular, the vulnerability of coastal and riverine shoreline development is growing as sea-level rises.

Storm and flooding impacts include the generation of increased shoreline debris during a storm event, and the potentially severe interruption of regional energy distribution (coal, oil, natural gas, and fuel) due to storm-induced damage or destruction of Rhode Island's upper bay port facilities and related energy infrastructure.

Existing coastal and riverine infrastructure, facilities, and development in general were not designed to accommodate future sea-level rise and the increased height in storm surges that will result. Erosion 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. Sections of Rhode Island's south shore barrier beaches now experience erosion rates greater than three feet per year—an average rate that could be substantially exceeded during a single major storm event.

In addition to the long-term exacerbation of coastal and riverine flooding hazards due to sea-level rise and increased precipitation and storm intensity due to climate change, these hazards will also increase due to continued development and redevelopment along Rhode Island's coast and river systems. In order to begin mitigating future property and infrastructure destruction levels, and their attendant threats to public safety, tighter controls will have to be exerted upon the development of additional infrastructure, commercial facilities, and housing situated in Rhode Island's expanding coastal and riverine floodplains. Thus, Rhode Island will have to pursue a greater range of incentives and requirements to ensure that local governments expand and consistently enforce such controls.

The growth of storm and flooding risks increases the importance of better storm surge modeling and high-resolution elevation data to update floodplain maps for Rhode Island's coasts and riverfronts. The current lack of such data and updated floodplain delineations severely hampers Rhode Island's ability to predict and prepare for future flooding events and the risks they present.

CRMC's Coastal Resources Management Program (CRMP) contains numerous provisions intended to minimize the impact of storm and flood hazards and regulate reconstruction after severe storm events. Erosion setbacks, construction of shoreline protection structures, and beneficial reuse of dredged materials all provide means for mitigating the risks of coastal hazards. CRMC has worked closely with URI's Jon Boothroyd and other partners to develop accurate, fine-scale shoreline erosion information for Rhode Island's south shore that provides a firm basis for shoreline setback requirements. Relatedly, increased natural hazards underscore the importance of efforts to prohibit or restrict development activities that disrupt long-shore and onshore-offshore migration of sand and sediments along Rhode Island's south shore. For high hazard areas of Rhode Island's coast, there is a growing public interest in outright construction bans.

CRMC, the Rhode Island Emergency Management Agency, and other government and research entities should collaboratively increase efforts to help local governments and related state programs develop and implement planning for natural hazard mitigation and storm and flood responses. Regional state federal partnerships such as the Northeast Regional Ocean Council (NROC) have recognized coastal hazard response and resiliency as a major priority for ocean and coastal governance. Rhode Island should work closely with Connecticut, southeastern Massachusetts, and NOAA and the Federal Emergency Management Agency to incorporate state and local hazard mitigation and response efforts with parallel regional efforts.

As already discussed, CRMC is looking closely at how sea-level rise will exacerbate coastal and riverine hazards. New regulations related to coastal development and new coastal construction standards based upon sea-level rise projections are urgently needed. For example, CRMC is working with the Rhode Island State Building Commission to incorporate sea-level rise into current building codes and update freeboard requirements.

River Flooding Hazards[10]

Impervious Cover and riparian buffers

The spreading of impervious cover throughout Rhode Island's watersheds due sprawl development patterns has intensified flooding events along urban rivers and streams. Current DEM and CRMC initiatives to promote wetland and riparian buffer restoration, if adequately implemented, will begin to reverse the loss of water containment areas essential to control flooding and minimize flooding damage in developed areas. Upgraded flood zone maps and other tools are essential for ensuring that redevelopment and new development are appropriately sited and permitted in order to mitigate property loss and destruction along Rhode Island's rivers.

[10] This section based in part upon material produced by DEM's Office of Compliance and Inspection.

Dams

Of the more than 600 dams located on Rhode Island's rivers and streams, approximately 204 are classified as "significant" and "high hazard" dams that have the potential to cause loss of life or extensive property damage in the event of their failure. Dams provide great benefits to the citizens of the State. The waterbodies created by the dams provide drinking water, flood management, recreation, and scenic beauty. In addition, many are surrounded by valuable wetlands that sustain a wide variety of animal and plant species. However, many of these dams, both public and private, have not been properly maintained through the years and continued residential and commercial development in the state has resulted in the re-classification of dams once considered low hazard to significant or high hazard. Many pose a significant threat to public safety and to the preservation of the State's natural and recreational resources.

DEM is responsible for ensuring that dams are managed and maintained in a safe condition. In December 2007, the Department finalized new regulations that require more frequent and thorough inspections and require dam owners to take necessary action to repair an unsafe dam. DEM is proceeding with repairs and upgrades to DEM-owned dams. Of the 204 dams in Rhode Island classified as high or significant hazard, 14 are owned by DEM's Parks and Recreation, Fish and Wildlife and Forestry Divisions (2007 Annual Report of the Dam Safety Program).

The challenges of addressing significant or high hazard dams, most of which are owned privately or by local government, have been well-articulated. The importance of addressing these challenges may be growing as annual precipitation rates increase due to climate change.

Table 4: Natural Hazards Strategy

Goal: *Human life, property, infrastructure, and natural resources will be protected against the hazards of storms and floods.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
Significantly reduced natural hazard risks to coastal and riverfront residents, infrastructure, and development.	Incorporate advancements in coastal hazards science into State and local policies.	Generate regional Light Detection and Ranging (LIDAR) topographic surveys and high-resolution bathymetry databases to support floodplain mapping and sea-level rise and storm surge modeling.	**CRMC**, RIEMA	1-4 years
		Develop accurate inundation models for Rhode Island coastal and riverine floodplains.	**CRMC**, RIEMA	1-4 years
	Enhance the resilience of existing structures in flood zones.	Adopt more stringent building standards, flood ordinances, permitting processes, and best practices that enhance the resilience of existing structures in coastal flood zones.	**CRMC**, DOP, RIEMA, DEM, RI State Building Commissioner	Ongoing
	Develop 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.	Ensure that where necessary BRWCT agencies develop and implement natural hazard mitigation plans for their facilities and assets under management.	**RIEMA**, DOP, CRMC, DEM	1-4 years
	Implement Section 145 of the RI Coastal Resources Management Program.	Coordinate with RI Builders Association to update state building code freeboard requirements and design life standards.	**CRMC**, RI State Building Commissioner	Ongoing
	Control and guide reconstruction after severe storm events to direct future development away from high hazard areas, and/or ensure that redevelopment minimizes future hazards.	Develop a pre-disaster checklist for municipalities in order to facilitate federal disaster funding.	**CRMC**, DEM	Ongoing

Table 4: Natural Hazards Strategy

Goal: *Human life, property, infrastructure, and natural resources will be protected against the hazards of storms and floods.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
	Reduce dam hazards through increased inspection, enforcement, and the rebuilding of high hazard structure.	Hire an additional dam safety inspector. Increase funding for dam reconstruction or removal.	**DEM**, RIRC	1-2 years
	Reduce impervious cover and restore wetland and riparian buffers to decrease flooding along rivers	Promote restoration of impaired/destroyed wetlands, buffers and greenspace along rivers and streams	**DEM**, CRMC	Ongoing
Timeframes: For many listed actions additional funding will be required for successful completion.	Ongoing: Action is currently being pursued by one or more agency. Additional funding may be required for completion.	1-2 Years: With adequate funding, action should be completed within 1-2 years. 1-4 Years: With adequate funding, significant progress on the action will require ongoing efforts over the next 4 years.		

FRESHWATER SUPPLY

In 1999, the Rhode Island General Assembly designated the Water Resources Board (WRB) as the state agency responsible for managing "the withdrawal and use of the waters of the state of Rhode Island" (RIGL 46-15.7). The WRB is required to define a fair and equitable allocation of water resources among users and uses, and to ensure that long-range considerations of water supply statewide are properly incorporated into short-term or local supply imperatives.

Accordingly, the WRB has initiated over the past decade a collaborative water allocation program (described below), watershed studies, hydrologic modeling efforts, drought planning and management, and planning to develop a water supply in the Big River Management Area.

WAPAC OVERALL GUIDING PRINCIPLES
(Not in priority order)

Management of fresh water resources of the state should be based on:

- *Adequate data in order to determine the capabilities of the state's water resources to support various uses and users and the quantities of water needed for these uses*
- *Long-range planning for and conservation of these resources;*
- *Optimizing conservation, water reuse and recycling;*
- *Fairness, equitable distribution, and consideration for all human uses;*
- *Matching the use of water with the quality of water necessary for each use, giving priority to those uses that require the highest quality water;*
- *Maintenance of native aquatic and terrestrial animal and plant species, populations, and communities and statewide diversity;*
- *Continued upholding of and improvement in the quality of the environment and especially of the water resource itself;*
- *Careful integration with all other social, economic, and environmental objectives, programs, and plans of the state;*
- *Allocation of water resources in a manner that provides for agricultural sustainability while recognizing the importance of other water uses.*

Specifically, in June 2002, the WRB launched an inclusive planning effort called the Water Allocation Program Advisory Committee (WAPAC), with 66 participating organizations (150 individuals) and a mandate to develop a water allocation program for Rhode Island. In 2003, WAPAC presented to the WRB 21 priority recommendations. The WRB approved six of these recommendations in 2004 to establish the framework for a full-fledged, statewide water allocation program:

- Adopt a Priority Water Use Policy.
- Create a Water Management System using a Watershed Approach.
- Continue the detailed Water Resources Inventory and expand the Water Use Data Reporting System.
- Establish a Water Allocation Program Implementation Team (to work with staff in the design of a water management system and develop a pilot project in a Rhode Island watershed).
- Establish a separate WRB/DEM/USGS Partnership to be known as the Streamflow Working Group to address streamflow issues such as: aquatic base flow and the

further development of a statewide streamflow gaging network.

- Establish an Education and Outreach Program (working collaboratively with existing public and not-for-profit organizations).

Priority Water Uses Policy
(Adopted by the Water Resources Board, March 2004)

The waters of the State of Rhode Island are a natural resource held by the State in trust for the public and subject to the State's sovereign power to plan, regulate, and control the withdrawal and use of those waters, under law, in order to protect the public health, safety, and welfare.

In order to equitably allocate the state's water resources, as stated in RIGL 46-15, preference, but not exclusive use should be given to allocation up to the safe yield as currently defined in RIGL 46-15.7-2(3) and further defined in State Guide Plan Element 722 Water Supply Plan for Rhode Island according to the following priorities:

(a) Direct human consumption or sanitation or fire suppression in so far as necessary for human survival and health;
(b) Uses necessary for the survival or health of livestock and to preserve crops or physical plant and equipment from physical damage or loss in so far as it is reasonable to continue such activities in relation to particular water sources; and
(c) Other uses in such a manner as to maximize employment and economic benefits within the overall goal of sustainable development as set forth in the comprehensive water plan [currently the State Guide Plan].

Within each preference category, uses are to be preferred that optimize the reasonable and efficient use of water. These broad principles might not be applied automatically to every basin/sub-basin of the State. Specific priorities may be established for basin level management.

The WRB's Priority Water Use Policy parallels policies established in State Guide Plan Element #721 – Water Supply Policies. Together, they establish a clear framework for discussions and decisions regarding "effective and efficient conservation, development, utilization, and protection of [freshwater] resource[s] in ways that meet the present and future needs of the state and its people." (RIGL 46-15.3-1.1)

In 2006, water usage annual reporting by the major public water supplies was initiated by the WRB. This new reporting requirement provides critical data necessary to project the adequacy of water supplies for future needs in relation to improving knowledge regarding the extent and quality of the state's freshwater resources and supplies.

The WRB website provides additional information on the Water Allocation Program and implementation of supporting tasks and projects as well as other programs, efforts and data.

Since November 2005, the Rhode Island General Assembly has been engaged in intensive discussions on Rhode Island's public water supplies, along with a diversity of stakeholders. Three legislative study committees convened to assess the state's

freshwater resources and the management and operation of public water supply systems. These commissions received testimony from local, state, and federal agencies, environmental organizations, user groups, water supply managers, water resource scientists, and water treatment experts.

The WRB website provides archived reports and policy recommendations produced by these efforts and the Coalition for Water Security website provides links to its recommendations, relevant water news and information and its organizational partners' websites.

The 2007 "Joint Hearings on Water-Related Issues" conducted by the Rhode Island Senate's Committee on Environment and Agriculture and Committee on Government Oversight, concluded that Rhode Island faces a number of challenges. Key findings of the hearings included:

- Development continues to take place in areas without substantial water supplies and storage capacity, placing greater demand on existing systems, especially the Providence Water Supply Board system.
- There is insufficient coordination of water supply availability and development planning by the state and major public water suppliers.

Three policy goals are delineated as a result of the 2007 hearings:

- Provide adequate water supplies to meet Rhode Island needs, including reasonable seasonal use.
- Secure system reliability by establishing back-up and supplemental supplies and increasing storage reserves.
- Protect environmental functioning, ground water system replenishment, stream flows and wetlands adequate to support diverse aquatic life.

This section incorporates the findings of the General Assembly in the 2007 and 2008 legislative sessions, statutes related to water system supply management and planning, most notably RIGL 46-15.7 (establishing the framework for WAPAC and the watershed approach), as well as the underlying principles regarding public trust, public health and safety.

Systems-Level Considerations

Rhode Island enjoys access to high quality freshwater resources that for most of the year provide sufficient quantity to meet human needs and support natural systems (flow in water bodies and groundwater levels). Rhode Island has abundant supplies of ground and surface fresh water, receiving between 39 and 54 inches of precipitation annually to replenish these supplies under normal conditions. However, water is not always located where it is needed or available in sufficient quantities for all uses at all times. Freshwater may become contaminated, and public drinking water is routinely used for purposes not requiring water of drinking water quality. The long-term considerations regarding Rhode Island's freshwater resources center on:

- o Sustainable use and protection of the state's freshwater resources for human and environmental needs;
- o Ensuring reliable, ample drinking water supplies; and
- o Ensuring efficient freshwater use for human needs.

The health, safety and economic well-being of Rhode Islanders depend on safe and predictable quantities of freshwater, potable (water that is safe for human consumption) and non-potable. Non-potable sources (direct withdrawals from natural waterbodies, or farm ponds) support the generation of electricity and agricultural uses. In 2000, according to the US Geological Survey, thermo-electric power generation accounted for 68% (293 million gallons per day (MGD)) of non-potable water used each day in Rhode Island. Domestic, industrial, and irrigation potable water uses accounted for 32% (136 MGD) of total daily freshwater and brackish water utilization for a total consumption rate of 429 MGD.

Potable water is delivered to Rhode Islanders via 480 public water systems. Rhode Island's public water supply "system" consists essentially of thirty, independently operated large systems that together supply 98% of the state's public water supply (136 MGD) (Figure 5). The largest of these systems were developed decades ago to support Rhode Island's 20th century population and manufacturing centers. More than half of Rhode Island's thirty largest water supply systems are municipal and six are regulated by the Public Utilities Commission (PUC) (Table 5). The largest 28 systems must prepare five-year water supply management plans that are reviewed by the staffs of WRB, DEM, the Rhode Island Department of Health (DOH), Division of Planning and the PUC (for PUC-regulated water utilities).

Category	Number of Systems
Municipal Departments that produce and deliver water regionally (**Pawtucket, Providence, Newport, Woonsocket**)	4
Municipal Departments that purchase water and deliver it within a municipality: (East Providence, Johnston, Lincoln, Narragansett, Portsmouth, Smithfield, South Kingstown, Warwick)	8
Municipal Departments that produce and deliver water within the municipality (Block Island, Cumberland, Jamestown, North Kingstown, Richmond, Westerly)	6
Regional authorities covering two or more municipalities: (**Kent County Water Authority**, Bristol County Water Authority)	2
Special districts, usually serving part of one municipality: (East Smithfield, Greenville, Harrisville, Kingston, North Tiverton, Pascoag, Quonset Development Corporation, Stone Bridge, URI @ Kingston)	9
Private companies: (**United Water Rhode Island**)	1
Total**:**	30

Table 5: Types of local water suppliers in Rhode Island.
(Water rates of those water suppliers noted in bold are regulated by the PUC)

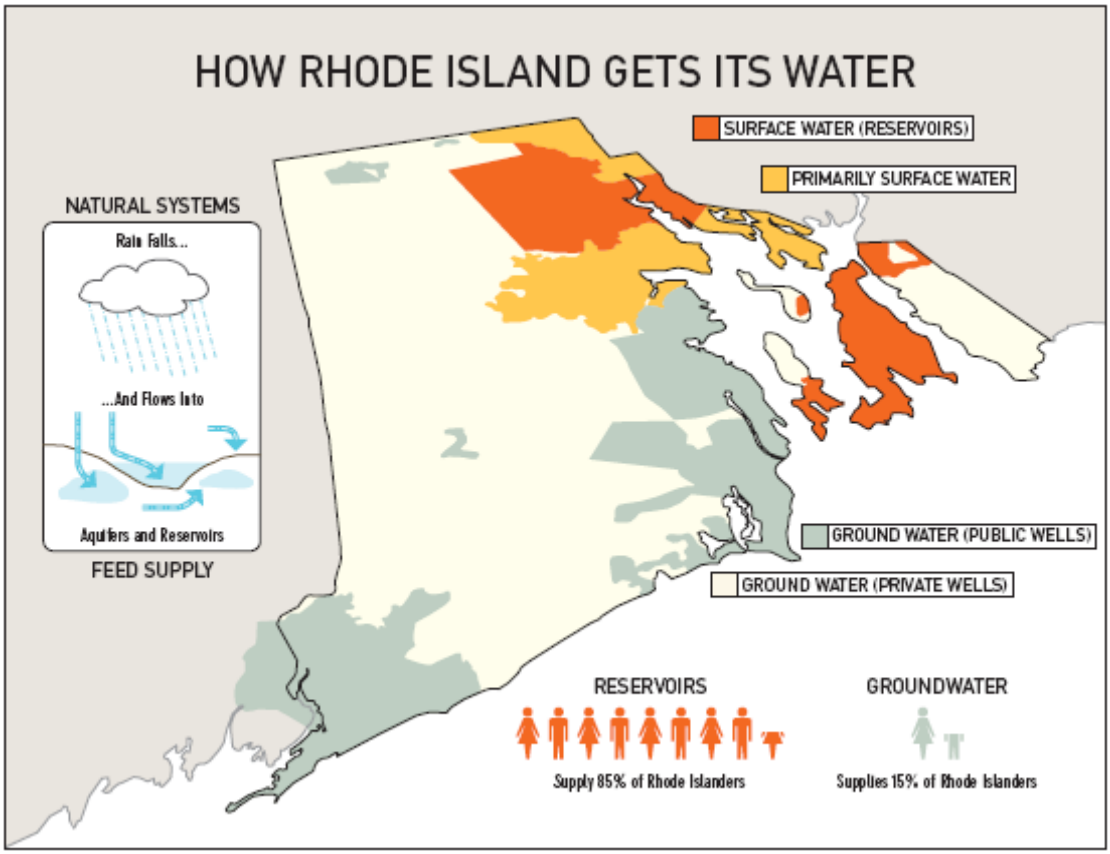

Figure 5: Overview of Rhode Island's Drinking Water Supply Sources.
(Illustration produced by the RI Economic Policy Council, 2007, using WRB/USGS data sources)

Sustainable Use and Protection of the State's Freshwater Resources

The amount of water that exists in rivers, streams, public supply reservoirs and groundwater varies over time, and with climate and water use patterns. The amount that can be directly drawn or intercepted for human use while supporting the environment can also vary, particularly for groundwater withdrawals and direct stream withdrawals. Management structures and public policy should identify when there are insufficient supplies to fulfill all uses and, if so, which uses should be given priority. Under the current management and decision structures, local water suppliers, cities and towns and state agencies determine water availability on a project basis.

At the local level, development decisions are based on supplier capacity and local regulatory processes (subdivision regulations, zoning, etc.). State decisions are also made on a project basis. While DEM's review process takes into account the cumulative impacts of existing water users when considering proposals for additional withdrawals, there remain gaps in the data pertaining to existing users that may leave some withdrawals not properly accounted for in such analyses. Wetlands and riparian impacts are assessed only when development or redevelopment of water supplies has been proposed, or in response to a complaint about environmental

degradation. Withdrawals from existing sources have been periodically increased significantly without appropriate review of the potential impacts.

Hence, cumulative impacts of multiple, individual project review and approval decisions are often poorly addressed, increasing the likelihood that key freshwater resources and/or watersheds will be degraded or over-utilized. For example, a dry summer in 2005 resulted in record high water use and record low flows in the Hunt River. In the Chipuxet Basin, stream flows have decreased noticeably as summer withdrawals have increased.

Ensuring Reliable Water Supply

The reliability of freshwater supplies depends on supply and treatment system predictability, sufficiency, and redundancy, which in turn are determined by the availability of emergency and back-up supplies, and the quality and level of planning and investment in water quality protection, storage, operations and infrastructure.

Public freshwater supplies require substantial capital investments. The ability of local Rhode Island water systems to invest long-term in needed infrastructure and to respond to greater consumptive demand is tightly constrained by local budgets, jurisdictional issues and the ability of ratepayers to pay. Infrastructure investment decisions and planning are generally the responsibility of individual water suppliers. Some decisions that benefit the public water system as a whole are difficult to address at the local level.

> *"Rhode Island must be able to store, treat, and supply water for all users especially during emergencies. System failures and natural calamities could leave much of our city-state without water. As the late Representative Leona Kelley once said, "If you haven't got water, you haven't got much."*
>
> *During the wetter times we need to store enough water to meet the dry times and avoid stressing existing systems. We need backup supplies to our primary sources in all regions of the state. The development of a new major water supply is critical to RI's future."*
>
> Henry Meyer, Manager**,** Kingston Water District
> *Water For Rhode Island - Today and Tomorrow*, 2006

A 2007 compilation by the WRB of water supplier Infrastructure Replacement Plans revealed that infrastructure investments totaling $800 million are needed statewide. This estimate does not include the costs of developing the Big River groundwater wells, re-establishment of abandoned supplies, or the infrastructure needed to distribute supplies produced by these new sources. These infrastructure investment projections illustrate the magnitude of future water supply investments and the need for coordinated planning and management so that such major investments benefit in an optimal manner the statewide public water supply system.

In addition to high capital investment needs, water market conditions also strongly influence local water supplier decisions. Currently, the Scituate Reservoir operated by the Providence Water Supply Board has maintained relatively low water rates while expanding its customer base because of the reservoir's surplus capacity. As

the Scituate Reservoir's supply capacity becomes fully utilized (Figure 6), new freshwater sources or redevelopment of locally abandoned sources will be more attractive as means for adding capacity statewide. However, these new systems may entail higher development and operating costs. Existing systems, as noted,

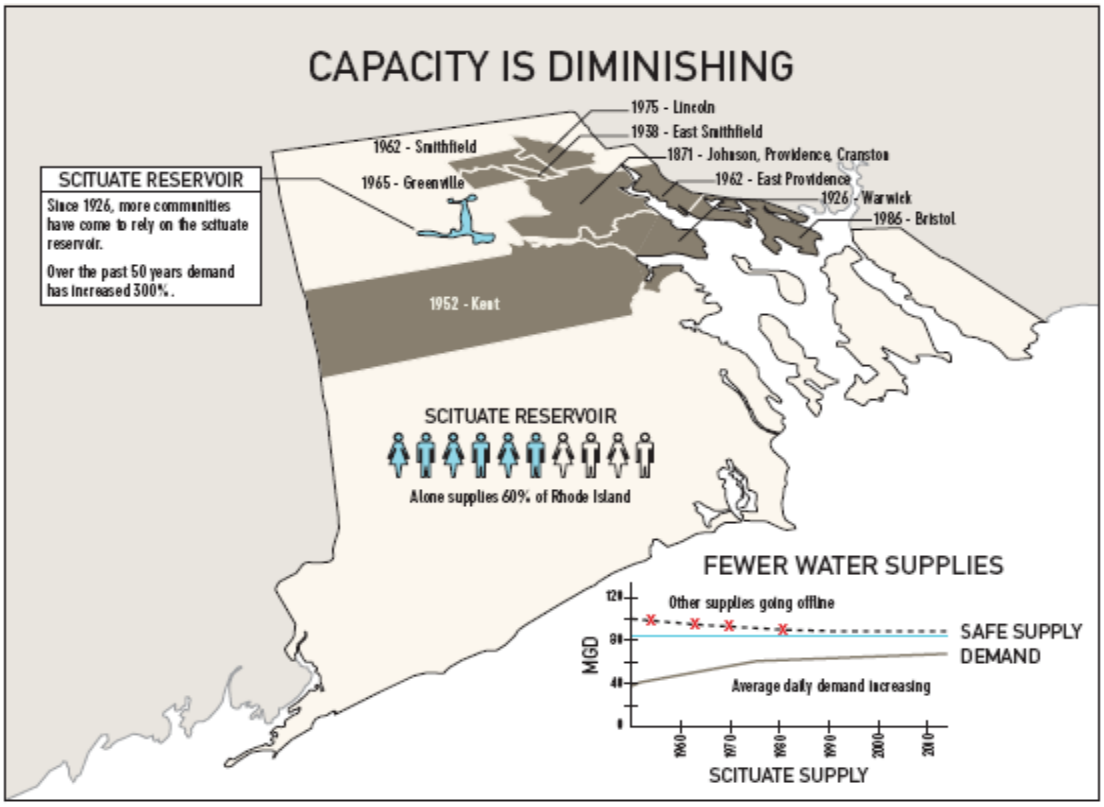

Figure 6: Growth in connections to Scituate Reservoir 1952 to 1986.
(Illustration produced by the RI Economic Policy Council, 2007, using ProvWater, WRB, USGS data sources.)

have considerable investments to make to continue to maintain the reliability of present sources and systems. Policy questions center around who should pay for new sources, who should invest in infrastructure renovations and improvements, and how the benefits from these investments should be equitably distributed. Effective policies will have to be based upon a shared understanding of what are the true costs of providing potable water to all who demand it and how water prices should reflect those costs.

How water is used and land-use patterns and characteristics also affect the reliability of freshwater supplies. Sprawl development patterns have increased populations in regions of the state that rely upon groundwater, and led to expansions to the Scituate Reservoir distribution and customer base, which in turn has resulted in the creation of excess capacity in some urban reservoir systems. Land development can reduce the available water supply as well as the water quality through impervious surface expansion. A 2003 WAPAC report entitled The Economic, Social, and Environmental Impacts of Water Use in Rhode Island 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 discussed in the SLP's Watersheds section, Rhode Island urgently needs to establish a comprehensive management system that will speed integration of freshwater resource protection and available water supply considerations into land-use planning by local governments. Water suppliers are being challenged to accommodate recent watershed development patterns in terms of how they affect supply quantity and quality, and they must forecast future needs that will arise from future growth and invest now in supplies to meet those future needs. The WRB's mandate to address statewide water supply issues has become increasingly difficult meet in relation to the complex, semi-autonomous network of local water suppliers that most of Rhode Island relies upon.

In summary, over the past several decades water supply trends and changing water use patterns have resulted in:

- Increased residential use as a percentage of overall water use and a corresponding increase in maximum day demands and peak water use particularly in the summer months.
- Increased reliance on the Scituate reservoir - The Scituate Reservoir is now the primary supply for more than 60% of the state's population.
- A decrease in the number of water supply sources over the last ten years.
- A growing need for infrastructure investment as supply systems age and expand.
- Some areas of the state nearing or exceeding supply capacity

<u>Ensuring Efficient Water Use</u>

Water use efficiency and conservation activities and programs include anything that prevents and reduces unnecessary, wasteful, uneconomical, impractical or unreasonable use of public drinking water resources.

A key issue is to enforce existing state policy on water use efficiency and conservation of the resource as well as to find ways to substitute non-potable water for uses that do not require drinking water. These imperatives will entail both the implementation of demand management and water system management practices and programs. Demand management programs, including conservation by the end user, require active involvement by the user as well as the public water supplier. Water system

Water, when plentiful, presents great opportunities. When unavailable or in short supply, water presents major challenges for today's society that expects water to be readily available, inexpensive and abundant. For growth opportunities to continue into the future, more efficient and better use of water is needed to improve its availability. While development of new sources of water will occur, the quickest means of finding new water is through improved efficiencies of usage:

\- Juan Mariscal
WRB General Manager
Water for Rhode Island - Today and Tomorrow (2006)

management to minimize infrastructure system water loss requires active participation primarily by the public water supplier.

Demand management programs include changes in plumbing hardware and/or usage habits to affect the amount of water used. Plumbing codes govern the design and flow rates of faucets, showerheads, toilets, urinals, irrigation systems and other plumbing fixtures. Code changes in the 1980s and 1990s required lower flow fixtures to be installed in new buildings and during remodeling of bathrooms and kitchens. These plumbing changes do not require any action by a water user other than to install and use the newer water-saving fixture once it has been installed. There are no data regarding the number of toilets in the state that meet the current building code standard (i.e. 1.6 gallons per flush) adopted in the 1990s. New high-efficiency-flush toilets (less than 1.28 gallons per flush, 20% less than the current standard) are now becoming available on the market and are now required by at least one state (California) based on recent state legislation and building code changes. As part of EPA's national WaterSense partnership program, new, high-quality, water-efficient products are being defined and labeled similar to the EPA EnergyStar Program. Water usage habits are typically addressed through public education and awareness campaigns. The WRB and the Pawtucket Water Supply Board are active partners in this EPA program.

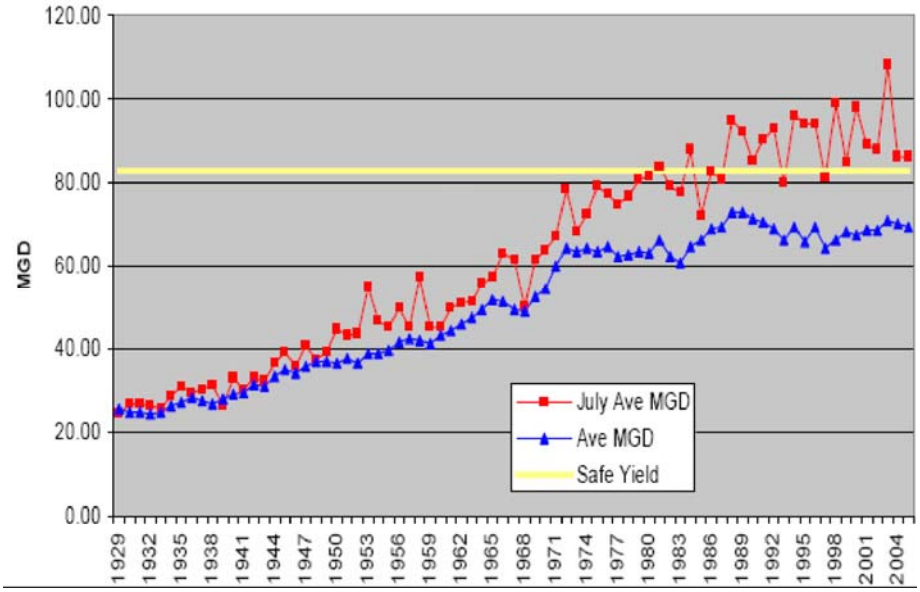

Figure 7: Water consumption rates versus safe yield for the Scituate Reservoir. Illustration produced by the RI Economic Policy Council, 2007, using Providence Water Supply Board data sources.

The most critical water usage period is the summer during which water use in Rhode Island more than doubles. This considerable increase in usage is attributable to outdoor water usage, primary from irrigation systems and lawn watering. During the summer, precipitation and water availability decrease in most watersheds. In groundwater dependant systems, river flows can drop significantly when rainfall does not keep up with water use as groundwater withdrawals increase significantly.

Even where there is storage (i.e. surface water reservoirs), summer demand taxes supply capacities. Since the mid-1980's, summer water use from the Scituate Reservoir has frequently exceeded its average daily demand safe yield (Figure 6), while on an annual average basis water usage has not increased significantly since the 1980's. For a typical suburban groundwater system, like North Kingstown, the summertime pattern of water usage is very similar (Figure 8)**.**

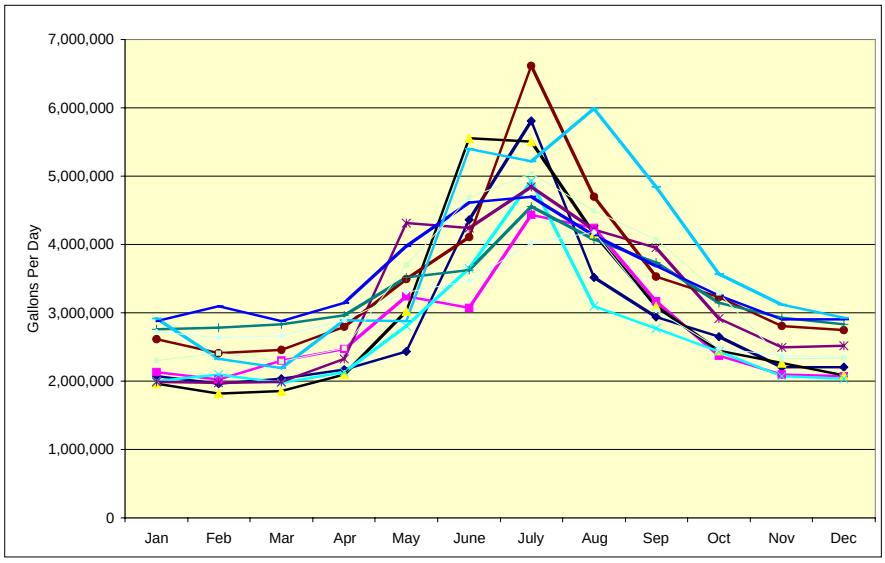

Figure 8: Seasonal Water Use, Town of North Kingstown, 1997 - 2007
Illustration Produced by WRB using North Kingstown data

New "smart" irrigation systems (with soil moisture, precipitation sensors and timers) coupled with the appropriate and effective use restrictions and seasonal rate structures are management tools that need to be evaluated and implemented. An example of a successful one-day-per-week water restriction system is in the nearby Town of Franklin, Massachusetts. Based on the knowledge and advice of the University of Rhode Island's Healthy Landscape Program, and other regional experiences, "most lawns require about one inch of water each week to remain actively growing during summer months."

The use of rain barrels that allow individuals to store water for later use on gardens has grown considerably over the last year in Rhode Island. Examples of larger scale rainwater harvesting though the use of cisterns are at the Quonset Development Corporation's new administration building and at a private florist and gardening supply shop in Wickford. In addition, the Gordon Avenue Business Incubator Project in Providence incorporated rainwater harvesting in its demonstration project to convert former factory space to commercial office space. This project uses the building's flat rooftop for the collection of water that is internally stored and re-circulated for internal use for the flushing of toilets and urinals.

System management efforts include: system leak detection and repair programs; tracking and defining sources of unaccounted-for water use determining if it is

recoverable water; and maintaining and upgrading master and user water meters coupled with more frequent billing. In addition, most Rhode Island rate structures consist basically of a uniform usage rate plus a flat fee (service charge) type structure. Block Island has the only water rate structure with seasonal water rates. There are a few Rhode Island water systems, notably Jamestown, that have increasing block rate structures that were implemented 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.

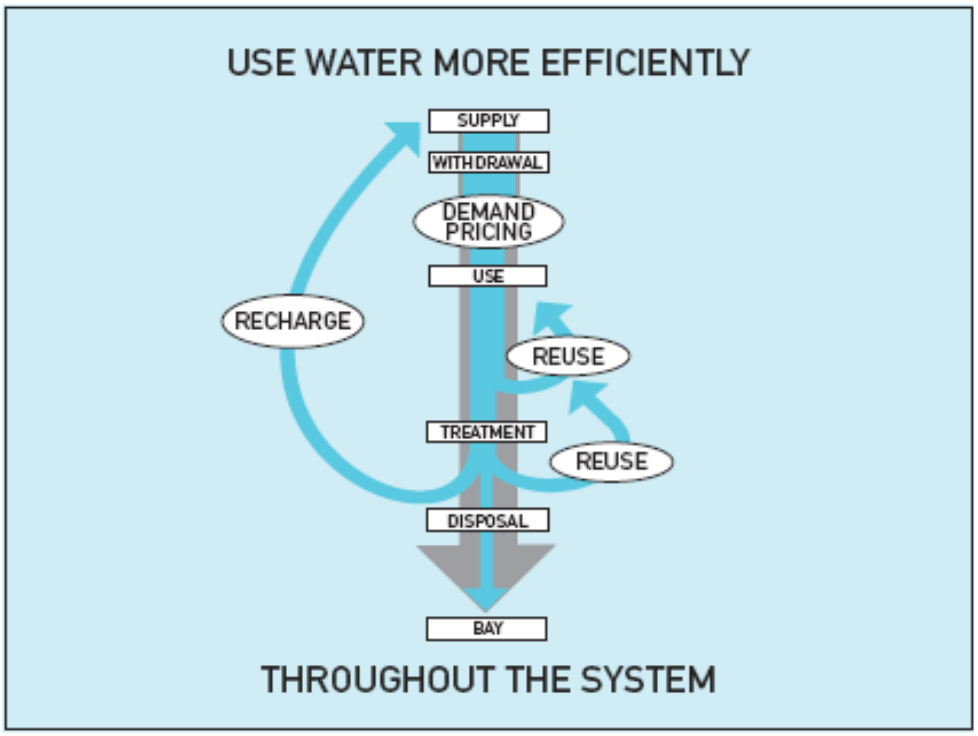

Figure 9: Integrated water supply systems management
Illustration produced by the RI Economic Policy Council, 2007

Targeted efforts by government agencies, public water suppliers, business and industry and individuals to use water efficiently will protect Rhode Island's freshwater resources and preserve supply for the future (Figure 9). Efforts to reduce demand particularly during periods of peak use and reducing outdoor water use in the warm months are critically needed. State government should provide effective leadership, and expanded assistance and oversight to suppliers, local governments, industry and agriculture. Local water suppliers need to enhance systems operations (including demand management), expand infrastructure maintenance and renovation, and participate in and help implement regional planning and management efforts. Individual Rhode Islanders need to become more aware of how

much water they use, how it affects values and resources they care about, and what actions they can take to reduce their water use.

Table 6: Freshwater Supply Strategy

Goal: *Rhode Island will have ample, reliable safe fresh water supplies for the future.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
Sustainable use and protection of the state's freshwater resources.	Improve water data management.	Collect, maintain, and distribute adequate scientific data on the quantity, quality and use of the State's freshwater resources.	**WRB**, DEM, USGS	Ongoing
		Establish water use reporting requirements for all major water users.	**WRB**	Ongoing
		Maintain the state's streamflow gage network, and expand as needed to fill critical data gaps as resources allow.	**WRB,DEM,** USGS	Ongoing
		Develop and communicate overall water availability projections for individual watersheds	**WRB**	1-4 years
	Promote and practice integrated (regional, state and local) water management.	Develop Watershed-based Resource Protection and Water Management Plans.	**WRB**, DEM	1-4 years
		Continue to provide examples and encourage that local development controls are consistent with watershed protection and regional management plans	**DOP**, DEM, RIRC	1-6 years
		Establish stream flow standards and protocols	**DEM**,WRB, RIRC	1-2 years
		Manage and monitor water withdrawals comprehensively on a watershed basis	**WRB**, DEM, RIRC	Ongoing
	Upgrade the state and community information bases and technology systems to integrate land and water use data	Continue to contribute to the Rhode Island Geographic Information System (RIGIS) for all aspects of natural and water resource data.	**DOP**, DEM, DOT, URI	1-4 years

Table 6: Freshwater Supply Strategy

Goal: *Rhode Island will have ample, reliable safe fresh water supplies for the future.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
Reliable Water Supplies.	Implement strategic water supply plan to ensure reliability of supply	Consolidate and update State Water Supply Policies and Plan.	**DOP**, WRB Water suppliers, DOH, DEM	1-2 years
		Develop Big River Groundwater Wells	**WRB**	1-4 years
		Establish enterprise accounting for all major public water suppliers	Water Suppliers	1-4 years
		- Develop implementation plan for supplemental water projects and interconnections. - Invest in redundant and backup supplies.	**WRB**, WRB Corporate, RI CWFA Water Suppliers	1-2 years Ongoing
		Regionalize small systems to improve overall system reliability.	WRB, Water Suppliers	1-4 years
Efficient Water Use	Integrate management of land use and water use	Coordinate community comprehensive plans and water supply management plans to included guidance for watershed-based planning for municipalities.	**WRB** Municipalities DOP,DEM,DOH	1-4 years
	Promote water use efficiency and conservation.	Develop and Implement statewide water use efficiency and conservation plan and public outreach program, including major user water audits.	**WRB**, Water Suppliers	1-4 years
Timeframes: For many listed actions additional funding will be required for successful completion.	Ongoing: Action is currently being pursued by one or more agency. Additional funding may be required for completion. 1-2 Years: With adequate funding, action should be completed within 1-2 years.	1-4 Years: With adequate funding, significant progress on the action will require ongoing efforts over the next 4 years. 1-6 Years: With adequate funding, significant progress on the action will require ongoing efforts over the next 6 years.		

WATER QUALITY

Restoring and maintaining water quality is essential to the ecological health of Narragansett Bay, Rhode Island's other coastal waters, their tributary rivers and watersheds. Despite considerable investment in water pollution controls, further actions to abate both point and non-point sources of pollution are needed to restore the beneficial uses of the state's waters and ensure sustainable marine and aquatic ecosystems for future generations.

As the state's water pollution control program, DEM's Office of Water Resources exercises broad authority and jurisdiction to administer the state's water quality program. Water quality management entails monitoring and assessment, setting water quality criteria and standards, various regulatory and permitting programs including those delegated by EPA under the Clean Water Act, water quality restoration planning, technical and financial assistance, outreach and training, enforcement and emergency response. Several other state agencies or entities play important roles including the Department of Health (bathing beaches, laboratory services, fish tissue consumption advisories) and Clean Water Finance Agency (State Revolving Fund and related loan programs). In the coastal zone, CRMC's authorities to oversee development or certain activities in the coastal zone have been applied in certain programs to reinforce water quality goals, such as SAM Plan requirements affecting the density of development.

DEM and other state agencies such as the Department of Health and the Narragansett Bay Commission assess coastal and fresh water quality within the framework of Rhode Island's water quality regulations that designate uses for all surface waters and establish numerical standards to protect and support those uses. DEM standards are consistent with and no less stringent than EPA requirements pertaining to the federal Clean Water Act. Water quality standards and their associated criteria are designed to protect both aquatic ecosystems and public health. They also provide targets for water quality restoration efforts and are an important basis for setting discharge permit limits and requirements.

Water quality standards and criteria are periodically revised to incorporate advancements in science. In Rhode Island, for coastal and estuarine waters, new water quality criteria for dissolved oxygen, derived from consideration of nine species that live in Narragansett Bay, were adopted in 2006. In 2008, DEM expects to further refine its water quality standards by designating warmwater and coldwater fisheries. Future ecosystem-based management approaches to water quality management will entail refinement of water quality standards to support application of conceptual tools such as tiered aquatic life uses (TALU), biological condition gradient and indices of biological integrity.

Coastal and Estuarine Water Quality

Monitoring by DEM, the Narragansett Bay Commission (NBC), researchers and others has documented a general gradient of water quality degradation in Narragansett Bay with conditions improving as one moves south from Providence down the Bay's East and West Passages into Rhode Island Sound. (DEM, 2006, DEM 2000; RI Sea Grant, 2005) Over the past five years, expanded monitoring initiatives funded by the BRWCT, NOAA and EPA have improved understanding of water quality conditions and highlighted the differences in condition that occur across various regions of Narragansett Bay. NBC conducts routine monitoring of upper bay, urban rivers, riverine inputs at the state border and participates in states Fixed Site Buoy Monitoring Network.

DEM recently completed its 2008 statewide assessment of water quality which included 156.4 square miles of estuarine waters and 78.62 miles of coastal shoreline. The assessment (DEM, 2008) revealed:

- An additional 7.62 square miles of mid- Narragansett Bay was designated by DEM as impaired due to hypoxia, or low oxygen conditions in April 2008. As a result, over a third of the total Rhode Island area of Narragansett Bay, including the Providence and Seekonk Rivers, Mt. Hope Bay and Sakonnet River, is now considered subject to hypoxia (low oxygen conditions) during the warm weather months. Within the Bay, hypoxia appears most persistent in Greenwich Bay, the Seekonk and Providence Rivers and portions of the upper Bay.

- Hypoxia has been documented in Green Hill Pond and the tidal Pawcatuck River.

- DEM currently lists 22 coastal water areas as impaired by pathogens.

- Elevated levels of pathogens cause 21% of the state's shellfishing grounds to be closed either permanently or conditionally.

- Estuarine waters are generally safe for swimming with 10% designated as impaired for this use.

- Of Rhode Island's 69 licensed saltwater beaches, 20 are classified as at high risk for pollution and sampled at least once per week during the warm weather months. In 2006, 20 saltwater beaches were closed at least once due to bacterial contamination of their bathing waters. (Total days closed ranged from 1-47 days). In 2007, 24 beaches were closed for a total of 69 days (4-15 days each). (RI Department of Health Beach Monitoring Program, March 2007 & March 2008). Variations in beach water quality correlate strongly with precipitation patterns. Rain events generate stormwater discharges that lead to pathogen contamination of bathing waters.

Sediments in the upper portion of the Bay are contaminated with metals, PCBs and other toxics; largely due to historical releases of these substances.

Where coastal and estuarine waters fail to meet water quality criteria or support designated uses such as shellfishing and swimming, then such waters are designated as impaired and targeted by DEM for development of water quality restoration plans, also known as total maximum daily loading assessments (TMDL's). Using a watershed-based approach, TMDL's provide the technical basis for identifying the pollution control actions that are needed to reduce current point and non-point pollutant loadings sufficiently to restore water quality and eliminate violations of ambient water quality criteria. This work is done at a scale appropriate for management decision-making. An early focus of the TMDL program has been restoration of shellfish growing area waters. DEM has currently designated 29 estuarine waterbodies, or portions of waterbodies, as impaired with the primary pollution problems being pathogens, low dissolved oxygen, and nutrients. Watershed restoration plans have been completed for at least one parameter of concern in 13 of the 29 impaired waterbodies. For the remaining waterbodies that require TMDL development, the current schedule for completing TMDL's extends through 2022. In some cases, pollution abatement actions planned or underway such as NBC's CSO abatement program may negate the need for future TMDL development.[11]

The major impacts on the uses of coastal and estuarine waters are due to 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 septic systems. In addition, thermal discharges affect Mt. Hope Bay and the Providence River and atmospheric deposition is a significant source of mercury. (DEM, 2008)

Freshwater Water Quality

Rhode Island's freshwater resources include 1,498 miles of rivers and streams, over 20,917 acres of lakes and ponds and over 124,000 acres of wetlands. These surface waters and wetlands are hydro-geologically interconnected with the groundwaters underlying the state. As noted above in the Watersheds Section, restoring and maintaining acceptable water quality conditions in the state's freshwaters is integral to sustaining healthy watersheds and a healthy Bay. With the exception of the larger rivers that receive wastewater discharges, the pollution sources of concern in freshwaters are primarily non-point source in origin.

Due to continuing gaps in monitoring data, it is not possible to comprehensively assess the water quality conditions of our freshwater resources. For example, while the percentage of river miles assessed for at least one designated use increased from 42% in 2006 to 49% in 2008, DEM still found that sufficient data was lacking in 51% of the state's river miles. DEM intends to reduce this data gap as more data generated from the rotating basin monitoring strategy becomes available and is incorporated into future assessments.

[11] For details: go to http://www.dem.ri.gov/programs/benviron/water/quality/rest/index.htm

Another continuing major gap is information on fish tissue contamination. In 2008, DEM used available data and determined the following with respect to freshwaters:

- Where data was available, approximately 45% of the river and stream miles indicated one or more water quality impairment (failed to meet water quality criteria).

- Pathogens were the leading cause of impairment in rivers and streams.

- In lakes and ponds, persistent pollution by pathogens occurred infrequently (affecting about 4 % of lake acres). However, in 2007 the Department of Health 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, a significant monitoring gap that has been highlighted by the BRWCT Environmental Monitoring Collaborative.

- Biological monitoring revealed impairments due to reduced biodiversity in 26 rivers and streams. This data is an indicator of degraded ecological conditions that may be due to a number of stressors including various pollution sources as well as changes in hydrology, for example stream depletion.

- Low-level metals, typically lead, copper and cadmium, are a noted cause of impairment in rivers and streams, especially those within more urbanized watersheds.

- Reflecting a regional problem, where tested, tissue from fish in RI rivers and lakes often reveal contamination at unacceptable mercury levels.

- Aquatic invasive species were the largest cause of impairment in freshwater lakes and ponds.

Where freshwaters fail to meet water quality criteria or support designated uses such as swimming and aquatic life, then such waters are designated as impaired and targeted by DEM for development of water quality restoration plans (TMDL's). One early focus of the TMDL Program was contamination of shellfish growing areas and as a result many of the water quality restoration plans completed to date for freshwater address pathogens in streams that are tributary to shellfish waters. More recently, the TMDL program has addressed other pollutant concerns including nutrients in lakes, multi-parameter impairments, such as in the Blackstone River, biodiversity impairments and mercury.

DEM has currently designated 136 freshwater waterbodies, or portions of waterbodies, as impaired due to pollution with the primary problems being pathogens, biodiversity, low dissolved oxygen and nutrients. For these waters, TMDL's have been completed for at least one parameter of concern in 30 of the 136. In some cases, pollution abatement actions planned or underway; e.g. WWTF

upgrades or site remediation actions, may negate the need for future TMDL development.

Pathogens and biodiversity are the major causes of impairment in rivers and streams. Sources of pollution include wastewater discharges, including combined sewer overflows, stormwater discharges and septic systems. In lakes and ponds, the major sources of impairment are aquatic invasive plants, excess nutrients and low dissolved oxygen. Mercury has also resulted in fish tissue contamination throughout Rhode Island's freshwaters.

Wastewater Treatment Facilities

Most Rhode Islanders utilize public sewer systems to handle residential and commercial wastewater flows. Over 140 million gallons per day of wastewater is collected via sewer systems around the state and is treated by Rhode Island's wastewater treatment facilities. Over 75% of this treated wastewater is discharged directly into estuarine waters (the remaining 25% discharged into rivers). Overall, of Rhode Island's nineteen major wastewater treatment facilities (WWTF's) thirteen discharge directly into coastal waters, including the state's largest WWTF at Fields Point operated by the Narragansett Bay Commission. The remaining six major WWTF's discharge into freshwater rivers, five of which are located on the Blackstone, Woonasquatucket or Pawtuxet Rivers, all of which empty into upper Narragansett Bay. Five additional WWTF's located in Massachusetts discharge into the Ten Mile and Blackstone Rivers, both tributary to upper Narragansett Bay.

Following the passage of the Clean Water Act in 1972, DEM, which implements the state's water pollution control program, began to develop and implement the financial and regulatory programs that have resulted in all Rhode Island WWTF's achieving what are referred to as secondary wastewater treatment processes. Rhode Island received $284.2 million dollars via the Federal Construction Grants Program that was matched by $64.6 million in state bonds resulting in a total investment of over $348 million in wastewater treatment facility and system improvements made from the mid 1970's to 1998. Industrial pretreatment programs were instituted in the early 1980s and have dramatically reduced the discharge of toxic metals such as cadmium, copper, and nickel, and toxic organic compounds such as cyanide. The Narragansett Bay Commission has reported a 97% reduction in total metal loadings since 1981 from its Field's Point WWTF, from 950,000 lbs. to 26,000 lbs. annually from 2002 onward.

In 1990, the State Revolving Loan (SRF) program replaced the construction grant program. Co–managed by DEM and the Rhode Island Clean Water Finance Agency, the SRF has awarded over $564 million in below market interest rate loans for 230 projects in 27 communities and is the state's largest financial assistance program. Through this program, which is supported by U.S. EPA funds and state bonds, as well as smaller bond programs including the Narragansett Bay and Watersheds Restoration Fund, Rhode Island has continued to make substantial investments in upgrading and maintaining wastewater infrastructure and has begun to address

certain priority stormwater infrastructure needs. However, the capacity of the SRF and other financial assistance programs is far exceeded by the estimates of $1.36 billion in wastewater infrastructure needs documented in the 2004 Statewide Needs Survey. This cost estimate would be increase further if stormwater management needs were included. The recent decline in federal funding to capitalize the SRF is therefore a major concern, as is the General Assembly not approving clean water bond referendums in FY 2008 and FY 2009. Funding reductions have already constrained the SRF program to making funding commitments only for single construction seasons. It is now expected that it will not be possible to support all scheduled projects, resulting in delays in the implementation of critically needed wastewater infrastructure improvements. Addressing the capacity of the SRF to meet infrastructure needs will be critical to the overall success of the state and municipalities in achieving clean water goals and requirements.

In the late 1980's, DEM started incorporating more stringent effluent limits based on updated federal wastewater treatment standards and increased considerations for the condition and resources of Rhode Island's receiving waters. These permitted effluent limits were developed using assessments specific to the water quality of particular natural waterbodies and corresponding wasteload allocations. This adaptive management approach is intended to incorporate continued advancements in scientific understanding to be incorporated into discharge permits as they are periodically re-issued.

Nutrients Management

The three WWTF's discharging to the Pawtuxet River are among the first in Rhode Island to move to advanced treatment for nutrients. Water quality studies and modeling initiated in the 1980's led to a wasteload allocation to address documented water quality problems caused by nutrient loadings; e.g. low levels of dissolved oxygen in the Pawtuxet River and upper Narragansett Bay. Revised permits issued in 1989 compelled WWTF upgrades to reduce discharges of ammonia and organic material. Construction was completed by 2006 and all three WWTF's have achieved compliance with their current effluent limits. As a result, DEM monitoring during the expected worst condition period in the summer of 2007 found the Pawtuxet River complied with dissolved oxygen criteria.

Aware of evidence of hypoxia in the Providence River dating back to 1979, and reflecting a national trend in estuarine management, in the mid-1990s DEM began focusing on reducing WWTF loadings of nitrogen in order to abate persistent hypoxic conditions in the upper Bay. As WWTF's designed upgrades for other purposes, nutrient reduction was incorporated. In 2004, on the basis of recommendations from the Governor's Commission on Narragansett Bay and its watershed, a predecessor to the BRWCT, the General Assembly established a goal of achieving a 50% reduction in seasonal summer nitrogen pollutant loadings from Rhode Island's WWTF's. Building on work already underway, in 2005 DEM released a nutrient reduction plan that applies to eleven RI WWTF's and mandates a 50% reduction in the summer seasonal nitrogen loadings into upper Narragansett Bay. In

accordance with the 2005 plan, DEM has issued revised permits with effluent limits ranging from 5-8 mg/l of total nitrogen to ten of the eleven WWTF's that discharge into the Providence Seekonk River and upper Bay.

Since July 2006, improvements at eight of those WWTF's have resulted in a 35% reduction in overall nitrogen loadings from upper bay WWTF's.[12] Two of these eight facilities (NBC Bucklin Point and Woonsocket) require additional modifications to achieve their permit limits of 5 mg/l total nitrogen (TN).[13] NBC's Bucklin Point WWTF was designed to meet a total nitrogen limit of 8 mg/l, based upon a facility plan upgrade approved by DEM. The new permit limit of 5 mg/l was imposed at the same time the newly upgraded nitrogen treatment facilities went on-line. NBC is now in the process of making additional design upgrades in order to meet the 5 mg/l TN limit.

To further control loadings to the Seekonk River, DEM has advocated strongly for comparable reductions from several Massachusetts WWTF's located upstream on the Blackstone and Ten Mile Rivers, the largest of which is the Upper Blackstone Water Pollutant Abatement District WWTF serving the Worcester metropolitan region.

With respect to NBC Field's Point WWTF, which averages 45 MGD, a facilities plan has been completed (and approved by DEM) for treatment upgrades designed to meet a total nitrogen limit of 5 mg/l TN during summer months. Final facility design plans will be completed by November 2008. Once the design plans are approved by DEM, the Field's Point WWTF biological nutrient removal facility upgrades will take approximately three years to build.

Overall, DEM is beginning to apply an adaptive management approach to nutrients controls that phases in the necessary nutrient reductions and allows for continued monitoring and re-assessment of the need for further reductions.

Ensuring WWTF effluent limitations are met requires controlling the flows into WWTF's. Through oversight of wastewater facility plans, expansion of sewer service districts and other system modifications, DEM works with the WWTF's to ensure plants operate within their design flows. This oversight, coupled with operator certification and training, and state inspections has resulted in a high level of compliance with WWTF effluent limits around Rhode Island. However, as more plants are upgraded and treatment systems become more complex, continued training for operators will be important to sustain the overall excellent performance of Rhode Island's WWTF's.

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[12] The eight WWTF's are: Cranston, West Warwick, Warwick, East Greenwich, Smithfield, Burrillville, Woonsocket and NBC Bucklin Point. The 35% reduction is based on current WWTF flows. If plant design flows are used, the reduction would equal approximately 20%.

[13] The status of the three remaining facilities is as follows: The Narragansett Bay Commission's Fields Point WWTF is designing upgrades to achieve 5 mg/l (seasonal), the East Providence WWTF has submitted a facilities plan to DEM and revised effluent limits for the Warren WWTF should be completed in 2008.

While there has been significant recent investment in WWTF plant upgrades, the age and condition of the collection or sewerage system infrastructure is creating additional challenges. In 2005, it was estimated that 114 sewer system overflows (SSO's), events in which untreated sewage is spilled or released into the environment, discharged 37 million gallons into Rhode Island waters; in 2006 the number was reduced to about 8 million gallons from 71 SSO's. EPA and DEM have recently emphasized addressing SSO's. DEM receives reports of dozens of SSO's annually and is encouraging WWTF's to adopt or expand asset management approaches to the operation and maintenance of their collection systems. In 2007, EPA took formal enforcement action against 12 wastewater system operators for SSO's and is requiring system-wide assessments, plans to remedy deficiencies, and adoption of long-term preventive maintenance programs. NBC has been actively reducing the number of SSO's in its system through implementation of an Assent Management Program, by eliminating CSO discharge points, reconstructing regulator pipes and by instituting inspection and monitoring initiatives.

Another area of recent attention has been energy efficiency. Energy is often the second largest expense behind labor in running a WWTF. Advanced treatment processes at WWTF's consume even more electricity. In many municipalities, wastewater treatment facilities are the largest municipal user of energy. (EPA, 2008) EPA, through its energy challenge program, is offering technical assistance to encourage the adoption of energy efficiency measures that often present major operating cost savings. Four RI communities to date have chosen to participate. The State's capacity to assist these efforts remains limited, but should be expanded to promote more use of renewable energy sources. NBC is finalizing two alternative energy feasibility studies; one investigating installation of a wind turbine generator at Field's Point, and the other evaluating the use of biogas (generated by the WWTF's anerobic solids digesters) to fuel a micro-turbine or reciprocating engine. Ranking criteria for the Project Priority List (maintained by the Clean Water Finance Agency and DEM) have been updated to favor energy efficiency and sustainable infrastructure practices when considering funding requests.

Combined Sewer Overflows

The primary sources of bacteria in upper Narragansett Bay are combined sewer overflows (CSO's) that discharge a combination of untreated sewage and stormwater. Currently, eighty-six CSO outfalls discharge to the Providence River or its tributaries. The Narragansett Bay Commission (NBC) has eliminated twenty CSO's by simply plugging the discharge pipes. Nevertheless, NBC estimates that 66 CSO's in its service district annually discharge over 2 billion gallons of untreated combined wastewater after rain events. CSO's also degrade water quality in Newport Harbor and Mt. Hope Bay.

The initial CSO Abatement plan proposed by NBC featured three bedrock tunnel systems and seven near surface storage facilities for an estimated cost of $476 million. In the late 1990's, NBC established a CSO Abatement Stakeholder Group to evaluate CSO abatement needs and requirements for the upper Bay, review NBC's

facilities plans, propose additional and alternative strategies for stormwater management, and make recommendations on preferred CSO Abatement facilities designs and construction. This stakeholder group eventually reached consensus regarding a CSO facilities plan divided into three phases. NBC has proceeded successfully with implementation of Phase I of this plan, which entailed construction of a bedrock storage tunnel with 66 million gallons of capacity under the City of Providence, two stub tunnels and a major facilities upgrade of the Bucklin Point WWTF. The Phase I bedrock storage tunnel will come on-line in late fall 2008.

Upon completion of Phase I, NBC projects that annual CSO discharge volumes in the upper Providence River will decrease by 40% and conditional shellfish closures in the upper bay will be reduced by 50%. Numerous recreational and fishery values in the upper bay will be enhanced and restored as well.

Design for Phase II of the CSO Abatement project is currently underway. Phase II shall include construction of two near-surface interceptors, one to receive overflows along the Woonasquatucket River and one to receive overflows along the Seekonk River. Phase II of the Abatement Project will also entail construction of sewer separations for the CSO located on the Seekonk River and the CSO located on the Moshassuck River, and construction of a wetlands facility in Central Falls. Phase II construction is scheduled to commence in 2010 and be completed by 2014.

Design for Phase III shall begin after construction of Phase II is complete. Construction for Phase III is scheduled to commence in 2017 and be completed by 2022.

Stormwater Discharges

Due to the landscape development patterns that have become pervasive across Rhode Island since the 1950's, stormwater discharges have become a major, widespread cause of water quality degradation. Stormwater is a contributing source in a large majority of Rhode Island waterbodies designated as impaired. With respect to coastal waters, stormwater discharges have been directly implicated as the cause of pathogen contamination that results in the majority of Rhode Island's beach closings, including Scarborough Beach in Narragansett and Easton's Beach in Newport, and in shellfish growing area closings in the upper Bay.

Stormwater discharges also contribute to the eutrophication of coastal ponds, coves and embayments. The Narrow River (Pettasquamscutt) exemplifies the problem. Following a decade-long effort to extend sewers to mitigate septic system problems in the Narrow River watershed, water quality monitoring continues to document elevated concentrations of pathogens attributed to untreated stormwater discharges. In rivers and streams, untreated or inadequately treated stormwater has degraded both water and habitat quality. Stormwater discharges also carry excess nutrients and other pollutants such as metals into lakes and ponds.

Given the density and pattern of development in the state, strategies to address stormwater management must involve both prevention and abatement. Stormwater regulations were first developed to address flooding, erosion and related hydrodynamic issues. Growing recognition of the contributions of stormwater discharges to water quality degradation spurred an expansion of regulation to address stormwater pollution controls. Federal Clean Water Act requirements for stormwater went into effect in Rhode Island in during the 1990's.

Today, stormwater discharges are managed via a multi-faceted regulatory framework that includes individual discharge permits (DEM) for certain types of facilities, general permits (DEM), and regional permits, known as MS4s, that apply to municipal governments and state roadways. Both CRMC and DEM have begun requiring new land development to treat stormwater prior to disposal. As mandated by state law, DEM, in coordination with CRMC, is updating the state stormwater manual to reflect the application of Low Impact Development (LID) as a primary strategy for managing stormwater and to strengthen policies, to require greater use of infiltration and compel adequate treatment. The manual will compel new developments and redevelopments to better manage both the quantity and quality of stormwater runoff being generated. The NBC has operated an award winning Stormwater Management Program since 2003 which requires developers to mitigate stormwater discharges by implementing LID technologies. This program eliminated the discharge of 7.3 million gallons of flow from the sanitary sewer system based upon a 2-year storm event.

Local governments have a major role to play in ensuring effective stormwater management via exercise of their local land use authorities. Current practice varies widely with many municipalities lacking adequate staff or expertise. Lack of proper maintenance of stormwater management structures, such as detention basins, infiltration basins, etc., is a widely acknowledged problem.

Implementation of federally mandated "Phase II" stormwater requirements will increase demand for state and federal technical and financial assistance from local entities. In 2001, DEM distributed $825,000 in planning grants to municipalities to support development of local stormwater management plans. Utilizing 2004 Clean Water Bond funds, DEM has distributed grants to enhance local capacity to implement stormwater management through equipment purchases and support for illicit detection. Additional local needs include improved guidance on best management practices (BMP's), training and technical assistance related to Phase II stormwater requirements, and continued financial assistance to build and implement local stormwater programs.

Many of the completed TMDL's identify the need to retrofit existing stormwater systems to reduce pollutant loadings to surface waters. DEM has linked its TMDL programs and stormwater management programs via regulations that will require local actions to abate stormwater discharges. The responsibility for upgrading stormwater infrastructure rests largely with municipal governments and the Rhode Island Department of Transportation.

Major current obstacles to abating stormwater pollution include the lack of a reliable source of funding for retrofitting existing infrastructure and limited local capacity to take on such work. DEM has been able to utilize certain state bond funds and limited federal funds to provide matching grants to municipalities and others, but the funding sources are variable. Rhode Island has begun exploring stormwater utility districts as a mechanism to provide stable funding to support the retrofitting of stormwater infrastructure to provide treatment as well as the long-term operation and maintenance of stormwater systems. Over 800 districts have been established nationally, but their adoption in the New England region lags the rest of the nation.

On-site Wastewater Treatment Systems

There are over 157,000 on-site wastewater treatment systems (OWTS) in Rhode Island. Up to 50,000 of these systems may not comply with current state and local regulations, including all remaining cesspools given passage in 2007 of the cesspool phase-out law. In many areas of the state, it is not realistic, cost-effective, or even desired to extend public sewer service. In addition, *Land Use 2025* discourages the expansion of sewer services in areas outside of the Urban Services Boundary. Therefore, many communities will continue to utilize OWTS's for the foreseeable future. To properly manage OWTS, DEM is implementing its Nonpoint Source Pollution Management Plan as a multi-faceted strategy to prevent and abate pollution from OWTS's, including: (1) licensing of OWTS designers, (2) institution of soil-based siting methods and requirements, (3) expanded use of innovative and alternative (I & A) technologies; (4) establishment and support of local wastewater management programs, (5) financial assistance for OWTS upgrades through the Rhode Island Clean Water Finance Agency (CWFA) and (6) expansion of public education and outreach to increase the willingness of homeowners to upgrade and maintain their OWTS's.

23 of the 27 Rhode Island communities that rely primarily on OWTS's are now developing or implementing local wastewater management programs. The CWFA has committed over $4 million in loans to assist homeowners in repairing or replacing their systems. DEM and Rhode Island should expand investments in these local wastewater management programs, particularly given the new demands that will be placed upon them via implementation of the 2007 Cesspool Phase-out Law.

Finally, DEM promulgated a major revision of its on-site wastewater regulations in January 2008. The new rules update technical standards and mandate nitrogen reduction technology for systems located in sensitive regions such as the watersheds of the south shore coastal lagoons and the Narrow River. These south shore watersheds have already been identified by CRMC in the Salt Pond Region SAMP as areas continuing to experience significant residential and commercial development that must when feasible utilize nitrogen reducing treatment technologies.

Boating and Marinas

To address pollutant discharges from boating activities and marinas, in August 1998 Rhode Island designated all of its coastal waters as a No Discharge Area, including state waters out to three miles and all of Narragansett Bay. A No Discharge Area is a body of water for which the discharge of treated and untreated boat sewage is prohibited (this does not include gray water or sink water).

To ensure the highest possible compliance with Rhode Island's No Discharge Area, DEM has provided nearly $750,000 in grants for pump-out facilities to service boaters in Rhode Island waters. There are currently over 40 pump-out facilities installed in Rhode Island's marinas and harbors.

Marinas must manage a variety of hazardous and non-hazardous materials whose release into coastal waters could be highly detrimental. A certification program known as the Clean Marina Program, developed collaboratively in 2006 by CRMC, DEM, the RI Marine Trades Association, and Save the Bay, recognizes and rewards marinas that go beyond regulatory requirements by applying innovative pollution prevention BMP's to their daily operations.

Table 7: Water Quality Strategy

Goal: *Rhode Island's fresh, estuarine, and marine waters will support aquatic habitats, biological diversity, and their traditional and emerging human uses.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
Significant progress toward meeting all water quality standards for RI waters, including attainment of fishable, swimmable water quality in upper Narragansett Bay and the Blackstone River by 2015.	Fulfill 2004 State Mandate for 50% reduction in total nitrogen discharges (May to October) from WWTF's discharging into Narragansett Bay or its major tributaries.	Oversee consent agreements that will implement nutrient reductions at RI WWTF's over the next six years (through 2014).	**DEM, NBC,** other WWTF's	On-going
		Support issuance and implementation of revised EPA New England permits for nutrient controls at WWTF's located in the Blackstone River and Ten Mile River watersheds.	**DEM**	1-2 years
		Ensure operator training in advanced plant operations associated with nutrient removal and biosolids management.	**DEM**, NBC	Ongoing
	Implement NBC's CSO Abatement Project and monitor resulting reductions in pathogen concentrations.	Complete Phase I of the NBC CSO Abatement Project. Comprehensively monitor the upper Bay for pathogens and other key water quality parameters related to CSO discharges.	**NBC, DEM**	October 2008 Ongoing
		Complete planning and evaluation related to Phase II of NBC CSO abatement Project	**NBC**, DEM	1-4 years

Table 7: Water Quality Strategy

Goal: *Rhode Island's fresh, estuarine, and marine waters will support aquatic habitats, biological diversity, and their traditional and emerging human uses.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
	Develop funding sources to meet the state's estimated $1.36 billion worth of wastewater infrastructure needs.	Increase federal and state support for Rhode Island's State Revolving Fund.	RI Congressional Delegation, RI General Assembly	Ongoing
	Institute ecosystem-based management for federal and state water quality planning and management.	Initiate incorporation of new tools including tiered-aquatic life use and the biological condition gradients into RI water quality standards.	**DEM**	2-5 years
		Develop indices of biological integrity for fresh and estuarine waters.	**DEM**, NBC, U.S. EPA, RIRC	2-4 years
		Develop and implement TMDL's which address multiple stressors on aquatic biological communities.	**DEM**, U.S. EPA, RIRC	1-4 years
		Update the state strategy for nutrient control and management for RI coastal waters, including Narragansett Bay, taking into consideration monitoring results and consideration of EBM	**DEM**	3-4 years
		Evaluate ambient and watershed-scale water quality conditions to track consequences of WWTF's upgrades for biological nutrient removal.	**DEM**, NBC	Ongoing
	Significantly reduce sewer system overflows.	Promote and continue NBC's Asset Management Program as a model for other sewer authorities.	**DEM**, NBC	Ongoing

Table 7: Water Quality Strategy

Goal: *Rhode Island's fresh, estuarine, and marine waters will support aquatic habitats, biological diversity, and their traditional and emerging human uses.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
		Ensure financial assistance is available to support necessary WWTF improvements and to address repair and replacement of aging infrastructure.	**DEM**, **RICWFA**, General Assembly, Congressional Delegation	Ongoing
	Identify and implement pollution abatement actions necessary to restore water quality in RI's impaired waters	Continue to development TMDL's consistent with schedule in the 2008 303(d) list.	**DEM**	On-going
		Continue work with municipalities and others to implement TMDL recommendations.	**DEM**, local governments	On-going
	Comprehensive management of on-site wastewater systems in coastal and freshwater watersheds that lack public sewers.	Develop capacity of local sewer authorities to meet the needs of residential and commercial users of on-site wastewater treatment systems (OWTS).	**DEM**, local governments	1-4 years
		Improve how financial assistance programs meet local needs for OWTS.	**DEM**, local governments	1-4 years
		Phase out cesspools in sensitive coastal regions via implementation of the 2007 cesspool phase-out law.	**DEM**, CRMC, local governments	Ongoing

Table 7: Water Quality Strategy

Goal: *Rhode Island's fresh, estuarine, and marine waters will support aquatic habitats, biological diversity, and their traditional and emerging human uses.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
		Approve alternative OWTS technologies and promote their use. Periodically evaluate performance and level of maintenance of OWTS systems.	**DEM**	Ongoing Ongoing
	Significantly enhance stormwater control and management state-wide	Adopt low impact development (LID) site permitting approaches for new construction and redevelopment designed to reduce stormwater pollution.	**DEM**, CRMC, DOP	1-4 years
		When applicable, promote as a model for other municipal or sewer authorities the NBC's Stormwater Management Program that requires developers to incorporate LID technologies into construction plans as an element of its sewer connection permit process.	**DEM**, **NBC**	Ongoing
		Promote as a model for other sewer authorities NBC's rain barrel distribution program. Develop LID technology demonstration sites.	**DEM**, **NBC**	Ongoing 1-2 years

Table 7: Water Quality Strategy

Goal: *Rhode Island's fresh, estuarine, and marine waters will support aquatic habitats, biological diversity, and their traditional and emerging human uses.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
		Complete in 2008 the update of the DEM stormwater manual. Integrate manual guidance into permitting of state and municipal stormwater programs. Provide training to facilitate its use by municipalities, developers and others.	**DEM**, CRMC local governments	Fall 2008 1-4 years
		Help local governments establish utility districts to provide a stable source of funding for stormwater management, including needed retrofits of existing systems.	**DEM**, DOP	1-4 years
		Strengthen state requirements for retrofits of existing stormwater systems as part of TMDL implementation	**DEM**	1-4 years
		Renew funding for the Narragansett Bays and Watersheds Restoration Fund to provide incentive grants to entities that need to retrofit stormwater systems to improve treatment. Continue to give priority to projects that implement TMDL's.	**General Assembly, DEM**	1-2 years
		Ensure that state and quasi-state facilities demonstrate leadership in adopting effective stormwater management practices.	**DEM**, NBC, DOT, DOA, URI, State colleges	1-2 years

Table 7: Water Quality Strategy

Goal: *Rhode Island's fresh, estuarine, and marine waters will support aquatic habitats, biological diversity, and their traditional and emerging human uses.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
		Increase the federal and state funding available at DOT to support construction of stormwater retrofits identified in TMDLs.	**DOT, General Assembly, Congressional Delegation**	1-4 years
Significantly Improved water quality in sensitive coastal regions including the south shore coastal ponds, state beaches, and Greenwich Bay.	Implement requirements for on-site wastewater treatment in sensitive coastal areas such as embayments and coastal lagoons.	Implement revised DEM rules for on-site wastewater treatment that require de-nitrification in certain coastal areas.	**DEM**, CRMC, local governments	Ongoing
	Promote and enforce no-discharge zone provisions in all Rhode Island's marine.	Promote the network pump-out stations and services throughout state waters. Assess and work to increase boater compliance.	**DEM**	Ongoing
		Promote the Clean Marina Program.	**DEM**, **CRMC**	Ongoing
		Investigate and increase resources for resolving pollutant sources that diminish public beaches and bathing water quality, particularly stormwater sources of pathogens such as those at Scarborough Beach.	**DEM**, DOH, DOT	1-2 years
Restoration of shellfish resources in historically closed areas throughout Rhode Island's estuarine and marine waters.	Reduce pathogen loadings from sources other than CSO's.	Shorten the time schedule if possible for completing any remaining pathogen TMDL's.	**DEM**	Ongoing

Table 7: Water Quality Strategy

Goal: *Rhode Island's fresh, estuarine, and marine waters will support aquatic habitats, biological diversity, and their traditional and emerging human uses.*

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
	Implement priority pathogen discharge abatement actions.	Renew funding to provide grants or other financial assistance to ensure timely implementation of priority control actions .	**DEM**, RICWFA	Ongoing
	Where warranted, extend or establish public sewer service to mitigate pollution problems resulting from continued reliance on septic systems in densely developed coastal areas.	Prioritize design, and construction of sewers for Portsmouth (Island Park and Portsmouth Park), Greenwich Bay. Support financing for these projects.	**DEM**, local governments	1-4 years
Timeframes: For many listed actions additional funding will be required for successful completion.	Ongoing: Action is currently being pursued by one or more agency. Additional funding may be required for completion.	1-4 Years: With adequate funding, significant progress on the action will require ongoing efforts over the next 4 years. 1-2 Years: With adequate funding, action should be completed within 1-2 years.		

FISHERIES & AQUACULTURE[14]

The [global] demand for fish, to meet population growth, is expected to increase by about 1.5 per cent annually in the coming decade.

- UN Environment Program, Global Outlook 4 (2007)

Rhode Island commercial fisheries support approximately 2,800 license holders. Landings of groundfish, squids, shellfish, and lobster provide the mainstay of the industry (Figure 10). Sea scallops, American lobster and squid have been the most valuable commercial species in Rhode Island, 2004-2006. The estimated value of commercial sea scallop landings showed a 72% increase between 2005 and 2006.

The direct dockside value of total commercial landings has been somewhat variable over the last ten years between a high of $86 million recorded in 1999 and a low of $64 million in 2002 (National Marine Fisheries Service, Fisheries Statistics Division, Silver Spring, MD, pers. comm.; Figure 10). In 2006, this value was estimated at nearly $100 Rmillion. This value does not include domestic sales, exports, or purchases of supplies and services, which suggests that the total value of the commercial fishing industry to the Rhode Island economy is much higher. The recent upswing in dockside value of total commercial landings can be attributed to the strong increase in sea scallop landed values since 2004.

Total recreational harvest of marine fisheries is nominal when compared to commercial landings in terms of weight when all species are combined (Figure 11). However, the recreational take has exceeded the commercial take in Rhode Island for several important species in recent years (*e.g.*, striped bass, bluefish, and tautog). In 2006, recreational harvest of bluefish was largest in terms of weight relative to other species (Figure 11). Striped bass, summer flounder, tautog, and scup also contributed substantially to the recreational harvest by weight in 2006. Rhode Island's recreational saltwater fisheries are a major component of its outdoor tourism and recreation offerings. Recreational saltwater angling directly generates approximately $70 million a year in direct economic activity, with an estimated $90 million in indirect impact. More than half of Rhode Island's saltwater anglers, of which there are about 182,000, are from out of state, and up to half of Rhode Island's seasonal residents engage in saltwater fishing.[15]

[14] The Rhode Island Division of Fish and Wildlife's (RIDFW) Marine Fisheries Section prepares annual reports on the conservation and management of marine fisheries resources for the General Assembly and the citizens of the State. This section is based upon the latest available annual report for 2006.
[15] RI Saltwater Angler Association 2007 report entitled, Recreational Saltwater Fishing Industry Trends and Economic Impact. (conducted by Ninigret Partners.)

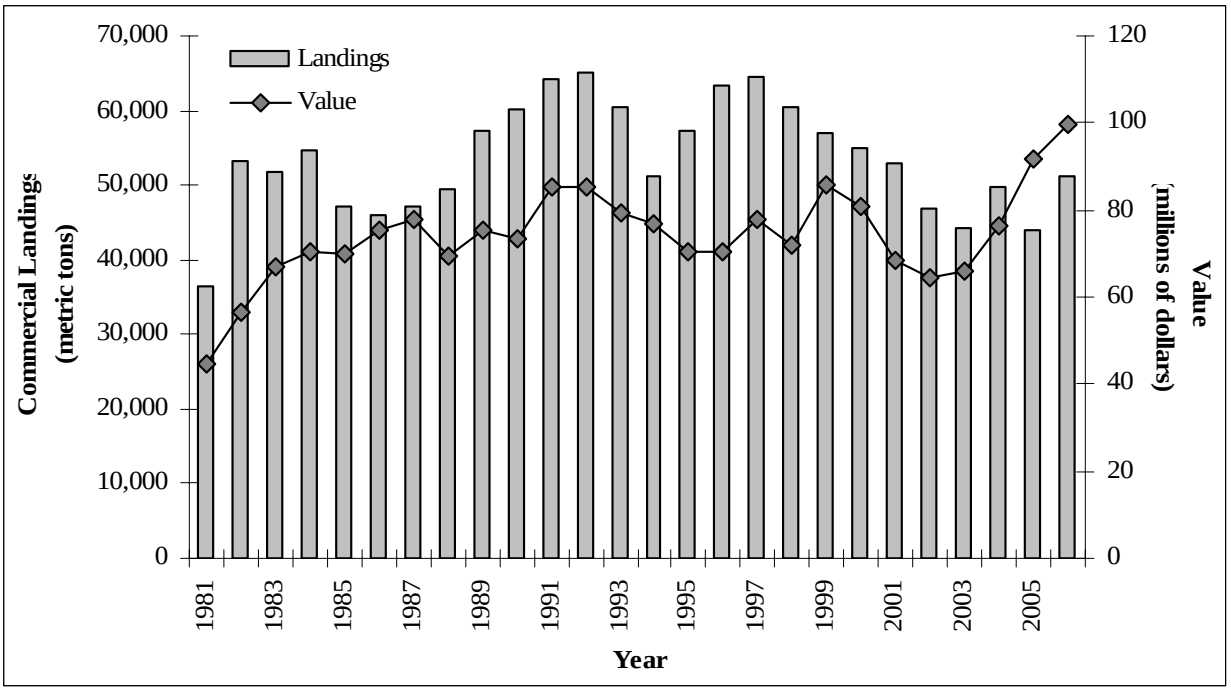


Figure 10: Total weight and estimated value of commercial landings in Rhode Island, all species combined. *Data source is NMFS.*

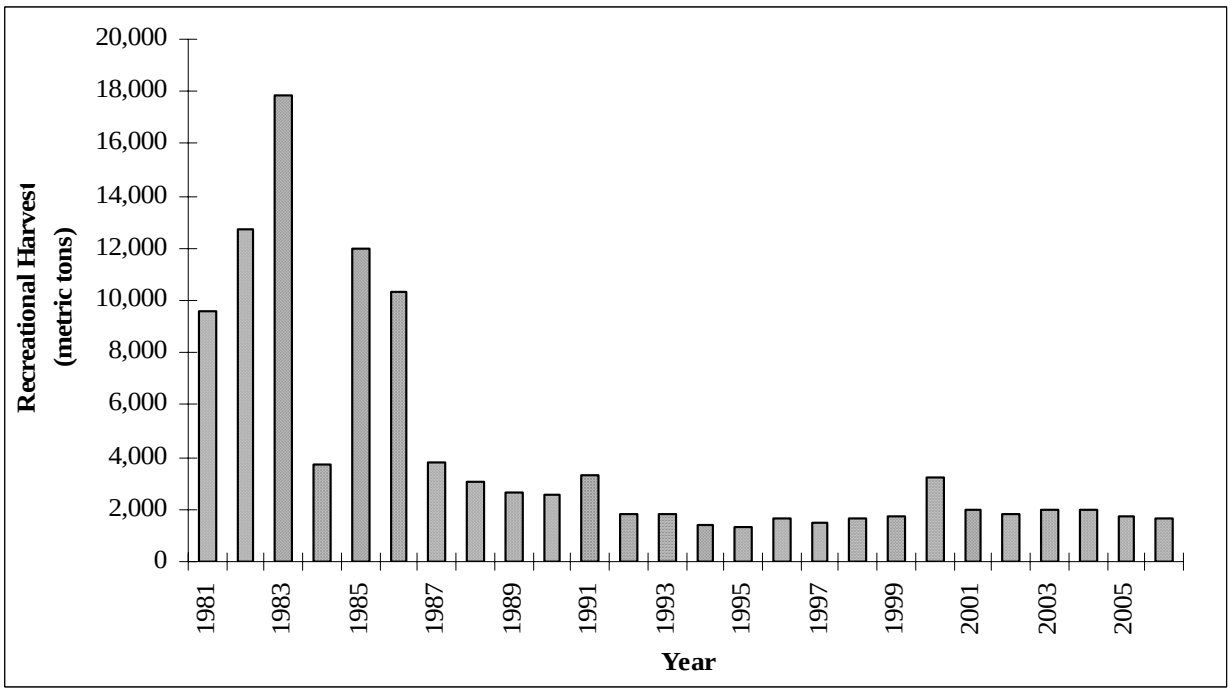
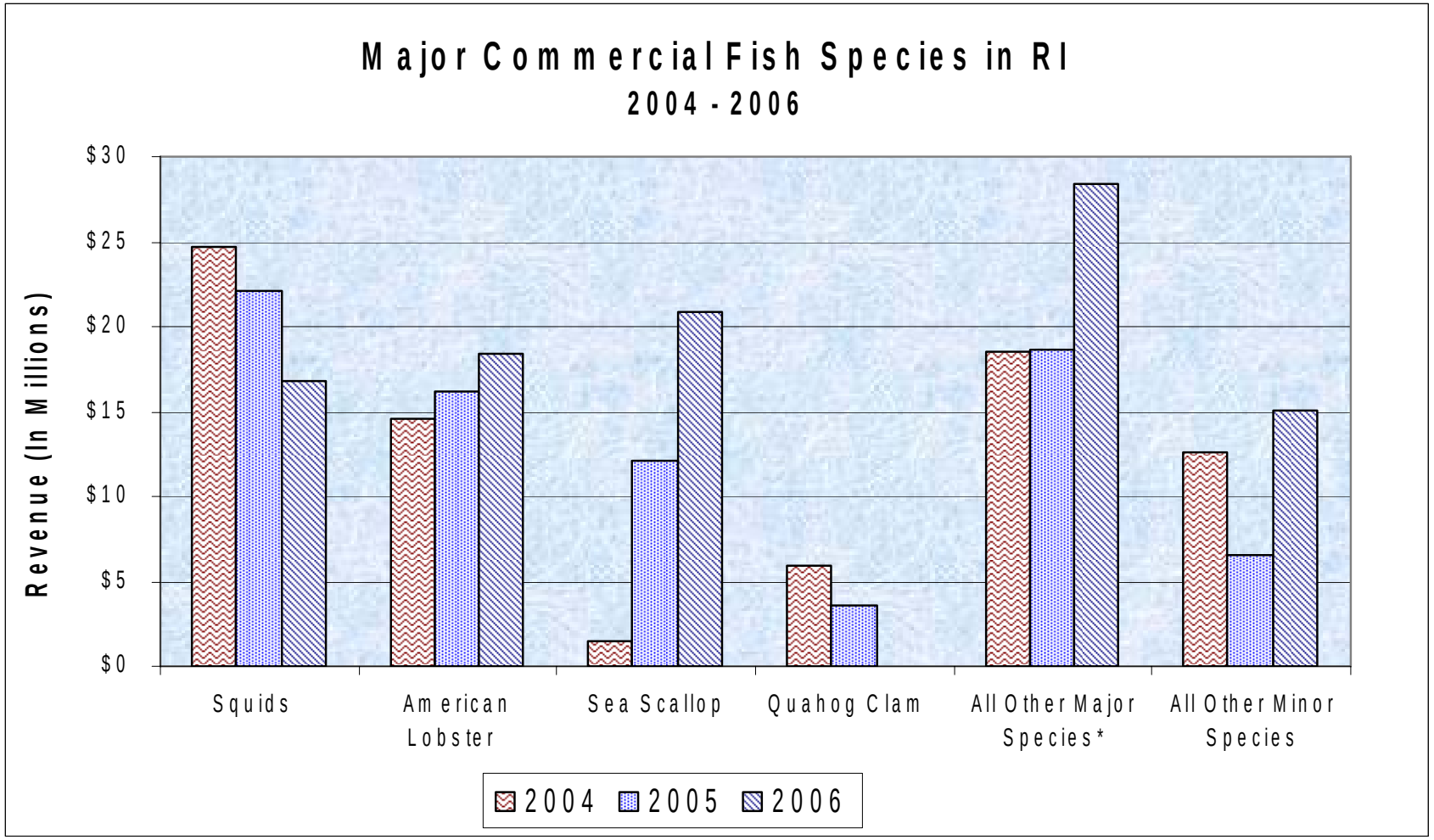
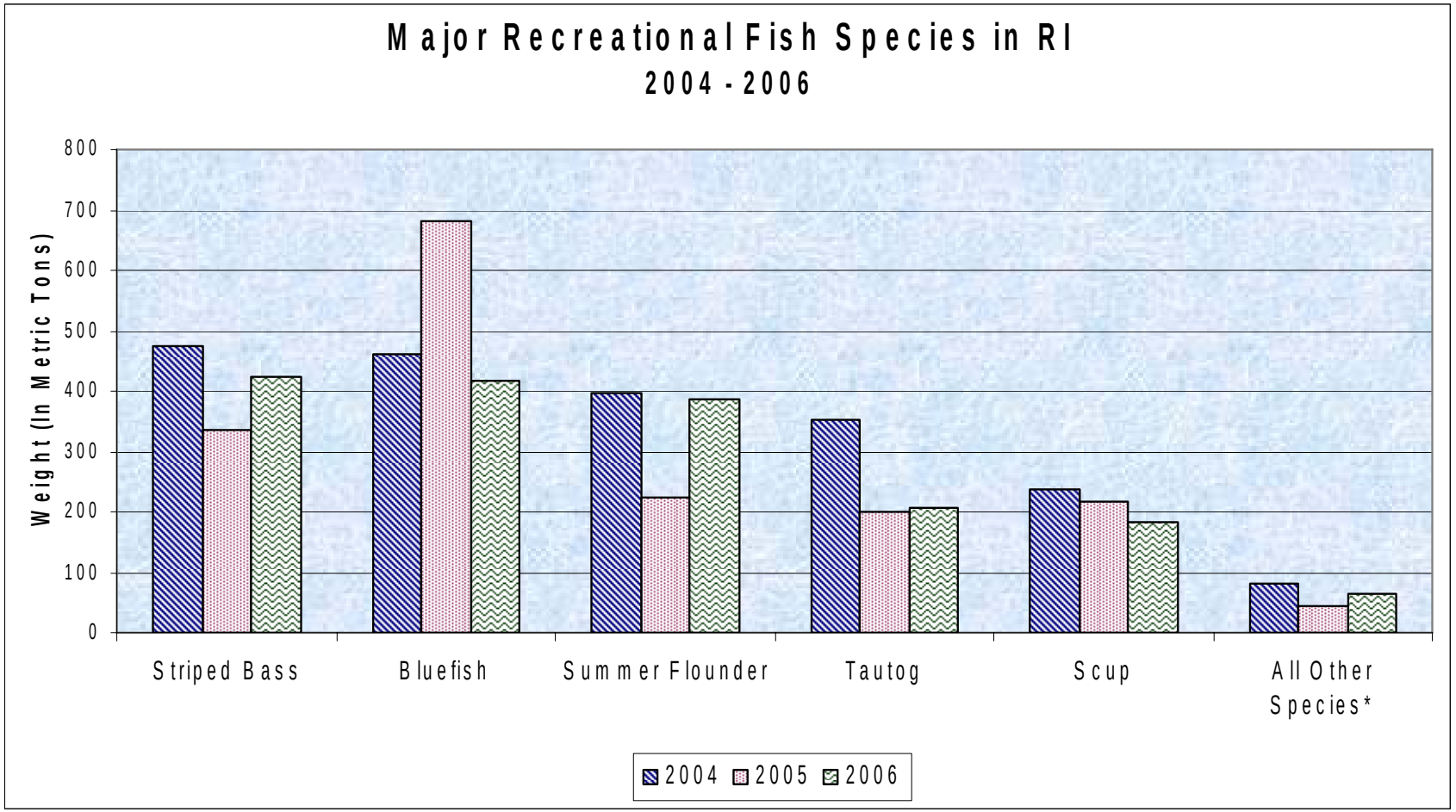


Figure 11: Weight of recreational harvest taken in Rhode Island, all species.
Data source is NMFS.



*Other Major Species include Summer Flounder, Goosefish (Monkfish), Atlantic Mackerel, Scup, Silver Hake (Whiting), Atlantic Sea Herring and Black Sea Bass

Figure 12: Top Commercial Fisheries in Rhode Island, 2004-2006.



*Other Species include Tunas, Mackerels, Black Sea Bass, Weakfish, King Mackerels, Atlantic Cod and other species.

Figure 13: Top five recreational fish species landings by weight, 2004 – 2006.

In 2006, approximately 467,000 recreational anglers—62% of them non-residents—participated in over 1.7 million fishing trips in Rhode Island waters. According to the most recent National Survey of Fishing, Hunting, and Wildlife-Associated Recreation sponsored by the U.S. Fish and Wildlife Service (USFWS), U.S. residents spent over $71.1 million on fishing trips and equipment in Rhode Island in 2001 (USFWS 2003). This estimate includes expenditures on food and lodging, transportation and other trip costs, and equipment combined.

Marine Fisheries Management

A fish stock or stock complex is judged to be overfished when its population level falls below a predefined population threshold where the population size is too low to replenish itself, i.e., when fishing pressure on a stock prevents the stock from sustaining itself at population levels necessary to maintain maximum sustainable yield (MSY). Overfishing is judged to be occurring when the harvest rate threatens a stock's ability to produce Maximum Sustainable Yield (MSY) on a continuing basis. MSY is the largest yield that can be continuously removed from a stock under current environmental conditions without adversely affecting the stock's ability to reproduce. Federal fisheries law requires rebuilding plans for all stocks that are overfished. A stock rebuilding plan is a management strategy to rebuild a stock to a size that is at or above the population threshold required to maintain MSY.

For species of commercial and recreational importance to RI fisheries, nine species are considered overfished and overfishing is occurring in eight species (Table Eight). Management restrictions on catch of these species must be maintained if these stocks are to reach sustainable levels. There are ten species that are not being overfished and not experiencing overfishing. The status of six species with respect to both overfished and overfishing is not known due to undefined overfishing definitions and/or unreliable or unavailable estimates of stock size or exploitation rates.

Specific information on the stock status of the three fishery sectors within RI follows this section. The status information presented is based on the most recent scientific peer-review stock assessment for the given species.

<u>Lobster</u>

The RI inshore fishery for American lobster (*Homarus americanus*) has declined sharply in recent years. Commercial fishery landings decreased from 3,700 metric tons in 1999 to 1,701 metric tons in 2006 (Figure 14). Biomass trends measured from RI's fishery-independent trawl survey also showed a decline from the mid-1990s through 2002; however, observations in recent years suggest a potential increase in relative biomass (Figure 15).

The value of the fishery in Rhode Island peaked in 1999 at a value of over $31 million dollars (NMFS, pers. comm.). The landings and value have since declined. In

SPECIES	OVERFISHED	OVERFISHING	REBUILDING STATUS
American Lobster (Southern New England stock)	Undefined	Yes	Restore egg production above overfishing definition by 2008
American Shad	Undefined	Unknown	Benchmark assessment and peer review pending
Atlantic Herring	No	No	Rebuilt
Atlantic Menhaden	No	No	Rebuilt
Atlantic Striped Bass	No	No	Rebuilt since 1995
Atlantic Sturgeon	Yes	No	1998 moratorium in effect until there are at least 20 protected year classes of females in the spawning population; to be rebuilt by ~2038
Black Sea Bass	Unknown	Unknown	Scheduled to be rebuilt by 2010
Bluefish	No	No	Scheduled to be rebuilt by 2008
Butterfish	Yes	No	Plan under development
Longfin Squid (*Loligo*)	No	No	
Monkfish	Yes	Yes	Scheduled to be rebuilt by 2009
Northern Shortfin Squid (*Illex*)	Unknown	No	
Quahog	Yes	No	
River Herring	Undefined	Undefined	
Scup	Yes	Yes	Draft amendment in development/review
Silver Hake (Southern stock)	No	No	Scheduled to be rebuilt by 2009
Spiny Dogfish	No	No	FMP reads “the time necessary to rebuild the female portion of the spawning stock biomass at $F = 0.03$”
Summer Flounder	No	Yes	Biomass exceeded threshold since 2003; scheduled to be rebuilt by 2010
Tautog	Yes	Yes	Biomass is not rebuilding at a substantial rate.
Weakfish	Unknown	Unknown	Six-year rebuilding period if spawning stock biomass < threshold level
Winter Flounder (Southern New England stock)	Yes	Yes	Scheduled to be rebuilt by 2015
Winter Flounder (Narragansett Bay stock)	Yes	Yes	Rebuilding schedule to be established under Amendment 1
Yellowtail Flounder (S. New England / Mid-Atlantic stock)	Yes	Yes	Scheduled to be rebuilt by 2015

Table 8: Summary of most recent stock status information available for fish species important to Rhode Island.

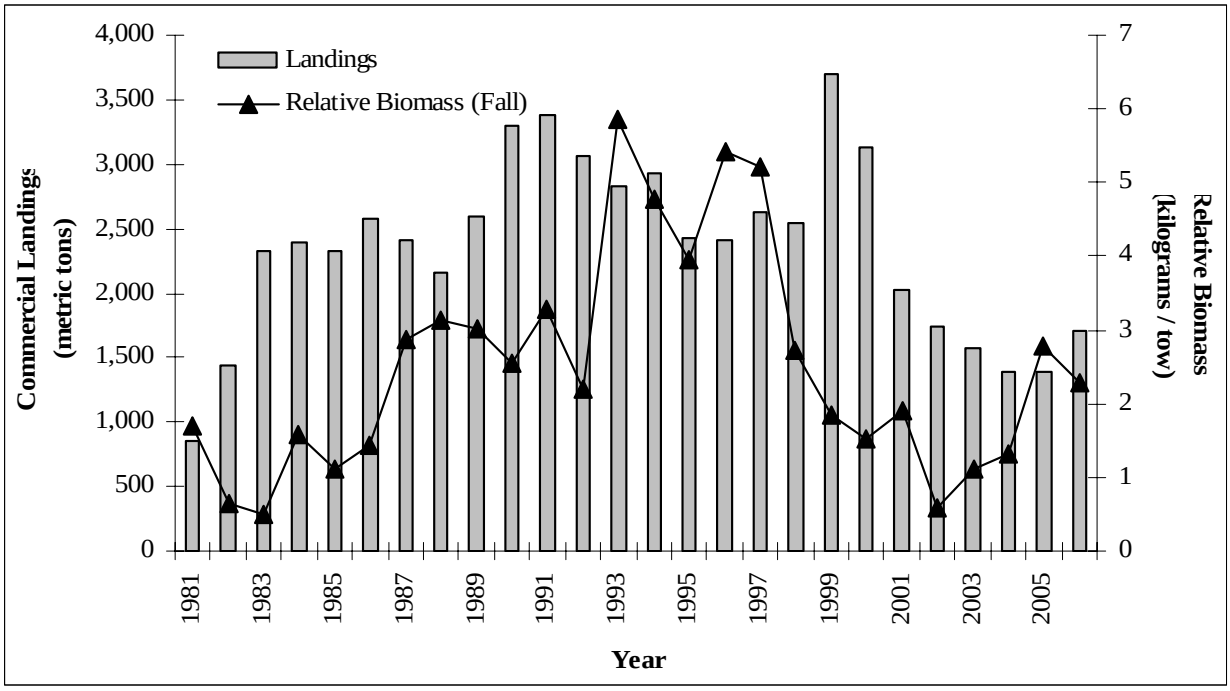


Figure 14: American lobster commercial landings in Rhode Island versus relative biomass as observed in the RIDFW Marine Fisheries Section's Trawl Survey.

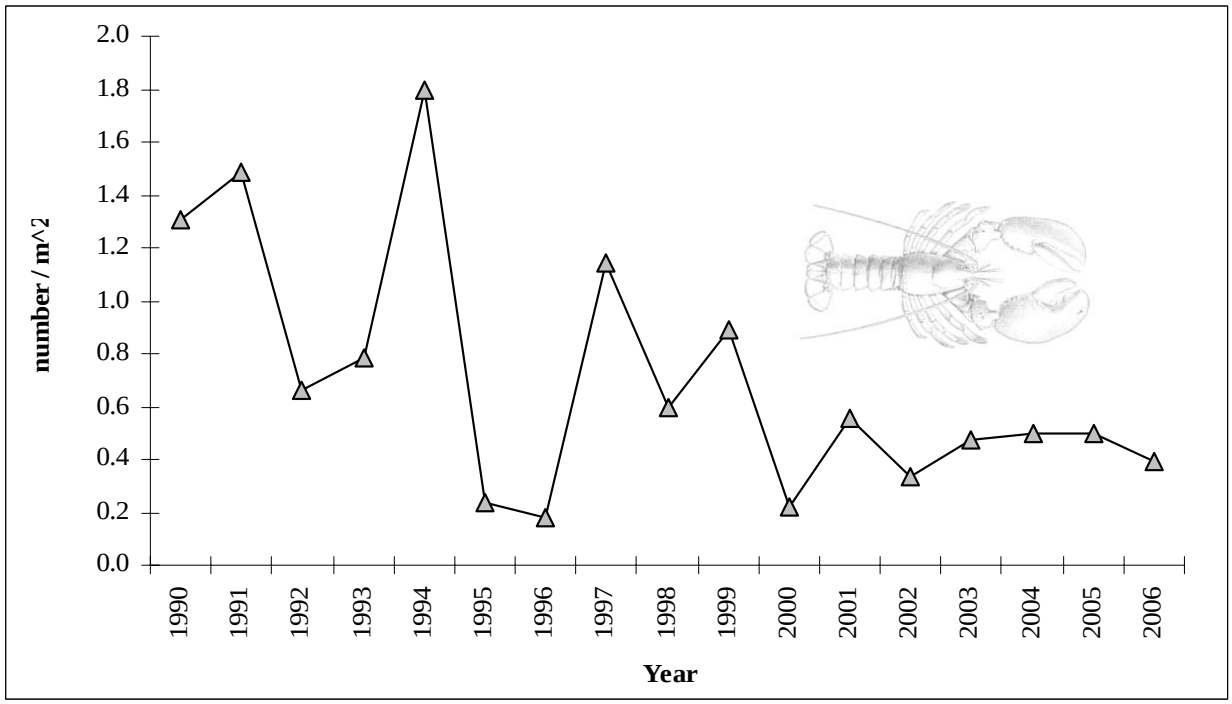


Figure 15: Relative abundance of newly settled American lobster as measured by the New England lobster settlement index. (Wahle et al. 2005)

2006, the commercial lobster fishery landed just under 1,700 metric tons with an estimated value of $18.4 million. A number of factors have been implicated in the decline including oil spills, natural cycles, increased predation, pollution, and overfishing.

The fall-off in lobster landings can be traced back to a decline in newly settled lobsters observed in the early 1990s. In the first summer after hatching, lobsters spend several weeks in the water column as larvae before settling to the bottom as miniature adults. Rhode Island, Massachusetts, Maine, and New Brunswick support a sampling program to monitor larval settlement along the New England coast. New settler abundance trended downward from 1990 to 1995 reaching a low point in 1996 (Figure 15). It is generally accepted that lobsters take 6 to 8 years to reach legal-size. The 1995–1996 settler low is consistent with low abundance of adults in the trawl survey and fishery in 2003 (Figure 14). It should be noted that, although there was some improvement in settler abundance in 1997–1999, the settlement index exhibited relatively low values from 2002–2006. This suggests that abundance of legal-size lobster could take some time to rebuild to former levels.

The decline in settler abundance apparent from 1990 to 1996 preceded an outbreak of shell disease and the North Cape oil spill. Although these factors may have contributed to the problem, they are not likely the root cause. The source of Rhode Island lobster larvae is not well known, but is likely from both local and offshore spawners. Because of intense fishery removals, sublegal first-time spawners dominate inshore spawners while the offshore stock contains a higher proportion of older, larger spawners. It may be that changing oceanographic conditions have reduced the subsidy from offshore spawners, leaving only the limited inshore spawning stock to effect reproduction. A scientific peer-review panel determined that, over the past few years, the Southern New England (SNE) stock of American lobster has been at low abundance, experiencing low recruitment, and subject to relatively high fishing mortality rates (ASMFC 2006). The ASMFC is developing remedial measures to rebuild stocks. This includes the development of an effort control plan that will be implemented in 2007.

Shellfish

The Rhode Island shellfish fishery is dominated by the Bay quahog (*Mercenaria mercenaria*). RI DEM manages quahogs entirely within state waters (except Block Island) with incorporating advice from the Rhode Island Marine Fisheries Council. The Department, through the RIDFW, uses a set of management areas and a rotational transplant/harvest system to manage the resource. Permanent and conditional pollution closures restrict the fishery in addition to seasons, possession limits, and management closures.

The shellfish fishery management plan specifies that bay-wide fishing mortality rates (F) should be maintained near the target level but below the F_{MSY} overfishing definition to allow for biomass rebuilding. This requires maintenance of fishing effort

near current levels. The rotational harvest and transplant/spawner sanctuary program should be expanded to include more areas. The most recent boat counts conducted in 2000 through 2002 and analysis of dealer landings slips indicate that about 350 active shell fishers prosecute the quahog fishery.
Stock assessments based on fishery landings, fishery effort, and fishery-independent survey data indicate that quahog stock biomass is at a relatively low level and well below that needed to produce MSY (Figure 16). However, the steady decline observed between the mid-1980s and mid mid-1990s has since leveled off.

It is believed that the apparent stock stabilization is a result of improvements to Greenwich Bay water quality, which allowed for reopening in 1994, and the Department's rotational harvest/transplant program in the Pottowomut and High Banks spawner sanctuaries, which began in 1997. Overfishing on of the stock occurred from 1979 to 1995, but recent effort levels have been below that needed to generate MSY as is desired under precautionary management (Figure 17).

Continued limitations on new entry and continuation of the rotational harvest/transplant program are needed to rebuild stock biomass to the threshold level, B_{MSY} (Figure 16). Recent deterioration of water quality in Narragansett Bay is of major concern and could threaten future management efforts. Other shellfish species commercially harvested from RI waters include soft-shelled clams, oysters, surf clams, and blue mussels. There are insufficient data available to conduct regular analytical assessments for these species, but catch-per-unit-effort (CPUE) data can be used to examine relative trends. For instance, commercial landings suggest that the relative abundance of soft-shelled clams has been increasing in recent years. However, effort in the soft shelled clam fishery may also be increasing as indicated by an increase in licenses eligible to harvest this species. The decline in oyster abundance is associated with an increase in the parasitic diseases MSX and Dermo (Oviatt et al. 1998; Gomez-Chiarri and Rice 2004).

In August 2003, a substantial anoxic event occurred within Greenwich Bay resulting in the death of many organisms including four species of finfish, three species of crab, and one species of shellfish (soft-shelled clams). An estimated one billion soft-shelled clams perished, mostly young-of-the-year. The impact on the population is uncertain at this point but caution should be taken regarding an increase in fishing pressure.

A key factor governing Rhode Island marine fisheries management is that the marine finfish fisheries found in Rhode Island state waters are regional in geographic range and hence fall under the jurisdiction of the Atlantic States Marine Fisheries Commission (ASMFC) Rhode Island has exclusive management control only for those species that spend their entire lives in state waters. Exclusivity is effectively limited to sedentary bivalves such as quahogs, oysters, and whelks (except for Block Island, which maintains town jurisdiction over these species). ASMFC, a compact of

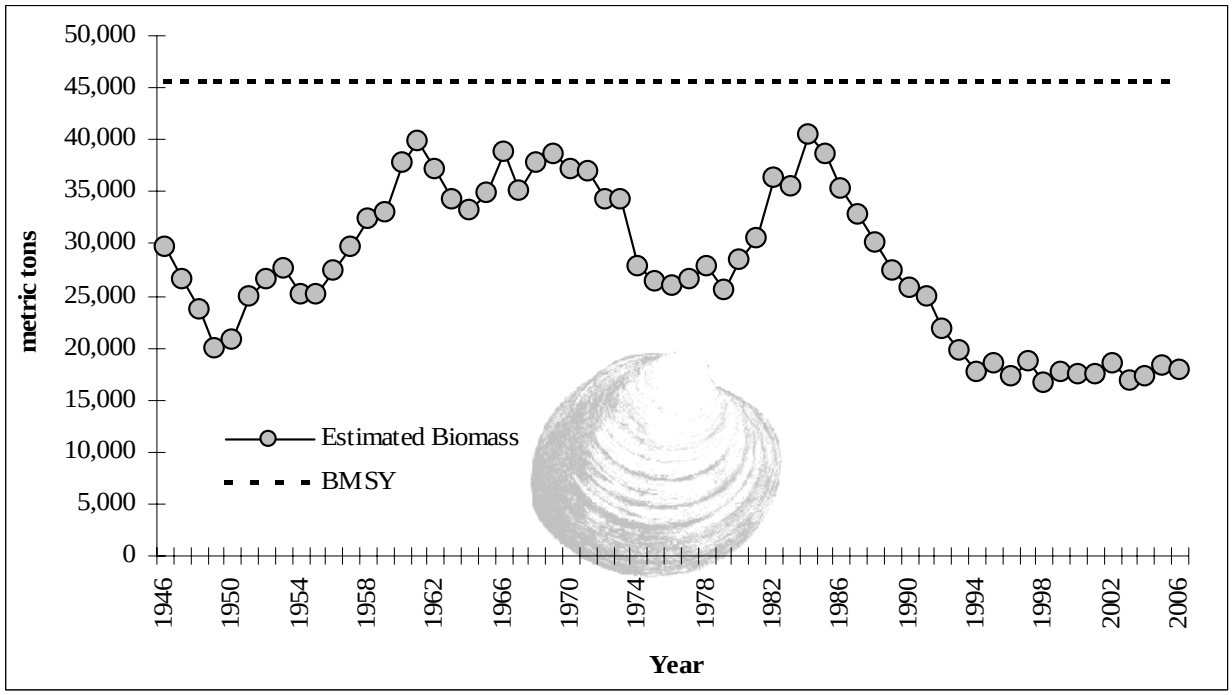


Figure 16: Estimated stock biomass of quahog in Rhode Island relative to estimated B_{MSY}.

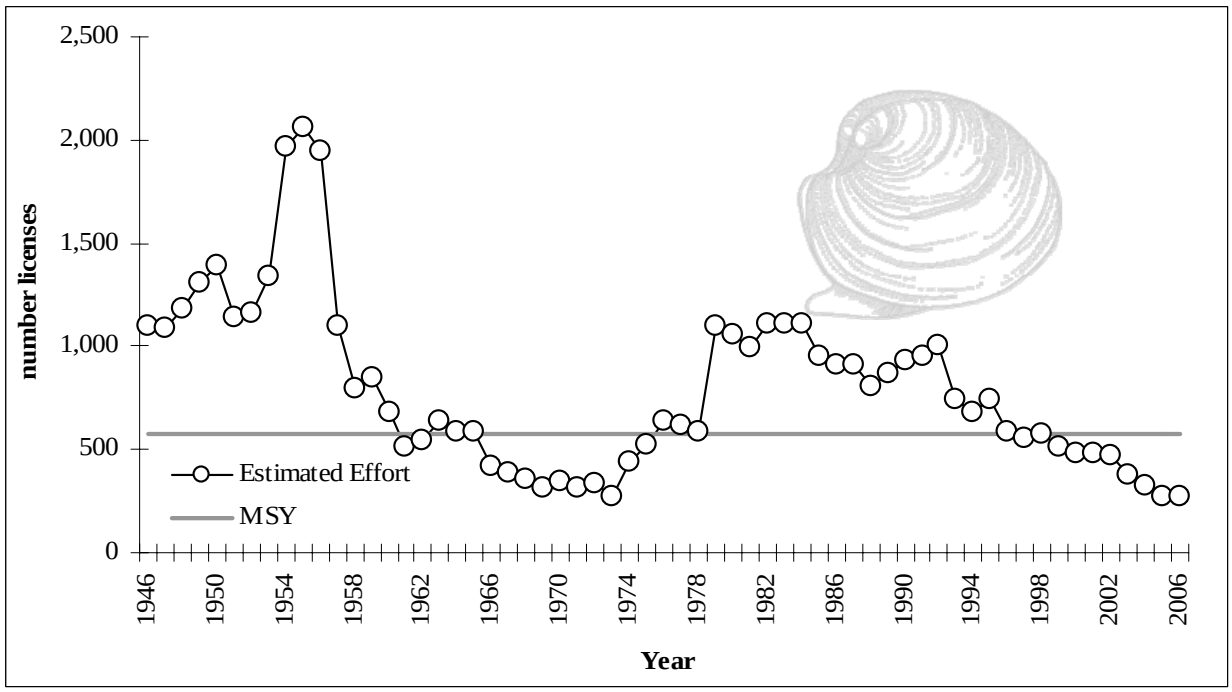


Figure 17: Estimated fishing effort in the Narragansett Bay quahog fishery.

the east coast States, manages inshore migratory species along the Atlantic seaboard inside of 3 miles. ASMFC assigns each member state an annual quota for each managed stock. RIDFW monitors catch rates and closes the fisheries once the state's quota poundage is reached. Most species under quota management are seasonal migrants to Rhode Island waters, including summer flounder, scup, black sea bass, tautog, striped bass, and bluefish.

Marine Finfish

State-federal management programs have called for reductions in fishing mortality rates of a number of species in order to allow for stock rebuilding. Commercial quotas decreased in 2006 from the 2005 levels for scup, summer flounder, and black sea bass as a result of potential decreased abundance. The quota for tautog and bluefish remained unchanged.

Indices derived from RIDFW's fishery-independent trawl survey are used to monitor relative trends in the local occurrence of marine finfish species. Fortunately, species such as scup, summer flounder, and black sea bass have exhibited an overall increasing trend in relative biomass over time.

Unfortunately, due to the apparent decreases in regional population size for some species, quotas assigned to Rhode Island are beginning to decrease. In addition, there is a lag between stock biomass increase and quota increase because it is necessary to keep fishing mortality (rate of removal) in check lest overfishing begin anew.

When available fishing effort exceeds sustainable quota levels, restrictive regulations are required. Rhode Island cannot currently maintain year-round open seasons in the quota fisheries. For example, in 2006 the summer flounder commercial fishery was only open 346 out of the 365 days available for the season. By comparison, the season in 2005 was open 359 days with a slightly larger quota. This trend of decreasing quotas and stable to increased effort will most likely exacerbate commercial fishery closures in Rhode Island for the next few years.

Resident demersal, or bottom dwelling, finfish have special problems not necessarily related to overfishing. Abundance of flatfish such as winter flounder, windowpane flounder, and hogchoker has declined substantially relative to historic levels (Figures 18 and 19). Winter flounder have been fished extensively, but the hogchokers, not targeted by commercial or recreational fishermen, have also declined at the same rate, possibly due to anthropogenic or environmental variables. Similar trends have been observed in other demersal species of Narragansett Bay that have little fishery value such as toadfish, sculpins, and grubbies. The wide range of species involved suggests that the Bay's bottom habitat has been impaired. Monitoring data indicated that Bay water temperatures have increased and that episodes of low oxygen levels occur in the Bay. Power plants and increased

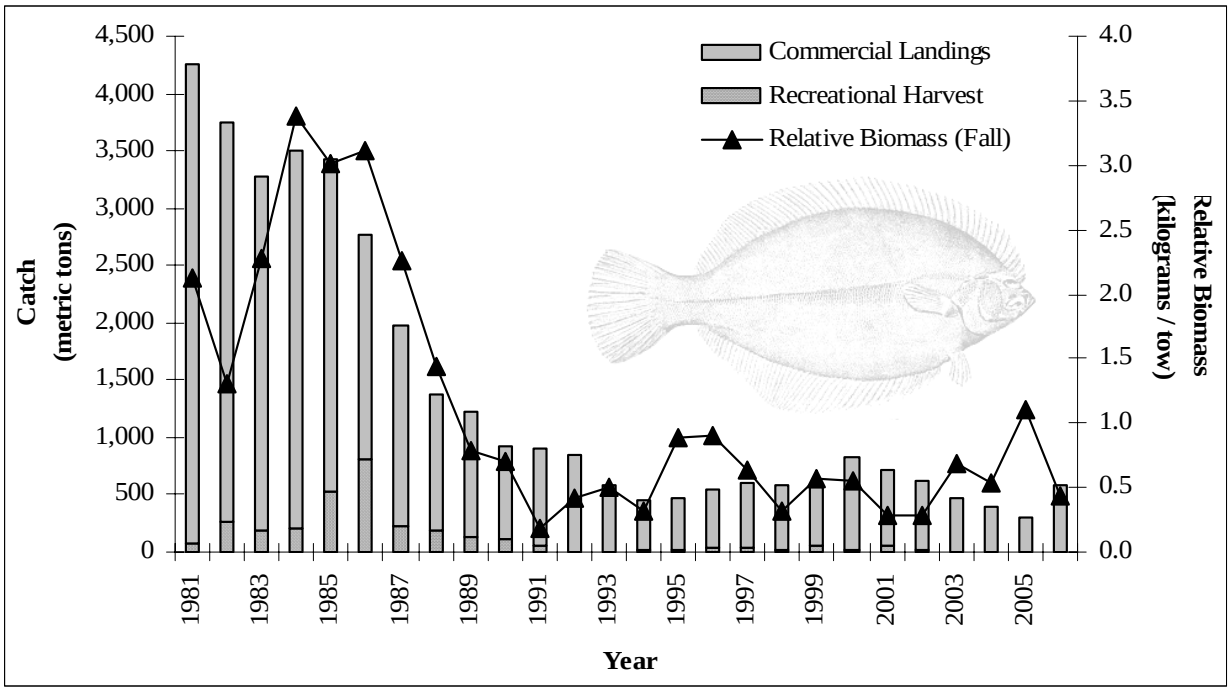


Figure 18: Commercial landings and recreational harvest of winter flounder versus relative biomass observed in the Trawl Survey.

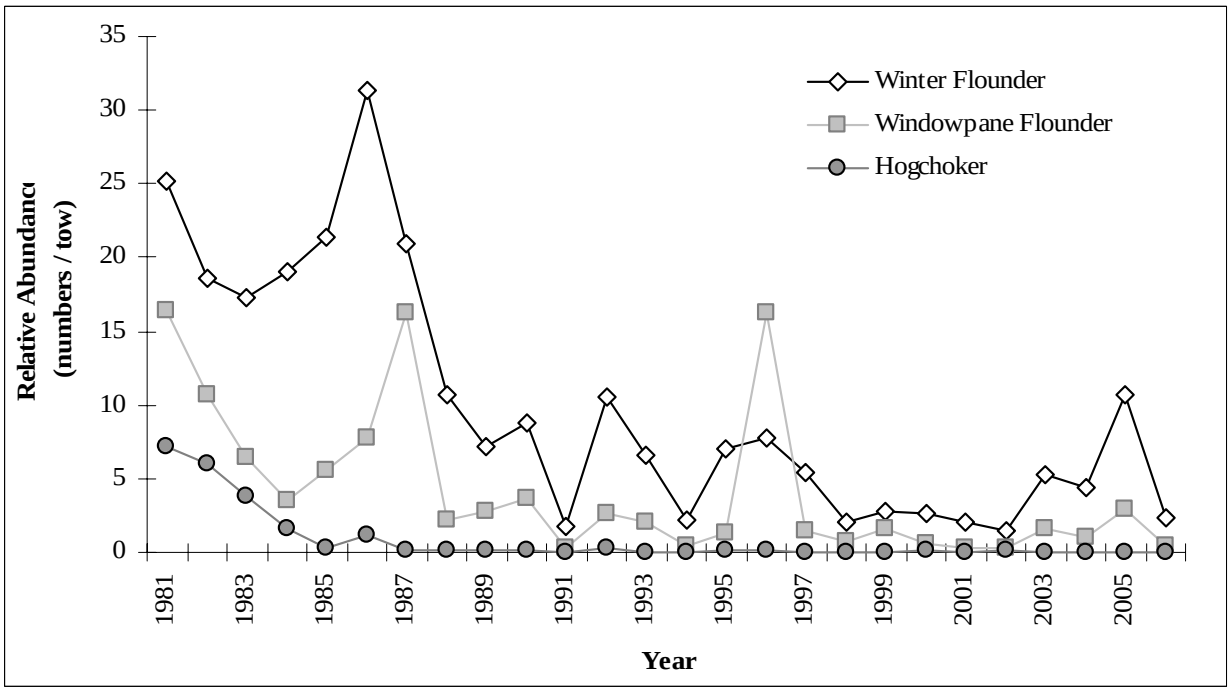


Figure 19: Relative abundance of winter flounder, windowpane flounder, and hogchoker in the fall Trawl Survey.

urbanization around the Bay impact selected fish stocks through entrainment, impingement, and thermal pollution. Overfishing continues to be a problem for winter

flounder, as confirmed by the 2005 Groundfish Assessment Review Meeting (GARM) convened in Woods Hole, MA in August of 2005 (NEFSC 2005).

Management Regimes

The New England Fisheries Management Council and/or the Mid-Atlantic Fisheries Management Council manage those species that spend most of their life cycles in federal waters (3–200 miles) and have fisheries that are prosecuted in federal waters. Once a fishery management plan has been formulated at the federal level through either ASMFC or the Regional Fisheries Management Councils, the RI Marine Fisheries Council advises the state as to how to implement management measures in state waters with regard to specifications such as seasons, quota allocations, and possession limits.

ASMFC covers species such as striped bass, bluefish, scup, black sea bass, summer and winter flounders, menhaden, weakfish, and tautog. Adding tautog to the list of state controlled species is currently under consideration, as this species has been found to spend the majority of its life in state waters. Currently, tautog is still managed through the ASMFC.

In 2002, the General Assembly passed comprehensive new legislation that restructured the commercial fishing-licensing program and further reformed the state's marine fisheries management program. The licensing statute identified new management goals and fishery conservation standards that are compatible with those by federal and interstate agencies to prevent overfishing and to assure sound management of marine resources. The Department Director was granted rule-making powers to establish a commercial licensing system in order to accomplish the goals and principals set forth in this Act with regard to participation, gear and effort restriction, area closures, and minimization of by-catch. This new commercial licensing system has been successfully implemented for the past four years.

In 2004, the General Assembly passed and the Governor signed new legislation (S 2771) that provides a framework for the Director of DEM and the Marine Fisheries Council to better manage Rhode Island's marine fisheries. The new statute creates a much improved fisheries management process, consistent with the goals established by the General Assembly in the Marine Fisheries Management Modernization Act of 2001.

Recent Regulatory Changes

Two of the larger regulation changes for 2006 were the enactment of a requirement for seafood dealers to begin reporting through SAFIS (Standard Atlantic Fisheries Information System) and the promulgation of a lobster effort control plan.

The SAFIS system is an internet-based electronic fisheries reporting interface that captures all of the commercial seafood transactions in the state at the dealer level and allows for greater detail for use in fisheries management.

The lobster effort control plan allocates a total quantity of lobster pots among fishermen based on their historical efforts in the Rhode Island industry. The intent of the plan is to bring the total effort in the Rhode Island lobster fishery to the effort level prosecuted during 2001-2003. Capping total allowable effort by limiting the total number of lobster pots utilized by the fishery will prevent a large increase in effort once the productivity of the lobster fishery begins to recover.

Rhode Island Commercial Fisheries Economics

In 2007-2008, the BRWCT Economic Monitoring Collaborative undertook an in-depth assessment ("value-chain" analysis) of a number of Rhode Island's water-reliant economic sectors, including commercial fishing. The purpose of the analysis was to begin to develop a deeper understanding of the economic health, productivity, and future prospects of commercial fishing in Rhode Island.

Commercial fishing has been a mainstay of Rhode Island's economy since the state's inception and continues to play an important role in Rhode Island's economy. However, developing estimates of the size and functioning of Rhode Island's commercial fishing industry is difficult for a variety of reasons:

- There are no detailed prior studies of the commercial fishing industry in Rhode Island to use as a benchmark;
- Large numbers of commercial fishing crews are self-employed, limiting the amount of easily collectible data through traditional sources such as ES 202 unemployment filing data;
- Seafood distributors are varied in their product mix, so discerning how much is seafood-related is difficult;
- Where a boat is domiciled and where its catch may "land" is often different;
- Catch estimates are not reliable measures for seafood processing due to the differences between distributor activities and seafood product processing versus local catch estimates

RI's commercial fishing catch over the last five years has had substantial variability in pounds landed. However, due to changes in types of landed catch the value of the catch has steadily increased (Figure 10).

In Rhode Island, the direct commercial fishing industry represents approximately 1,700 jobs and as much as $98 million in wages.[16] In addition the BRWCT

16 Employment estimates were based on using ES 202 reported data plus the number of individual commercial permits. NP estimated employment totals by taking an average employment per permit. This was derived by reviewing estimates of other fishery studies with selected discussions with boat crews based in Pt. Judith. Wage estimates were based on both national and regional ES 202 data.

Economic Monitoring Collaborative estimates that the RI fleet spends another $11 to $18 million in boat operating costs and approximately $9 to $15 million in maintenance associated costs. In total RI's commercial fishing industry is likely responsible for at least $100 million in annual economic activity and perhaps as much as $130 million annually.

As an example, Rhode Island represents a large share of the wild harvested shellfish and related species catch in the United States. An unintended consequence of the closing of the state's shellfishing beds due to the pollution control issues in parts of the Bay may actually increase the penetration rates of cultured shellfish products that are substituted for unavailable wild harvested catch. Therefore, how well Rhode Island's shellfish diggers handle increased competition from cultured shellfish products produced nationally may be determined in part by the control of pollution impacts upon Narragansett Bay's key shellfishing grounds. If Catch per Unit Effort (CPUE) can be reduced by the relatively greater ability for shellfishermen to access productive shellfish beds, the price competitiveness and year-round availability of wild shellfish landings will be enhanced. It is important to keep in mind that the wild shellfish harvest consists primarily of hard clams (quahogs) while the Rhode Island aquaculture industry focuses upon oyster culture. The competition Rhode Island's shellfish diggers face are generated by hard clam culture operations in other parts of the U.S.

The development of the commercial fishing industry and the constraints of distribution capabilities early in the development of the industry led to close association of the downstream processing activities with fishing ports. This clustering of production and processing activities created significant economic value and wealth for local fishing communities. The remnants of this clustering continue to exist in part due to the capital intensity of the industry. However, global logistics and improvements in refrigeration technology allow for fishery markets and processing to be less dependent on geographic proximity and be global in nature. Therefore in many cases downstream seafood processing industries may be less dependent on the local catch than in prior times. Moreover, improvements in global logistics have changed the nature of consumer markets.

The processing and brokering function represents approximately 448 jobs and $18 million in wages in Rhode Island. The final step in the chain (consumer markets) represents approximately 2,500 jobs and wages of $39 million in Rhode Island. These numbers include only seafood restaurants, not all restaurants that serve seafood.

This estimate may be overstated since it is not adjusted for FTE associated issues due to the difficulty of estimating an industry with high levels of temporary self employment.

In addition to their fisheries management responsibilities, DEM and other state agencies are responsible for maintaining and improving port facilities that support the economic viability of the both recreational and commercial fisheries, particularly in Newport and Point Judith. With funding from the Rhode Island Capital Fund, DEM recently announced the start of a renovation project for the "working pier" portion of State's Pier 9 in Newport, which is utilized by approximately fifty commercial fishing vessels, including inshore and offshore lobster boats. Capital funding for this project is contained in the FY 2009 state budget.

The future for Commercial Fisheries in Rhode Island

Rhode Island's commercial fishing industry will be challenged economically by rising fuel costs, as well as federal requirements to institute ecosystem-based management (EBM) approaches to marine fisheries management through essential fish habitat designations and related measures.

"Fuel Prices Drive Long-Term Fishermen Out of Business"

[In late March, 2008,] the price of marine diesel fuel jumped to nearly $3.65 a gallon, up from around $2 a gallon a year ago, says Chris Drew, the owner of Drew Oil Corp. in Cranston. "Fishermen have been complaining about the price of fuel since last October and it's done nothing but go up since," says Drew. In past years, fishermen have hunkered down during the bad times. They've survived boat fires, oil spills and ocean storms. When the lobster population thinned a half dozen years ago, many dipped into their retirement funds, and fished for other species. They stuck with it because they knew it would get better. Now, some are wondering, How long can I wait? "A lot of people are tying up their boats, waiting for better times," says Lanny Dellinger, president of the Rhode Island Lobstermen's Association.

Unlike some business owners, fishermen can't pass on to the consumer an increase in operating costs, says Dellinger. Fishing is a heavily regulated industry and most fishermen can sell only to licensed fish and lobster dealers. The dealers — not the fishermen — determine the price paid at the dock. "We can't cut out the middle man and sell directly to the restaurants," he says.

Lobstermen are catching as many lobsters this year as last, but they're getting less for them, he says. "Meanwhile, the overhead has gone through the roof. The price of bait has gone up. The gas we put in our trucks has gone up. All the stuff we use, things like buoys, are made of petroleum, and the cost of those things have increased tenfold. It's killing our industry coast wide.

Fishermen face other challenges, too, says Chris Brown, president of the RI Commercial Fishermen's Association. Tightening federal regulations have shortened the time they can spend at sea. And catch limits have reduced what captains and crews can take home. Brown says he understands the need to stop overfishing, but many species are rebounding, he says. However, the federal government can take years before it relaxes a law, he says.

Fishermen like Dellinger have another concern. If fuel prices remain high, fewer fishermen will need dock space. Waterfront dealers and other marine-related businesses could falter or fail. That, in turn, could put pressure on companies to sell to developers, he says."

- Paul Davis
Providence Journal
March 21, 2008

Sector-based management approaches where fishing fleets are given greater say in how stock quotas are consumed are also receiving significant attention in reform efforts regionally. Sector-based management approaches to the disbursement of ASMFC quota allocations have met with controversy in Rhode Island because of concerns that they will reduce future access to commercial fisheries. Other fishermen feel that allowing greater flexibility in how

fishermen operate within the limits of quota allocations will control operating costs and improve profitability while allowing overfished stocks to rebuild at mandated rates. The New England Marine Fisheries Management Council is moving forward with planning for sector-based management schemes as part of its effort to implement federal EBM requirements imposed by federal fisheries law.

Freshwater Fisheries

Rhode Island's rivers, streams, lakes and ponds support recreational freshwater fisheries including salmon, trout, black bass, northern pike and charr. Native species include the brook trout which requires a coldwater stream habitat. DEM is in the process of incorporating designations of coldwater streams into the State's water quality standards to strengthen protection of coldwater stream habitat, including the prevention of alterations which result in temperature changes.

Rhode Island's freshwater hatcheries, including the Carolina Trout Hatchery, Perryville Hatchery and the recently improved Lafayette Trout Hatchery in North Kingstown raise brook, rainbow and brown trout, producing over 1.3 million fish per year. Throughout the spring, summer, and fall, Rhode Island stocks over 110 of its ponds, lakes, and streams. Freshwater fishing is a major outdoor recreational activity for Rhode Islanders. The RI SCORP/LeisureVision study of 2002 indicated that 17% of Rhode Islanders engage in freshwater fishing as outdoor recreation. Improved water quality, adequate streamflows, riparian buffer protection, habitat restoration and other measures discussed in this plan all will contribute to the well-being and attractiveness of Rhode Island's freshwater fisheries.

Subsistence Fishing

Subsistence fishing, which entails fishing as a major means to meet human nutritional needs, occurs in Rhode Island's urban rivers, ponds and streams, many of which contain contaminated sediments and poor water quality. Anecdotal information and knowledge indicates that subsistence fishing is possibly occurring at a level that produces significant public health impacts. The RI Department of Health (DOH) provides detailed public health information on-line to advise consumers of freshwater fish caught in Rhode Island. Primary concerns center upon mercury contamination of freshwater fish, and the DOH advises that the consumption of freshwater fish other than stocked trout be avoided; it also advises against consuming any fish from certain fresh waterbodies including the Blackstone and Woonasquatucket Rivers. But, as discussed in the above Water Quality section there is insufficient to no data available about the extent of fish tissue contamination in Rhode Island's freshwater fish.

Rhode Island's goal of achieving fishable, swimmable rivers by 2015 will be important for the health and safety of Rhode Island residents in that improvements to water quality should continue to reduce the public health risks of consuming freshwater fish.

In the meantime, locally lead initiatives to promote fish ladders and/or dam removals, returning anadromous fish to our rivers, and continued stocking of our rivers and ponds by DEM will provide safe alternatives for those who recreationally fish and those who fish for sustenance.

Marine Aquaculture

High quality shellfish culturing environments exist in Rhode Island's coastal lagoons or salt ponds, and in Narragansett Bay. Shellfish aquaculture can contribute to water quality by filtering nutrients and providing habitat structure on featureless, sandy bottoms. Rhode Island shellfish aquaculture has been growing rapidly in the last decade with total sales in 2006 exceeding $1 million for the first time since the early 1900's. Rhode Island shellfish aquaculturalists are successfully marketing shellfish as premium seafood products (the "Watch Hill Oyster"), enabling local growers to compete successfully with industrial-scale shellfish aquaculture operations.

As with the commercial finfish industry, the aquaculture industry also must cope with high labor, energy and land-side costs. The Rhode Island commercial shellfishing industry has in the past resisted and opposed aquaculture development. Today, that resistance has been mitigated as a consequence of the fact that almost half of current aquaculture leaseholders are directly involved in commercial shellfish harvesting. With enthusiastic support from Rhode Island Coastal Resources Management Council (CRMC), the percentage of leases held by commercial shellfishermen has reached 57% of the leases in the salt ponds and 39% of all aquaculture leases throughout Rhode Island waters. The commercial diggers have also been experimenting with marina-based seed culture techniques to enhance the wild stock and improvement embayment water quality.

The CRMC and the Department of Environmental Management (DEM) strongly support shellfish aquaculture in Rhode Island's public trust waters with CRMC retaining lead permitting authority for all aquaculture operations in the state. Opportunities exist for current aquaculture leaseholders to improve operational efficiencies and profitability by reducing space requirements and controlling production costs.

In 2007, aquaculture in Rhode Island continues to be a dynamic – albeit small -- and fast growing industry. For the first time in eight years Rhode Island has a commercial finfish farm, which produces marine ornamental fishes for the aquarium trade. The "farmgate" value (the value for the product paid to the aquaculturalist) of the industry grew by nearly 18%, with an 8% increase in oyster sales and a 60% decrease in clam sales (Figure 20).

Year	Percent Change in Farmgate Value
1995-1996	9.6%
1996-1997	72%
1997-1998	13%
1998-1999	20%
1999-2000	47%
2000-2001	-4.7%
2001-2002	59%
2002-2003	16.5%
2003-2004	1.6%
2004-2005	29.9%
2005-2006	81.2%
2006-2007	17.75%

Table 9: Percent change of the "farmgate value" of cultured shellfish production in Rhode Island from previous year. (See Figure 20 for overall production value figures.)

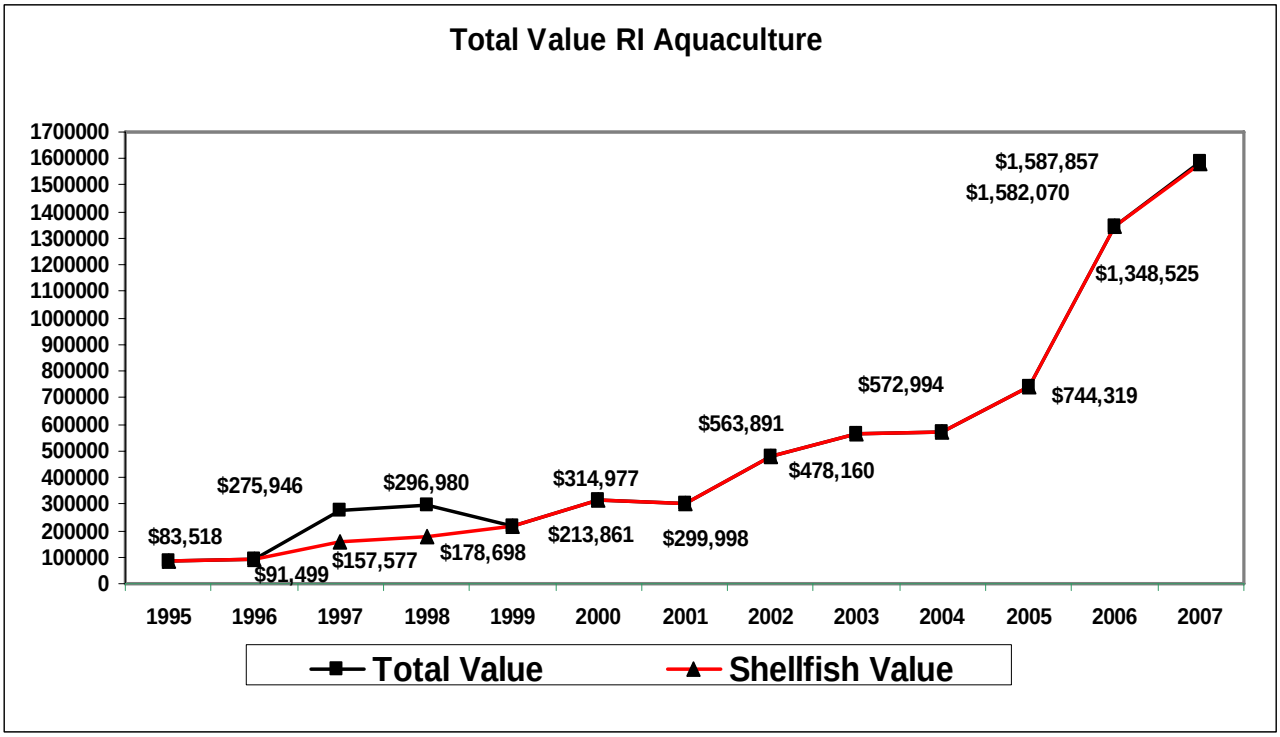


Figure 20: Annual Sales of RI Aquaculture Products, 1995-2007

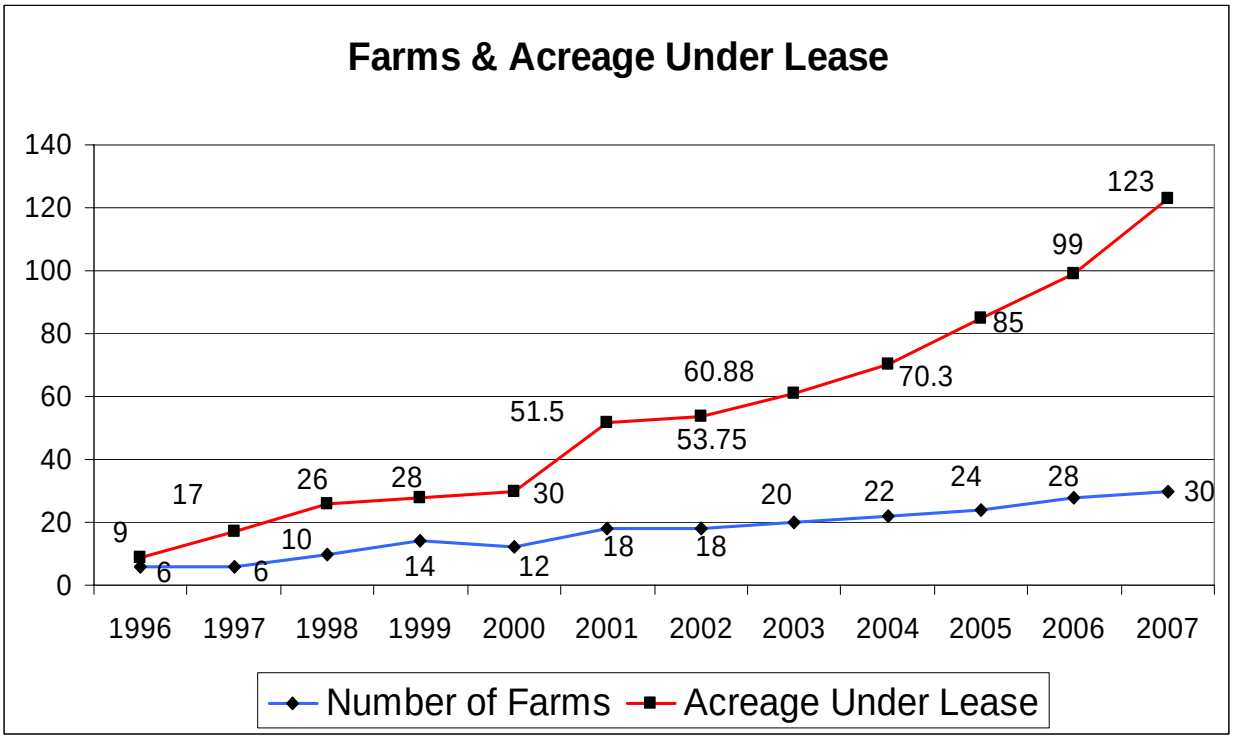


Figure 21: Number of Aquaculture "farms" and total acreage leased in Rhode Island, 1996-2007.

The increase in total sales stems from higher oyster prices, more farmers selling to the retail market and the addition of the ornamental fish culturing operation to state total sales.

The American oyster was the predominate species of shellfish grown in Rhode Island, accounting for 99 percent of the total harvest; the hard clam was the only other species cultivated, making up 1 percent of the total harvest. The amount of oysters harvested increased 8% from 2006. Clam production decreased 60% in 2007. In 2007, the number of farms increased from 28 to 30, a 7% increase, (Figure 21) with leased acreage increasing 24% from 99 to 123 acres.

From 2006 to 2007, total Rhode Island aquaculture product sales increased 18% (Annual sales for 1997 and 1998 included a retail ornamental finfish operation). In all other years up to 2006, 100% of Rhode Island aquaculture product sales entailed shellfish. The two numbers for 2007 in Figure 20 reflect the total value of all aquaculture products ($1,587,857) and the total shellfish value ($1,582,070).

CRMC Working Group on Aquaculture Regulations

During the past year the CRMC Working Group on Aquaculture Regulations reconvened to address concerns about the lack of a long-term plan for aquaculture development. The group first convened in 2000 and met until 2001. This first series

of meetings resulted in changes in CRMC regulations and helped to increase communication between the industries and regulators.

In early 2007, questions arose regarding the growth in aquaculture leasing applications for southern Rhode Island's coastal lagoons, or salt ponds. It is appropriate to address these questions while the extent of aquaculture leasing in Rhode Island's salt ponds remains small. As of 2007, only 55 acres of the salt pond region's 5,387 acres were devoted to commercial shellfish aquaculture.

The Rhode Island Marine Fisheries Council (MFC) and DEM's Division of Fish & Wildlife voiced concerns regarding whether there was adequate understanding and knowledge of potential impacts to permit such growth in salt pond bottom acreage leased for aquaculture. Potentially negative consequences of bottom lease expansions for shellfish aquaculture include: Loss of areas available for wild shellfish harvesting (commercial and recreational), diminished aesthetic values, interference with navigation and recreational activities, and the diminishment of critical habitat for finfish (winter flounder).

After a series of discussions between the CRMC and the MFC, CRMC decided to temporarily halt consideration of new aquaculture lease requests for the salt ponds until long-term priorities for aquaculture development could be collaboratively worked out. Accordingly, the CRMC reconvened the Working Group on Aquaculture Relations to address future aquaculture development in Rhode Island, with a particular focus on shellfish aquaculture expansion in the salt ponds.

This Working Group on aquaculture relations completed and approved its report in January 2008. The full report can be viewed on the CRMC web site at: http://www.crmc.ri.gov/projects/aquaculture.html. It makes the following recommendations:

- Limit shellfish aquaculture to no more than 5% of the area of any water body until specific estimates for Rhode Island waters can be generated with site-specific data.

- Seek funding to investigate the ecological carrying capacity of estuaries in Rhode Island for aquaculture and to investigate the interaction of shellfish aquaculture with native species.

- Establish a single interdepartmental advisory board that would be in charge of providing recommendations for the regulation and management of infectious diseases in wild and cultured populations of aquatic organisms.

- Provide funding and mechanisms for assistance in the form of disease monitoring for aquaculture and wild harvest industries, extension personnel and develop a rapid-response plan for the outbreak of disease.

- When considering new aquaculture leases, continue to provide special protection for eelgrass habitat and native species.

- Encourage growers, researchers and regulators to conduct studies to determine optimal stocking densities to maximize growth and minimize potential negative impacts

The report also cited the importance of continued work on aquatic invasive species (AIS) to:

- Ensure that regulations and management of AIS introductions are uniform throughout the region.

- Undertake an aggressive outreach and education program to teach the general public about the risks associated with the introductions of exotic species.

- Utilize the 2004 ICES Code of Practice on the Introductions and Transfers of Marine Organisms to review and approve any intentional introductions proposed for an aquaculture operation.

By the summer of 2008, the Working Group is expected to issue a consensus statement on recommended regulatory changes. Once these recommendations are completed, an aquaculture development plan for the state will be drafted and submitted to DEM and CRMC.

Aquaculture-Related Industries

Aquaculture support companies are actually the largest component of the state's aquaculture sector, including the distribution of aquaculture products (finfish and shellfish) and the manufacturing of aquaculture products to be used on farms. These companies produced a gross total of $4.3 million in business in the state in 2007 and employed 25 full-time employees. Not only do these companies serve local and regional farmers, but they also export internationally. As the industry grows in Rhode Island, the nation and the world, Rhode Island's aquaculture support companies have the potential to grow substantially.

Conclusion

Rhode Island's aquaculture industry takes advantage of the state's assets, its clean waters, universities and experienced, motivated, and highly skilled communities of shellfishermen and aquaculturalists. Regardless of its relatively small size, it is a diverse and dynamic industry. The companies, farmers and universities are showing their trust in the future of the industry by investing time and capital towards increasing their competitiveness now and into the future.

Table 10: Fisheries and Aquaculture Strategies

Goal: *Rhode Island will maintain sustainable and vital freshwater and marine fisheries, as well as a diverse, thriving aquaculture industry.*

Objectives	Strategies: 2009-2013	Action	Agencies lead agency in bold	Time Frame
Sustainable and profitable commercial fish harvests.	Rebuild fishery stocks in conformity with state and federal law.	Maintain fishing mortality rates and stock abundances to minimize the risk of stock depletions and recruitment failures.	**DEM**, ASMFC, N. England Marine Fisheries Council	Ongoing
	Institutionalize cooperative management regimes for commercial fisheries.	Promote state-wide and regional mechanisms for cooperative management with industry that emphasize efficient fishery operations, consistent with biological objectives.	**DEM**, ASMFC, N. England Marine Fisheries Council	1-4 years
		Incorporate adaptive management principles into fisheries regulations to improve management of unanticipated short-term events or circumstances.	**DEM**	1-4 years
		Develop stakeholder process (fisheries roundtable) to explore and balance the interests of Rhode Island recreational and commercial fisheries in relation to shared fisheries such as menhaden.	**DEM**	1-2 years

Table 10: Fisheries and Aquaculture Strategies

Goal: *Rhode Island will maintain sustainable and vital freshwater and marine fisheries, as well as a diverse, thriving aquaculture industry.*

Objectives	Strategies: 2009-2013	Action	Agencies lead agency in bold	Time Frame
A flourishing Rhode Aquaculture Industry that respects traditional commercial fisheries and cultures.	Support the development of innovative aquaculture businesses that take advantage of Rhode Island's core strengths in aquaculture research and technology development.	Consider offshore aquaculture opportunities in conjunction with future wind farm operations.	**CRMC**	1-2 years
		Expand shallow water shellfish aquaculture in relation to CRMC/MFC endorsed strategic planning.	**CRMC**, DEM	1-4 years
Timeframes: For many listed actions additional funding will be required for successful completion.	Ongoing: Action is currently being pursued by one or more agency. Additional funding may be required for completion.	1-4 Years: With adequate funding, significant progress on the action will require ongoing efforts over the next 4 years. 1-2 Years: With adequate funding, action should be completed within 1-2 years.		

BIODIVERSITY: AQUATIC HABITATS AND INVASIVE SPECIES

> *Only when society incorporates the values of **biodiversity** in political and market systems, internalizing environmental costs into prices, ending perverse subsidies – for instance, for energy, agriculture and fisheries – and properly valuing biological resources, will biodiversity loss really be slowed. Increased understanding of how people relate to biodiversity, and how to move towards greater stewardship of biodiversity, may the biggest question the world still must answer.*
>
> - UN Environment Program, Global Outlook 4 (2007)

Aquatic Invasive Species

Aquatic invasive species (AIS) are second in importance only to habitat destruction as a cause of declining biodiversity in the United States. While Rhode Island has been fortunate thus far to avoid the introduction of well-known aquatic invasive species like the zebra mussel and the Chinese mitten crab, many other species have already invaded and impacted the state's marine and freshwater ecosystems.

Marine aquatic invaders that have become established in Rhode Island include the European green crab, Asian shore crab, the red macroalgae, G*rateloupia turuturu*, and various species of sea squirts and shellfish pathogens. A 1999 Cornell University study estimates a $44 million annual economic loss to New England and the Canadian Maritime Provinces due to predation on commercial shellfish by the European green crab. Marine species of concern (due to their proximity to Rhode Island and/or high potential for environmental and economic damage) include the veined rapa whelk, Chinese mitten crab, the Pacific oyster, and the macroalgae *Caulerpa taxifolia – a.k.a. "killer algae"* – and *Porphyra* species used for the production of nori.

In freshwater systems, aquatic macrophytes such as variable water-milfoil and curly pondweed have become established and are spreading in lakes and ponds. DEM surveys and volunteer surveys in 2007 of lakes, found AIS in 78% of the locations inspected. DEM has reported that AIS are the largest cause of impairment in lakes, affecting over 4,900 acres or almost 25% of the lake acreage in the state. The resulting changes in habitat and interference with other uses such as swimming have prompted an increased demand from the public for more assistance to mitigate and manage AIS. Legislation directing DEM to strengthen regulation of aquatic invasive plants was adopted in June 2008. Introduced *Phragmites* and purple loosestrife are also well-established and continue to spread. Although the zebra mussel has yet to be documented in Rhode Island, it has been found in the Connecticut side of the Housatonic watershed, very close to the Massachusetts border. The Asian clam has been found in Rhode Island waters and is spreading. In the summer of 2006, Eurasian water milfoil was first documented in the state. An economic study in New Hampshire showed that the value of property adjacent to

lakes choked with aquatic weeds such as Eurasian water milfoil declined by 15% or more.

Other species of aquatic macrophytes such as hydrilla, water-chestnut, and giant salvinia are causing problems in nearby states and have a reasonable chance of causing similar problems in Rhode Island if their spread is not actively prevented. Recently, the first occurrence in the state of water chestnut was documented in Belleville Pond, North Kingstown. The Rhode Island Natural History Survey, in collaboration with volunteers, DEM and other organizations, is planning work to remove this plant in 2008 and monitor for its recurrence. The potential impacts of these species are evident: $500,000 is spent annually to manage and prevent the lake-wide spread of water chestnut in Lake Champlain on the Vermont/New York border.

Nationally, responses to the spread of aquatic invasive species have been marginal and fragmented. The “lake-by-lake” approach to control often employed by individual landowner groups has had only marginal beneficial impacts. Finally, there is a pervasive lack of public awareness of the problems and risks posed by AIS outside of fishery and aquaculture circles. Correspondingly, state and federal agencies have limited jurisdiction and inadequate resources of address and control the spread of AIS.

DEM’s Division of Fish and Wildlife, Division of Agriculture, and Office of Water Resources all are addressing AIS including potentially through the exercise of their regulatory powers: With respect to freshwater AIS, DEM is surveying freshwater systems for AIS, responding to and investigating citizen complaints, developing improved guidance for management of AIS in lakes, and exploring mechanisms to expand technical and financial assistance to address long-term management of AIS in lakes.

CRMC has been actively addressing AIS since 2000, when it conducted the first marine rapid assessment survey of AIS in Rhode Island in partnership with MIT Sea Grant, Rhode Island Sea Grant, the Massachusetts CZM program, the Narragansett Bay Estuary Program, and the Narragansett Bay National Estuarine Research Reserve. This survey definitively established the presence and distribution of numerous AIS in Narragansett Bay.

The CRMC’s role in the 2000 rapid assessment survey led to its further involvement in the AIS issue in the Northeast region when the agency became a charter member in the Northeast Aquatic Nuisance Species Panel (NEANS Panel). The NEANS Panel was established in 2001 under the auspices of the National Invasive Species Act with the mission to protect the marine and freshwater resources of the Northeast from AIS through commitment and cohesive coordinated action. The Panel's members represent state, provincial, and federal governments; academia; commercial and recreational fishing interests; recreational boaters; commercial shipping; power and water utilities; environmental organizations; aquaculture;

nursery and aquarium trades; tribal concerns; lake associations; and the bait industry. CRMC currently co-chairs the NEANS Panel which will lead and coordinate regional initiatives to prevent the introduction and control the spread of AIS in the Northeast.

Most recently the CRMC initiated and led Rhode Island's first comprehensive effort to address the problem of marine AIS in the state. CRMC's efforts with regard to marine AIS, in conjunction with efforts by DEM to address freshwater AIS, have resulted in the Rhode Island Aquatic Invasive Species Management Plan, approved by the federal Aquatic Nuisance Species Task Force in November, 2007. This approval makes Rhode Island eligible to receive annual federal funds to implement the Plan, the first installment of which will be received by the CRMC for expenditure in state FY 2009. Implementation of the Plan will be coordinated by the RI Aquatic Invasives Working Group, co-chaired by CRMC and DEM.

The Rhode Island Aquatic Invasive Species Management Plan provides Rhode Island an important means by which to implement a continued coordinated approach to minimizing the economic, environmental and social impacts of AIS on Rhode Island's marine and freshwater ecosystems. To that end, the Plan includes detailed management strategies for 1) coordination and communication; 2) monitoring; 3) education, outreach, and training; 4) research and development; 5) planning and assessments; 6) prevention and control; and, 7) legislation and regulation.

The Plan's specific tasks approved for funding during 2008 are: 1) coordination of statewide AIS activities (CRMC and DEM); 2) initiation of a freshwater lakes AIS management program (DEM); 3) initiation of an Early Detection – Rapid Response network (CRMC); and, 4) the establishment of a competitive Rhode Island Aquatic Invasive Species Grant program (CRMC).

Aquatic Habitat Protection and Restoration

Rhode Island's coastal, marine and freshwater habitats include salt marshes, seagrass beds, rivers, streams, lakes, brackish marshes, freshwater marshes, swamps, vernal ponds, benthic, inter-tidal, and water column habitats. They support a variety of flora and fauna and provide important ecological services that support Rhode Island's water-reliant economy, including $100 million per year in commercial fishery landings; a $150 million recreational fishery; and multi-billion dollar tourism and outdoor recreation industry.

Despite their exceptional ecological and socio-economic values, Rhode Island's aquatic habitats have been altered, degraded, and destroyed by human development and resource consumption since the early 1600's. Salt marshes have been diked, ditched, and filled. More than 600 dams were built in Rhode Island's rivers to generate hydropower, enable water-based transportation, and control flooding. Only recently has Rhode Island begun to assess the hazards dams pose to

public safety, the freshwater habitat values they provide, and how they should be altered to restore anadromous fisheries (see Natural Hazards section).

Coastal and Estuarine Habitats

Rhode Island's primary seagrass is eelgrass (*Zostera marina*). Eelgrass is crucial to many ecological functions. It produces organic material that becomes part of the marine food web; helps cycle nutrients; stabilizes marine sediments; and provides important habitat.

A major loss of coastal habitat quality is due to the progressive decline and disappearance of eelgrass in Narragansett Bay and Rhode Island coastal waters beginning approximately in the 1900's. Fortunately, the 2007 state-wide eelgrass survey shows an upward trend in state-wide totals of eelgrass acreage in Rhode Island since last assessed in 1996.

Rhode Island's remaining salt marshes are found along the shores of salt ponds, the Narragansett Bay estuary, small embayments (such as Allin's Cove in Barrington), and estuarine rivers (such as the Narrow River estuary). It is estimated that 53% of Rhode Island's salt marshes have been lost since colonization began in the 17th century (Wigand, 2008). Salt marshes provide nursery grounds and foraging habitat for hundreds of species of fish, shellfish, birds, and mammals. In addition to providing habitat value, salt marshes attenuate pollutants, protect coastal communities from storm and flood hazards, and provide scenic and recreational values.

Freshwater Habitats

Anadromous fish runs in Rhode Island occur in rivers, streams, and adjacent areas that drain into coastal ponds, Narragansett Bay, and Block Island Sound. Migratory fish rely upon these systems to feed and reproduce. River herring, Atlantic salmon, rainbow smelt, sturgeon, and American shad depend on passage upstream for survival. These anadromous fish spawn in fresh water, and mature and spend most of their lives in salt water. Conversely, American eels are catadromous fish, living in lakes and ponds as adults. They migrate downstream into the Atlantic, where they spawn and die in the Sargasso Sea, their newly born young returning to Rhode Island's rivers and streams.

Many of Rhode Island's rivers are blocked or obstructed by dams, weirs, tide gates, and other water-control structures. In addition to unobstructed passage through the water, migratory fish need healthy, vegetated riparian areas that provide cover, bank stabilization, and temperature regulation. Riparian vegetation also provides detritus (leaf litter, wood, etc.), which forms the base of the riverine food chain. Recreational and commercial fisheries benefit when river corridors remain healthy and passable to migratory fish.

There are gaps in what is known about RI's aquatic habitats. While certain aspects, such as submerged aquatic vegetation (eelgrass beds particularly), have been carefully mapped over time, a full characterization of aquatic habitat conditions is not possible due to a lack of data. The largest data gaps are with regard to benthic conditions in estuarine waters and identification of critical fish habitat.[17] Additionally, Rhode Island needs to update its statewide map of freshwater wetlands as well as survey and map vernal pools.

Freshwater Wetlands[18]

Rhode Island's landscape includes over 124,000 acres of wetlands that constitute a vital component of the state's surface water resources. Varying in size and type, wetlands provide important benefits including wildlife habitat, floodwater storage, groundwater recharge, water quality improvement and recreation. Historically, Rhode Island has lost a significant portion of its freshwater wetlands to land development and wetlands filling and alteration. Current federal and state laws and regulations seek to minimize continuing losses of freshwater wetlands through strong avoidance and minimization policies as well as mitigation requirements.

Freshwater wetlands habitats are addressed in a ten-year Comprehensive Wildlife Conservation Strategy completed in 2005 by DEM's Div. of Fish and Wildlife. The Strategy identifies habitats, threats to habitats, needed conservation actions and species of greatest concern. The Strategy identifies thirteen freshwater wetland habitats as well as 53 freshwater wetland species of greatest conservation need. A recent GIS analysis by DEM found that approximately 28% of the state's wetlands (including coastal) are considered part of protected lands – either owned for the purpose of open space by governmental or non-governmental entities, or protected as open space via easements; e.g. an open space portion of an approved subdivision.

Rhode Island has adopted a goal of no-net loss of wetland consistent with that established by the federal government. Over the five-year period of 2001-2005, the state wetlands permitting program has approached but not quite achieved this goal. Permitted net loss authorized by DEM and CRMC over this period totaled 1.3 acres annually. Unauthorized losses are higher and both agencies exercise their enforcement authorities to require restoration of altered wetlands. However, it is recognized that while some unauthorized losses are identified via compliance programs, not all losses are reported and as a result it is not possible to accurately quantify unauthorized wetlands losses state-wide.

Overall, the data reveal that while state regulatory programs are effective at limiting the authorized physical loss of wetlands, resource managers continue to face

[17] Two applied research programs known as Bay Map and Map Coast are collecting the survey data required for fish habitat mapping

[18] This section is based upon DEM's January 2007 report entitled "Wetland Regulation and Protection Status and Trends Report."

challenges in protecting wetlands due to cumulative impacts of land development, modifications of natural hydrological processes, and unauthorized losses.

Consideration should be given to revising the "no net-loss" wetland policy to a "net wetland gain" goal to recover wetlands, improve water quality, and ameliorate impacts of climate change.

Freshwater wetland restoration activities have included large projects, such as the Lonsdale Marsh in Cumberland, a seven acre wetland complex completed in 2003, and smaller projects in riparian areas. With support from EPA, DEM demonstrated a methodology for identifying and evaluating wetland restoration opportunities in the Woonasquatucket River Watershed. Hence, DEM, the Woonasquatucket Watershed Council, the Natural Resources Conservation Service, and others are implementing a Watershed Restoration Strategy for the Woonasquatucket.

Grants for riparian buffer restoration projects have been provided by the Narragansett Bays, Rivers and Watershed Restoration Bond Fund, with many projects reflecting a growing interest in eliminating invasive species from wetlands in order to restore native vegetation and habitat conditions.

The Purpose and Value of Habitat Restoration

> *Government and non-government groups have increasingly pursued habitat restoration through a variety of small-scale projects around the state. . . . Rhode Island also wants to restore anadromous fish runs and river habitats. This is now more attractive—in part because of success in pollution control and river conservation. Shellfish aquaculture projects have increased over the last decade as an option to enhance the ecosystem and fulfill the promise of highly productive coastal waters.*
>
> - CRMC 2006 Marine Resources Development Plan

Habitat restoration generates a number of important environmental and economic values. Habitat restoration aids in the reintroduction of locally extirpated rare plant species and increases available habitat for threatened and endangered species. Wetlands and riparian habitat restoration is beginning to reverse long-term trends in habitat loss degradation.

There are several state-wide planning documents that are key to the design and prioritization of habitat restoration:

- The *Rhode Island Coastal and Estuarine Habitat Restoration Strategy* identifies seagrass beds, salt marshes, and river systems (anadromous fish passages and riparian corridors) as priority coastal and estuarine habitats for state restoration activities.

- The *Strategic Plan for the Restoration of Anadromous Fishes to Rhode Island's Coastal Streams*, issued by DEM's Division of Fish and Wildlife in

December 2002, identifies priorities for restoring freshwater habitat for anadromous fisheries.[19]

- The *State Freshwater Wetland Restoration Strategy* issued in August 2001 by DEM's Office of Water Resources as an "effort is to reinstate wetland functions in areas where wetlands have been destroyed or degraded."

Specific restoration goals listed in the *Coastal and Estuarine Habitat Strategy* include:

- Re-establish chemical, biological, or physical functions or properties that underpin habitat structure; such as restoring or maintaining hydrological functions by reestablishing river, stream or tidal flows, restoring intermittent flooding regimes, or reconstructing natural topographic features;
- Control of exotic, non-native, or invasive plant or animal species;
- Restore natural community successional processes;
- Remove dams or construct fish ladders to provide passage for spawning or migrating fish;
- Control, reduce, or eliminate other impacts to habitat quality such as stormwater runoff.

The *Anadromous Fish Restoration Strategy* identifies and describes watershed sites with

> *potential to restore, establish, or enhance anadromous fish populations through upstream passage for migrating adults and downstream passage for juveniles. In both cases the primary goals are to minimize passage-induced mortality and [enable] expansion of [anadromous fisheries] into un-utilized and under-utilized [freshwater] habitats with the most cost-effective passage method available.*

Freshwater wetland restoration is particularly important for restoring natural hydrological functions and increasing biodiversity urbanized watersheds. Issuance of the *Freshwater Wetlands Restoration Strategy* was followed in 2002 by the *Wetlands Restoration Strategy for the Woonasquatucket River Watershed*.

Reintroduction of spawning broodstock as perpetuated by Rhode Island's freshwater fish hatcheries should also be considered a form of restoration.

On the basis of the above strategic plans, Rhode Island has worked actively to restore freshwater, coastal, and estuarine habitats and anadromous fisheries in the last ten to fifteen years, from Save the Bay's ongoing efforts to restore eelgrass beds

[19] Another important planning document with regard to anadromous fisheries is the *The Blackstone River Fisheries Restoration Plan*, issued in May 2002.

to DEM's and CRMC's ongoing habitat conservation (via land acquisition) and restoration efforts.

A variety of aquatic habitat restoration technologies have been developed and projects undertaken to restore productivity to degraded or destroyed coastal and other aquatic habitats. Since 2003, CRMC's Coastal and Estuarine Habitat Restoration Trust Fund has leveraged about $12.5 million in total project funding with direct state funding of $975,000 to restore a total of 235 acres including fish ladders, salt marsh and eelgrass beds. (Compiled data on freshwater habitat restoration efforts is currently unavailable.)

Finally, as discussed in the BRW SLP's "Water-Reliant Economy" section, it is state and federal policy to beneficially reuse dredged materials for restoration, beach maintenance, and other valued uses. The South Coast Habitat Restoration Project entails a major dredging project intended to restore coastal lagoon eelgrass habitat by dredging sand from coastal lagoon breachway tidal deltas and reuse the dredged sands to re-nourish adjacent barrier beaches. While federal funds are available to underwrite a portion of the dredging and beach replenishment components of this project, long-term maintenance of the breachways is the responsibility of Rhode Island. Failure to prevent reformation of tidal deltas in the breachways will nullify the long-term habitat restoration value of the initial project investments.

Interagency Collaboration on Habitat Restoration

Because of the numerous small and large-scale projects, underway throughout Rhode Island, and the long-term maintenance issues associated with restored habitats or essential facilities such as fish ladders, it has been recommended as early as 2004[20] that a Habitat Restoration Program be established to conduct state-wide planning, coordination, and cultivate multiple sources of support for priority habitat restoration projects. That recommendation remains valid today. An interagency habitat restoration working group has been functioning for a number of years, a voluntary effort that should be expanded into a full-fledged interagency program with a dedicated restoration coordinator.

Ecological and Economic Considerations

The emergence of restoration in the 1990's was a major advancement in environmental protection and management. It forced society, industry, and government to look beyond the reduction or elimination of environmental contaminants and/or the conservation of rare or threatened individual species. It represents the one of the first concrete examples of ecosystem-based management being put into practice. It is important to realize that preventing and controlling aquatic invasive species is a habitat protection strategy that must be pursued in close conjunction with restoring degraded habitat and/or enhancing biodiversity by

[20] Governor's Commission on Narragansett Bay and Its Watershed

re-establishing anadromous fish runs. Finally, restoration efforts must be planned to anticipate and accommodate the impacts of climate change.

The Rhode Island Senate Committees on Government Oversight and Environment and Agriculture issued a report in 2004 entitled, *Habitat-Based Management for Rhode Island's Marine Environment*, which invites us to conceive of "Narragansett Bay and its watersheds as one habitat system in order to redefine our means for interacting with this system." This report proposes to make "habitat-based management" the guiding principle by which [executive] agency programs and planning are organized, coordinated, and assessed." It points out what is apparent to many observers, that Rhode Island's

> *planning and management structures are oriented toward permitting the uses of the waters and regulating sources of environmental pollution rather than improving habitat functionality. State planning and management structures need to be [rendered] more responsive to habitat-based results . . . .*

Subsequent legislation based upon this report in 2004 launched a number of state-wide initiatives to bolster coastal, estuarine, and watershed management and protection, including the formation of the BRWCT. "Habitat-based" is synonymous with "ecosystem-based." Ultimately, the habitats we restore are human habitats as well that generate values that we readily recognize as economic. The 2002 RI Senate Policy Office report on Rhode Island's marine economy echoes this fundamental truth:

> *[T]he discussion of habitat restoration funding in recent years has been limited to the environmental benefits of restored habitat without making explicit linkages to economic development. In reality, the economic development benefits of habitat restoration could be quite significant, [including] better yields for commercial and recreational fisheries, increased value of waterfront property, enhanced opportunities for recreation, and mitigated vulnerability to flooding and other natural hazards.*

Developing greater insight and appreciation for the economic values generated by the suite of habitat restoration projects implemented in Rhode Island already, and the many more projects that merit funding, will hopefully increase capital funding for habitat restoration; considering potential economic values may be even more important to the growing need for maintenance and cultivation of the habitat we have restored already.

As habitat restoration and AIS prevention and control continue to mature as core environmental and economic strategies, Rhode Island will need to consider more deeply the question of "what are we restoring to?" In large part, the BRWCT agencies and their partners pursue a project orientation toward habitat restoration and AIS prevention and control. Focusing on the implementation of individual projects, even when incorporating multiple values into project design and scale, tends to obscure the fact that the true, long-term merit of these efforts entails protecting, enhancing, and maintaining biodiversity values, as well as attendant

instrumental values for human economies. A systems or EBM orientation to habitat restoration and AIS prevention and control helps correct the myopia engendered in focusing entirely on getting as many projects through the pipeline as possible.)The Woonasquatucket Watershed Restoration Strategy is a good example of putting EBM principles into practice in the pursuit habitat restoration.)

These concerns are thoroughly discussed in the existing restoration ecology literature. Ecosystem recovery has been shown to entail three basic phases (Aronson and Le Floc'h, 1996a, b):

Restoration: reactivating hydrological and related landscape or ecological processes (e.g. rebuilding culverts to restore tidal flows in salt marshes; constructing fish ladders for anadromous fish)

Rehabilitation*:* re-introducing key species or species groups (e.g., eelgrass bed restoration; or removing an AIS species before it becomes ubiquitous)

Reallocation*:* the establishment of different, unanticipated system trajectories leading to new ecosystems or new ecosystem states.

For Rhode Island, "reallocation" is a critical but still neglected phase of restoration or ecosystem change that is conceptually important in seeking to evaluate the outcomes of restoration projects, anticipate AIS events, and assess the ensuing values generated all within the context of major external drivers such as climate change. Reallocation is a systems-based concept that is difficult to characterize or measure reliably as a basis for strategic management. Nevertheless, given that the aquatic environments we seek to restore and protect from AIS are human-dominated systems, we must address how, cumulatively, our restoration and management initiatives are leading to a "reallocation" of aquatic ecosystem structure and function.

Table 11: Aquatic Habitats and Invasive Species Strategies

Goal: *Rhode Island's freshwater, coastal, and marine habitats will support healthy aquatic ecosystems for native fish and wildlife*.

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
Enhanced aquatic biodiversity due to successful AIS control and habitat restoration and conservation	The control and prevention of marine and freshwater aquatic invasive species.	Increase the capacity of Rhode Island, in partnership with NGO's and private interests, to implement the Rhode Island Aquatic Invasive Species Plan.	**CRMC**, **DEM**	Ongoing
		Establish a lake management program within DEM.	**DEM**	2-4 years
		Expand the partnership between the Northeast Aquatic Nuisance Species Panel and the Northeast Regional Ocean Council (NROC) to pursue shared goals relating to AIS and ocean ecosystem health.	**CRMC**, DEM, BRWCT Chair	1-2 years
	Successful restoration of a diverse array of fresh and marine aquatic habitats.	Establish a statewide habitat restoration coordinator.	**BRWCT**, Habitat Restoration Work Group	1-2 years
		Implement 2002 strategic plan for restoration of anadaromous fisheries.	**DEM**, RIRC, NBEP, NRCS, Habitat Restoration Work Group	1-4 years
		Renew state funding to ensure matching funds are available for priority habitat restoration projects.	**DEM, CRMC, Habitat Restoration Work Group**	Ongoing

Table 11: Aquatic Habitats and Invasive Species Strategies

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Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
		Establish a comprehensive set of status and trends indicators for coastal habitats program to assess habitat changes, impacts, and conservation and restoration progress.	**Narragansett Bay Estuary Program**, BRWCT Environmental Monitoring Collaborative	1-2 years
		Maintain and expand state-wide mapping for brackish and freshwater wetlands, salt marshes and seagrass beds. Use mapping to support wetlands and eelgrass restoration and conservation planning, and enhanced enforcement wetlands protection law.	**DEM, NBEP, CRMC**	1-4 years Ongoing
		Improve protection regulations for riverine vegetated buffers	**DEM**, RIRC	2-4 years
		Identify, assess, and maintain up-to-date databases on future coastal and riparian buffer restoration sites and projects,	**DEM**, CRMC, Habitat Restoration Working Group	1-2 years
		Develop incentives for private property owners to participate in habitat restoration projects.	**DEM**, CRMC	1-4 years

Table 11: Aquatic Habitats and Invasive Species Strategies

Goal: *Rhode Island's freshwater, coastal, and marine habitats will support healthy aquatic ecosystems for native fish and wildlife*.

Objectives	Strategies: 2009-2013	Actions	Agencies lead agency in bold	Time Frame
Timeframes: For many listed actions additional funding will be required for successful completion.	Ongoing: Action is currently being pursued by one or more agency. Additional funding may be required for completion.	1-4 Years: With adequate funding, significant progress on the action will require ongoing efforts over the next 4 years. 1-2 Years: With adequate funding, action should be completed within 1-2 years.		

BAYS, RIVERS, & WATERSHEDS COORDINATION TEAM RESPONSIBILITIES

A basic premise of the BRWCT is that by collaboratively developing and applying an ecosystem-based management (EBM) approach to aquatic resources management and water-reliant economic development, the BRWCT agencies will cultivate the organizational resources and capabilities necessary to fulfill Rhode Island's policies for its waters and watersheds. The responsibility of the BRWCT Chair is to help the agencies manifest EBM via development and implementation of the Bays, Rivers, and Watersheds Systems-Level Plan (BRW SLP). Upon completion of the first iteration of the BRW SLP in July 2008, the BRWCT Chair and agencies must together fulfill five essential responsibilities:

- Lead implementation of the BRW SLP (including evaluation and refinement of strategy) via BRWCT Annual Work Plans and related initiatives.

- Guide integrated monitoring and research carried out by the BRWCT's monitoring subcommittees (The Economic Monitoring Collaborative, the Environmental Monitoring collaborative) in support of BRW SLP implementation

- Fully engage the advisory subcommittees (Science Advisory Committee and Public Advisory Committee) in their respective areas of 1) advising on research priorities, technical matters, and best management practices and 2) involving the general public and a broad range of stakeholders in providing input and support for development and implementation of the SLP.

- Partner with federal and state agencies and programs, Massachusetts, Connecticut, non-governmental organizations, the private sector, academic institutions, and regional organizations to advance BRW SLP implementation.

- Expand and coordinate education, training, and technical assistance programs for local governments to advance BRW SLP implementation.

- Establish timely, accurate and well-designed communication and outreach to key constituencies and partners, including the state, local and federal policymakers, the private sector, non-governmental organizations and the general public.

Implement the Bays, Rivers, and Watersheds Systems-Level Plan

To implement the BRW SLP, the BRWCT shall develop Annual Work Plans that "prescribe the necessary projects, programs, and activities [that] each member of the team shall perform for the following fiscal year to implement the SLP" (RIGL 46-31-6). BRWCT Annual Work Plans shall consist of "significant program products including proposed regulations, grant solicitations, schedules for production of environmental documents, and project selection processes," linked to priorities delineated in the SLP

(RIGL 46-31-6 (b)). Finally, annual work plan budgets shall include “recommendations for the allocation of appropriated funds among agencies” (RIGL 46-31-6 (d)).

Upon completion of the BRW SLP: 2009-2013, the BRWCT will develop basic recommendations for state FY 2009 (which begins July 1, 2008) and a more comprehensive set of recommendations for state FY 2010 during the fall of 2008.

In addition, the BRWCT will report annually to the Governor and the General Assembly on BRW SLP implementation and the capacities of the state agencies to carry out BRW SLP strategies and actions. Every four years the BRWCT will convene a major public meeting to assess the state of Rhode Island’s aquatic environments and water-reliant economy, and provide forthright evaluations of BRW SLP implementation and where refinements to BRW SLP strategies may be necessary.

Additionally, the BRWCT must also determine how the BRW SLP will be incorporated into the Rhode Island State Guide Plan, or how it will be linked to related State Guide Plan elements.

Monitoring, Research, and Communications

Information is the currency of democracy.
- Thomas Jefferson

Environmental policy and management serve as both drivers and responders to an explosion of knowledge, technological and institutional capabilities, and information in the United States and globally about how our natural and built environments function as complex adaptive systems, and how they support and constrain economic and social well-being. Systems approaches to environmental management and economic development such as EBM demand comprehensive systems understanding based upon scientific knowledge, continuous baseline monitoring and indicator-based trend analysis, and evaluation of program outputs and outcomes that emphasizes learning and adaptivity.

Such sophisticated knowledge development and utilization is costly, time-consuming, and difficult to justify within politicized decision environments that emphasize short-term, concrete, economically-oriented results. Thus the BRWCT and its four standing committees (the Environmental Monitoring Collaborative, the Economic Monitoring Collaborative, the Public Advisory Committee, and the Science Advisory Committee) will be challenged in their pursuit of integrated environmental and economic monitoring initiatives, the identification of research questions and studies of highest relevance to their management priorities, and the enhancement of agency-based communications on the most pressing aquatic environmental and economic issues facing Rhode Island. This is why consistent, long-term pursuit of shared strategic goals and collaborative actions is so important to the overall effectiveness of the BRWCT agencies.

Why is it so difficult to fund and maintain ambient environmental monitoring programs widely acknowledged as fundamental to good management? Perhaps monitoring tends

to become associated with the identification of new problems or impacts, rather than its equally valuable contributions to solving problems. Better agency and science communications are needed to help convince the broader public and their elected leaders of the value of comprehensive monitoring and assessment to ensuring the timeliness and cost-effectiveness of management and regulatory programs. The BRWCT agencies need to articulate better how rigorous ambient monitoring will help them meet core management goals. Relatedly, much work remains to be done on how analyses of economic activities that depend upon aquatic resources should guide core management and regulatory programs.

Environmental Monitoring

> *The availability of consistent environmental data supports systems level planning and provides resource managers, decision-makers and citizens with information on how marine habitats are responding to management programs and what adjustments need to be made to existing programs or what new programs must be implemented to achieve a health marine environment. (RIGL 46-23.2-2)*

Without good monitoring Rhode Island will never be able to respond credibly to the public's urgent questions and concerns regarding the health of publicly-owned aquatic resources and how well they support current and will support future human uses. When the BRWCT agencies lack the scientific and empirical bases to assess and communicate how public health is being adequately protected from pollution, their public credibility suffers immeasurably. Given highly incomplete understanding regarding how Rhode Island's aquatic resources are impacted by diverse, consumptive human uses such as watershed development and fishing, empirical foundations for strategic decision-making will be highly constrained and other values will become the basis for action and investment decisions. Without the best possible understanding of the current state and trends of our aquatic resources and their contributions to human uses and values, Rhode Island will not make the investments it must make to prepare for a future that, due to global forces such as climate change and sea-level rise, may differ substantially from our present world.

The BRWCT Environmental Monitoring Collaborative and the BRWCT must coordinate and evaluate environmental monitoring activities and results, educate stakeholders and state officials on the problems and possible solutions revealed by monitoring, and tie propose management and regulatory solutions to carefully analyzed monitoring (and scientific) findings.

The BRWCT should develop an integrated, interoperable management system for the data collection, reporting, analysis by, among other tasks, investing in the development and maintenance of key data archive networks such as NarrBay.org, and the "Data Central" Web Site the Narragansett Bay Commission is developing to provide prompt on-line access to all NBC POTW, urban river, upper bay, industrial user and collection system monitoring data.

The BRWCT Environmental Monitoring Collaborative released a critical document in the fall of 2005 entitled the *Water Monitoring Strategy: 2005-2010*. Based upon that strategy it has helped to fund a subset of new ambient environmental monitoring programs since the summer of 2006 as delineated in Table 12.

Activities	Results	Benefits
The Coordination Team has allocates **$400,000** in OSPAR funds (FY 2007 and FY 2008) to initiate three key water monitoring initiatives.	$99,000 invested in activation of three gage stations on the Blackstone River, the upper Hunt River and Pawcatuck River at Kenyon. Initial data at: http://waterdata.usgs.gov/ri/nwis/current/?type=flow	Provides essential data for water supply management and drought management.
RI DEM initiates contracting of monitoring activities in the Fall of 2006).	$63,000 invested in Narragansett Bay fixed site water quality network. Initial data at: http://www.narrbay.org/chemical_data.htm	Establishes baseline information for monitoring reductions in hypoxia due to treatment plant upgrades.
Seasonal monitoring data posted on the Web.	$234,000 invested in monitoring on the Pawtucket River, the Branch River, three locations on the Blackstone River, Big River, Flat River, South Branch of the Pawtuxet River, Queens River watersheds.	Enables tracking of pollutant loadings into Narragansett. Bay from large rivers, particularly nitrogen inputs from Mass. Provides water quality data essential for assessing pollution inputs and ecological conditions.

Table 12: Summary of BRWCT Environmental Monitoring investments

Economic Monitoring

The BRWCT Economic Monitoring Collaborative must develop and implement an economic monitoring strategy to inform the "promotion of sustainable economic development" of the water-reliant economy and "provide the necessary information to adapt the (systems-level) plan in response to changing conditions." From 2004 to 2008, the Economic Monitoring Collaborative worked diligently on developing this strategy.

In 2007, the BRWCT Economic Monitoring Collaborative launched a baseline monitoring effort in order to track changes in the water-reliant economy and identify issues needing more focused research This effort differs from previous economic monitoring studies in that it attempted to measure not only the size of water-reliant economic sectors, but also to develop and propose indicators that highlight key capacity and conflict issues in Rhode Island's waters and waterfronts. The indicators reported out in the BRWCT Economic Monitoring Collaborative FY 2007 report are the first pass at capturing these multiple dimensions. These indicators will be refined over time as new data becomes available and as the BRWCT establishes SLP goals and

implementation priorities. The proposed “capacity and conflict indicators” are summarized in Figure 21.

Utilizing and communicating the significance of these economic, capacity, and conflict indicators will be pursued via a “scorecard” model originally advanced by the RI Economic Policy Council. The strength of this model rests on “its ability to incorporate different perspectives and generate insights into various components” of the water-reliant economy. The BRWCT Economic Monitoring Collaborative, with leadership from Kip Bergstrom, organized the initial BRW Economic Scorecard as follows in its FY 2007 report:

Economic: The results of economic and recreational activity	**Activity:** Economic and recreational actions
Capacity: The ability to conduct economic and recreational activity	**Conflict:** Economic, recreational and regulatory activities that may conflict with

Figure 21 encapsulates this initial scorecard model.

Integrated Environmental and Economic Monitoring

Although the BRWCT has made important steps to improve economic and environmental monitoring in Rhode Island, it has yet to formerly integrate the initiatives. In 2007, the BRWCT Economic Monitoring Collaborative concluded that, “if we are to better understand the relationships between environmental quality and the uses of our water and waterfront (e.g. the effects of improved water quality on coastal land use mix and value), we need to begin to think through indicators that will tie these issues together. As we begin to integrate the two, we will be able to answer questions such as whether more intensive uses are necessarily incompatible with higher water quality.”

Evaluation

Monitoring is a pre-requisite for evaluating, assessing, and judging the performance of government agencies and programs. Strategic, systems, or EBM approaches to policy, management, and regulation require evaluation to successfully target resources, adapt to changing circumstances and values, and to promote learning. A definitive knowledge base is required for improving the operations of state aquatic resource management programs in order to optimize the benefits they produce at current funding levels.

Public funding mechanisms require long-lead times because of decision transparency and review requirements, and their reliance upon complex financing systems. As a result, the BRWCT agencies compile and maintain detailed lists of priority infrastructure needs for wastewater, water supply, and habitat restoration that justify public financing and allow for efficient allocations when funds do finally become available. As these lists lengthen because previously established needs go un-met, investments targeting future needs receive progressively less attention. This in turn increases the costs of the future

Economic Indicators
Seasonal Effect of Summer Community Food & Beverage Sales: $104 million Captures the incremental increase in sales between the summer months and non-summer months in Rhode Island's coastal cities and towns and is a good indicator of tourism overall.
Commercial Fish Landings Value: $91 million Provides an indication of the economic health of the fishery and downstream industries.
Cargo Tonnage: 12.7 million tons Provides an indication of vessel activity within the Bay and the health of industries dependent on water-based transportation. This total includes the port of Fall River.
Navy Employment and Wages: 7,382 jobs and $530 million The Navy's employment and wages provide an indication of the health of the overall defense sector.
Coastal Land Value as a Percentage of Total Land Value: 36% This measure reflects the percentage value of coastal lands (defined as ¼ mile from the shore) to the total land value in Rhode Island's coastal communities. This reflects data from nine communities.
Government Expenditures to Support Infrastructure for the water-reliant economy: $78.6 million In fiscal years 2005 through 2007, the State contributed $78.6 million to infrastructure expenditures for water-reliant economic functions and activities ($12.6 million in FY05, $29.3 million in FY06, and $36.7 million in FY07). As a share of the State's Capital Budget, this expenditure represents 1.5 percent, 2.9 percent and 3.8 percent accordingly.
Coastal Median Home Price to State Median Home Price: 3.85 This indicator compares sales data for coastal homes (defined as having an oceanfront or salt water view) to the state median home price. It provides an indication of the overall health of the coastal housing market which drives a significant amount of the property values in some coastal communities.
Water-Reliant Economy Employment and Wages: 36,000 jobs and $1.8 billion Provides an indication of the overall health of the sectors of the economy tied to our bays, rivers and watersheds. This calculation reflects industries in all three areas of the water-reliant economy.
Water Dependent Industries Rate of Change Index: 2.26 Provides an analytical approach to measure RI's most water dependent sectors economic performance relative to the performance of the nation. Index is created by dividing the rate of change in RI employment (9%) for those 12 industries versus the rate of change for those same twelve industries nationally (4%).

Figure 21: Baseline indicators for assessing Rhode Island's water-reliant economy.

Activity Indicators
Registered Events: 30 events This is a measure of all events that involve the use of the Bay for activities that may have an impact on navigation. It is an indicator of water-related events. These events took place over a total of 71 days.
Commercial Vessel Transit (Cruise & Freighter): 674 Provides an indication bay activity related to commercial waterborne transit.
Coastal Residential Sales as a Percentage of Total Home Sales: 13% Provides a picture of the churn in the market for coastal real estate, an indication of the continued interest in coastal living in RI which may be a measure of the perceived health of the Bay and coastal areas.
Recreation Participation Rate: 24 Provides an indication of the use of the Bay which may be an indication of the perceived environmental health of the Bay. This rate was calculated by adding all the water-based recreational scores together, and dividing the sum by 9 (the number of activities) to generate an average participation rate.
Boating Usage: Recreational vessels - 16.53 - 38.93 days Provides an indication of the use of the Bay which may be an indication of the perceived environmental health of the Bay. Recreational boat usage varies based on the type of recreational vessel.
Land Use Conversion and/or Absorption This measure will allow us to calculate changes in coastal land use over time. Using this monitoring year as a baseline for the communities that data is available, the aggregate use is showed here.

Residential	34.56%
Commercial / Mixed Use	7.43%
Industrial	1.62%
Farm/Forest/Open Space	7.24%
Government/Institution	32.90%
Vacant	9.80%
Unknown/Other	6.45%

Conflict Indicators
Registered Boats to Slips & Moorings: 3.12 Provides an indication of the supply / demand situation for marina-related functions and subsequent potential development demand on the Bay & coast.
Residential Coastal Value to Industrial Coastal Value: 3.12 Provides an indication of the potential conversion risk of industrial land to residential development based on differentials in property values. This measure includes data for nine communities.
Boating Density (bay acres per boat): 2.15 A more refined version of this would incorporate only navigable waters, coastal water area in addition to the bay and take into account the difference in boat types which have different area footprints.
Registered Boats to Cargo Transit: 83 Provides a measure of potential conflict between recreational boaters and commercial vessels.
Vessel Calls to Industrial Piers: 10.3 Provides an indication of the potential back up in the Bay by commercial vessels. A more refined version of this would look at vessel days at pier compared to available pier days.
Seasonal Housing as a Percentage of Total Housing: 5% Provides an indication of the amount of seasonal resident activity in the area, potential pressures on the housing market and other related community planning implications. More recent granular data is not available which would allow for analysis at the coastal community level where the impact is far greater depending on the community. In addition it is self-reported data and the seasonal housing is estimated.
Water Classifications Compared to Land Use Illustrates potential inconsistencies between water classifications and existing and potential future land uses. This analysis is targeted for completion for the final report.

Figure 21: *(Continued)*

investments as problems worsen due to lack of attention. Without greater insight through monitoring and evaluation, such project-funding dynamics cannot be successfully redressed. Through better monitoring, assessment of monitoring data, and greatly expanded evaluation efforts, the BRWCT agencies will be better positioned to deal with such infrastructure investment and related funding challenges.

Quantitative data measures are only part of what comprises good guidance for policy and investment. BRWCT will need to identify appropriate benchmarks for monitoring outputs to guide future decision-making. If particular measures provide insight into an area where policy and management programs have a direct impact, then it is particularly important to establish corresponding benchmarks in order to drive evaluation.

Scientific & Technical Information for Policy and Management

> *[Coastal] managers should work[] closely with scientific experts from related disciplines to keep abreast of the latest research findings and to avoid misinforming policy-makers and the public. When associated implementation costs are high, it is especially important that the resource manager or scientist consider how best to inform policy-makers about the limits of scientific knowledge and to communicate issues in the context of balancing risks.*
>
> -Coastal States Organization (2005)

RIGL 46-31-9 states that a scientific advisory committee (SAC) shall be established to advise the BRWCT on research priorities, technical matters, and best management practices. Specifically, the SAC shall assist the BRWCT in:

- Ensuring that peer review is employed in the development of an environmental monitoring strategy;
- Providing the team with unbiased reviews of current validated scientific knowledge relevant to their work; and
- Assisting with the review of existing or future plans.

There are undoubtedly numerous management issues facing the BRWCT agencies for which unbiased reviews of relevant scientific knowledge and data would be valuable. The question is which issues are of the greatest urgency for the SAC to address given the needs and priorities of the BRWCT. Based upon the BRW SLP, three issues or topical areas stand out:

Recommendations for implementing ecosystem-based management principles via the BRWCT's Systems-Level Plan: Donald Boesch[21] has offered the following

[21] Donald .F. Boesch, *Scientific Requirements for Ecosystem-Based Management in the Restoration of Chesapeake Bay and Coastal Louisiana*. Ecological Engineering **26** (2006): 6-26. His definition of EBM is commendably concise: "EBM requires integration of multiple system components and uses, identifying and striving for sustainable outcomes, precaution in avoiding deleterious actions, and adaptation based on experience to achieve effective solutions."

recommendations on how “scientific contributions can be improved in response to the emerging consensus on EBM . . . in the U.S”:

- Orient[] scientific activity to providing the solutions needed for ecosystem restoration.
- Build[] bridges crossing scientific and management barriers to more effectively integrate science and management.
- Direct[] more attention to improving the capacity of science to characterize and more effectively communicate uncertainty.
- Fully integrat[e] modeling, observations, and research to facilitate more adaptive management.

In addition to supporting SLP implementation, specifying how these steps should be pursued in Rhode Island would have important implications for the BRWCT Environmental Monitoring Collaborative’s efforts to expand and refine the state’s water monitoring strategy.

The impacts of climate change upon Rhode Island’s freshwater, estuarine, and marine ecosystems: The science of climate change is already massive and continues to expand. It is impossible for managers to keep up with the science and to translate research findings into useful guidance on how to adapt and mitigate at state and local levels. In addition, work has been done to track the effects of climate change and to predict future changes regionally that each New England state should be cognizant of and working to elucidate at smaller, localized scales.

The SAC should help the BRWCT consider fully what impacts to anticipate with regard to Rhode Island’s aquatic environments and water-reliant economy, including impacts to estuarine nutrient cycling, impacts to marine and freshwater fisheries, the introduction and spread of aquatic nuisance species, and the alteration of riverine, estuarine, and marine shorelines, wetlands, and riparian areas due to rising temperatures, altered precipitation patterns and sea-level rise.

Improving the linkages between science, technology development, and Rhode Island’s water-reliant economy: The SAC should provide guidance to the BRWCT on how to advance coastal and ocean science and technologies for improved governance, monitoring, and economic development. This could entail partnering with EDC’s Science and Technology Advisory Council and the Slater Technology Fund to identify and promote scientific and technological innovations that fuel ocean technology commercialization and marine economic development, and further the application of technologies of value to management such as integrated water quality monitoring systems developed by Subchem, Inc., or the coastal modeling applications offered by ASA, Inc.

The SAC could delineate ways to strengthen links between scientists, technology innovators, and environmental managers in the state and the region in order to enhance

and expand private sector, independent sector, and academic expertise in monitoring, assessment, forecasting and treatment technologies that will help state agencies pursue their respective and collaborative mandates.

This is an ambitious task list for the SAC. It is currently unrealistic to expect significant responses to such requests from the SAC and/or the other committees if the BRWCT can provide little more than modest in-kind support. To fulfill the promise of its standing committees, the BRWCT should again assess how to support the SAC and the other standing committees.

Public Advisory Committee

RIGL 46-31-9 defines the purpose of the BRWCT Public Advisory Committee (PAC) as follows:

> *A "Public Advisory Committee" shall be established to advise the Coordination Team on the development and implementation of the systems-level plan, and the preparation of annual work plans and annual work plan budgets.*

PAC members have contributed to the BRWCT's development and initial monitoring and planning efforts since 2004. The basic mission of the PAC is to promote interaction and information exchange among public and private interests engaged in the issues of concern for the BRWCT.

Education, Training, and Technical Assistance for Local Governments

Rhode Island local government plays a determinative role in stormwater control, watershed management, land-use planning and numerous other issues covered in the BRW-SLP. The partnerships between state agencies and local governmental entities, from public works directors to zoning boards, determine how well and consistently state policies and laws regarding Rhode Island's waters and watersheds are implemented.

During development of the BRW SLP, regardless of the issue, concerns were expressed regarding the extent and quality of support provided by state government to towns and cities. There was strong agreement that the effectiveness of Rhode Island's efforts to manage, protect, and restore its waters and watersheds would be significantly enhanced by improving, expanding, and better coordinating training and technical assistance for local governments. Nearly all of the Strategy Tables contain recommendations for how Rhode Island should target additional support and assistance to local governments. Better coordination and greater support for such actions at the state level is a critical, unmet need.

This conclusion was not reached due the BRWCT's lack of appreciation for the valiant efforts by numerous federal-state partnership programs to provide assistance and support to local governments. The Rhode Island Sea Grant College Program, URI Cooperative Extension, the Rhode Island Rivers Council, Grow Smart RI, local

watershed organizations, the Rhode Island Land Trust Council, the Rhode Island Conservation Districts, the Narragansett Bay National Estuarine Research Reserve, the Narragansett Bay Estuary Program, and other programs strive to provide training of local decision makers, technical assistance for pollution control and habitat restoration projects, support for citizen volunteer water quality monitoring, and so forth. And BRWCT member agencies and other state agencies work concertedly to provide guidance, technical assistance, and grant funding to local governments, with discernable improvements in these efforts evident in recent years.

But, other than programs such as the Narragansett Bay Estuarine Research Reserve's Coastal Training Program (CTP), there are few permanent, dedicated mechanisms for coordinating and strengthening Rhode Island's suite of support and outreach programs for local government. Outreach, training, and technical assistance for local government must be enhanced, expanded, and better coordinated if significant progress is to be made in meeting goals set out in the BRW SLP and related state strategic plans.

Communications

Essential to better statewide coordination and integrated environmental and economic stewardship is timely, accurate, and well-designed communications with a number of audiences via media ranging from the Web to newspapers, television news, special reports and analyses. The BRWCT's communications responsibilities should include:

- Reports and presentations to the General Assembly, the Rhode Island Congressional delegation, the private sector, non-governmental organizations, and the general public.

- Concise and consistent public outreach to support the BRW SLP implementation and increase BRWCT visibility among decision-makers in business, science, government, and non-profits.

- Facilitated communications among the BRWCT, the PAC, the SAC, the Economic Monitoring Collaborative and the Environmental Monitoring Collaborative. Interaction and sharing of information among the BRWCT and its standing committees is critical to developing and disseminating consistent and informed communications to diverse stakeholders throughout the state and New England.

Partnerships

To implement the BRW SLP, a series of interstate and interagency agreements and mechanisms will likely need to be developed. Rhode Island benefits from a number of federal-state partnership programs dedicated to marine, coastal, and fresh water research, monitoring, education, and policy. In general, they are funded on an on-going basis by grants from federal, private, and independent sector entities, with required match support from the state of Rhode Island. These partnership programs include:

- Narragansett Bay Estuary Program
- Rhode Island Sea Grant College Program
- Natural Resources Conservation Service

- The Narragansett Bay National Estuarine Research Reserve
- The University of Rhode Island Cooperative Extension Program
- The Bay Windows Program

In addition, there is another class of partnership programs which rely primarily upon a mix of state, independent sector, and volunteer support, including:

- Rhode Island Rivers Council
- Rhode Island Conservation Districts
- Rhode Island Natural History Survey
- Local Watershed Councils

In general, these programs function autonomously, rely primarily upon grant and match funding (especially federal grants), or annual legislative earmarks to support staff, underwrite fixed costs, and implement programs. Operationally, they emphasize partnering, internally and externally, in all phases of their operations. Although, it is widely recognized that these partnership programs provide essential research, monitoring, management, and policy services in Rhode Island, the state's direct support for them has historically been minimal and in recent years declining, a problem well-known across the federal agencies and foundations that provide the bulk of their support.

The University of Rhode Island (URI) plays a key role in housing and providing in-kind support for a number of these programs. Therefore, cuts to state support for URI directly threatens its ability to fulfill its outreach and applied science mission as a State University through the support and cultivation of these programs. Forcing URI to withdraw support for its research, outreach, and graduate studies programs by reducing its state support directly undermines the ability of the BRWCT agencies to carry out their missions.

The historic lack of state support has compelled the federal-state partnership programs to function "entrepreneurially", required them to devote considerable time and effort to competing for federal and foundation funds, and forced them to rely upon one-time grants or annual legislative earmarks to fund staff and core operations.

The consequence is that, despite their strategic emphasis upon partnering, statewide coordination of these programs remains piecemeal. Although many of these programs partner with one or more state agency, no single state entity oversees and coordinates them in order to maximize their utility to Rhode Island and cultivate state support for them.

The contributions of federal-state partnership programs to Rhode Island could be enhanced if the BRWCT worked with them more closely via implementation of the BRW SLP. The BRWCT would work to align their efforts with BRW SLP implementation, eliminate programmatic overlaps, identify and encourage the most valuable partnerships, and cultivate state and other forms of support for them.

CONCLUSION

In 2004, the General Assembly created the Bays, Rivers, and Watersheds Coordination Team comprised of seven state agencies and programs and requested that it produce a Systems-Level Strategic Plan. Four years later, thanks to the patient, determined efforts of many dedicated individuals, the first iteration of BRW SLP has been completed, a BRWCT Chair, and four BRWCT standing committees are in place and have been working for several years, some critical monitoring needs have been addressed, a dedicated funding source for BRWCT-endorsed activities has been established through FY 2008's Budget Article 30, and support is growing for the execution of EBM via collaborative government networks. Those who have been working since 2004 to render the BRWCT a viable, interagency collaboration have reason to believe that important accomplishments have been made.

Despite these initial successes, the BRWCT must navigate a number of uncertainties:

- How should BRW SLP implementation proceed in light of the budgetary and personnel pitfalls facing the BRWCT agencies in FY 2009, and most likely in subsequent budget years?
- How will interagency strategic planning cycle improve allocations of static or dwindling agency capacities?
- How could EBM approaches to aquatic environmental management improve the performance of core regulatory operations?
- What new policy, management, and regulatory tactics will be necessary to address environmental and economic development challenges outlined in the BRW SLP?
- What can be done to cultivate political and public support for EBM approaches to meeting core agency mandates?
- What incentives or mandates should the General Assembly and the Governor consider to ensure that the BRWCT agencies collaborate successfully and move the state rapidly into EBM for its aquatic environments and resources?

Notwithstanding the short-term urgencies that the BRWCT agencies often seem to spend the bulk of their time and resources addressing, their leadership must be keyed into how what they do and decide now will play out in five, ten, and twenty years. This document discusses in detail the issues Rhode Island faces economically and environmentally. Hopefully, it can serve as a basis for helping the BRWCT agencies prepare organizationally for the future.

What are the consequences of governance by network for executive agency administrative functions? How should we be training and supporting the professional development of current and future agency staff? How should policy tradeoffs between current and future values be accomplished in order to increase public investments now

in projects and infrastructure whose values are primarily future-oriented? How could we more flexibly pursue policies and management goals at state and local levels while still upholding legal mandates for uniformity and consistency?

Given the continuing emergence of networked government, it would be a mistake to assume that state executive agency of the future will resemble in any way their current bureaucratic forms and functions. It may even be a mistake to assume that they will occupy a central role in how we govern ourselves if their overall organizational effectiveness isn't substantially improved in the coming years. The RI Economic Policy Council recently argued for compellingly for major state governmental reforms:

> *We need to leap-frog other places to make ourselves into a center of government innovation. There is no mileage for us in catching up with best practice in government, because it is only the best practice possible within the structure of the Administrative State, the universal model by which government is organized at the federal, state, and local level. This model . . . has served us well . . . in creating accountability and transparency, two critical ingredients to successful governance. The question we must ask . . . is whether, given our more dynamic times and the fiscal challenges we face, is this model the right fit? How do we take the values that underlie the Administrative State and apply them to a more nimble and networked approach that fits for Rhode Island?*
>
> *Rhode Island . . . [must] think outside of the box of the Administrative State in part because it is currently performing so poorly within it. Governing Magazine consistently ranks Rhode Island state government as one of the least effective in the country, particularly in its management of human resources. When you're last in the race, incremental improvements won't change your position; you need a whole new game plan.* (RI Economic Policy Council, 2008)

While there are new governance models that may be useful in constructing that "new game plan" for Rhode Island state government, who is going to provide the leadership to explore those models and experiment with their application? Whether or not one source of that leadership is the BRWCT will depend upon the commitment of the BRWCT agency leaders and their key constituencies to implementing the BRW SLP and in doing so fashion a networked approach to EBM that works for Rhode Island.

In conclusion, one governance imperative seems clear. Namely, in assessing Rhode Island's current governmental structure and the environmental and economic challenges we face with regard to climate change, stormwater, AIS, waterfront development, and watershed, management, what emerges strongly is the need for stronger state government influence over and support for local government decisions and actions. The BRWCT should help Rhode Island move in this direction by bolstering training and technical assistance for local governments; but expanded financial support and regulatory mandates will be essential pre-requisites as well.

The BRW SLP: 2009-2013 comprehensively reviews the challenges we face and what we should do about them. Developing such a plan implies a commitment to its execution. That is up to the leaders and staff of the BRWCT agencies, the Governor,

the General Assembly, and above all the citizens who truly care about the well-being and future of Rhode Island's waters and watersheds.

APPENDIX I: OVERVIEW OF BRWCT MEMBER AGENCIES

Rhode Island Coastal Resources Management Council

Stedman Government Center,
Suite 116, 4808 Tower Hill Road,
Wakefield, RI 02879-1900
http://www.crmc.ri.gov

Mission:

CRMC's core mission is to "preserve, protect, and where possible, restore the coastal resources of the state through comprehensive and coordinated long-range planning." It works to facilitate responsible coastal redevelopment and economic growth, while preserving and restoring coastal ecological systems and increasing and improving public access to the shoreline, based upon the goals established and applied via CRMC's Coastal Resources Management Plan (CRMP, the "Red Book"). The CRMC encourages marine-based economic development that meets the aspirations of local communities and complements Rhode Island's overall economic development needs and goals. CRMC believes that future coastal development should draw upon and be inspired by the beauty and quality of Rhode Island's coastal environment, including the protection and enhancement of maritime activities, marine culture and the quality of place.

Responsibilities:

Formulate policies and plans, and adopt regulations necessary to manage the state's coastal physical, hydrological, eelgrass and wetlands resources.

Coordinate its functions with local, state, and federal governments on coastal resources management.

Advise the Governor, the General Assembly, and the public on coastal issues.

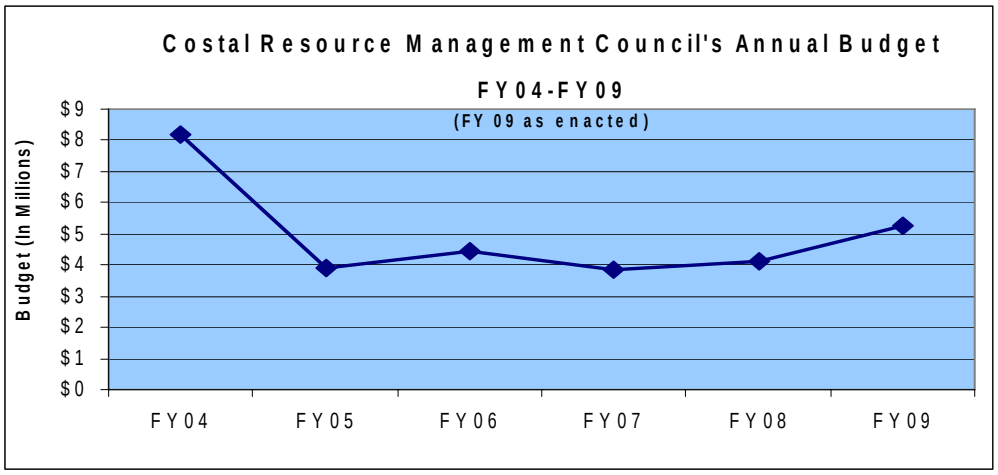
Arbitrate any dispute involving both the resources of the state's coastal region and the interests of two or more municipalities or state agencies.

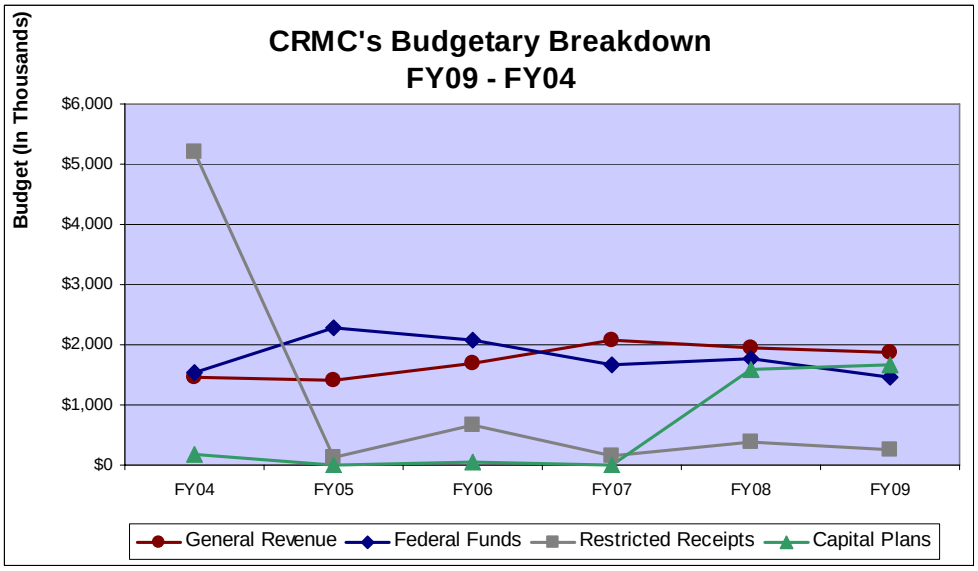
Designate public rights-of-way to the tidal water areas of the state.

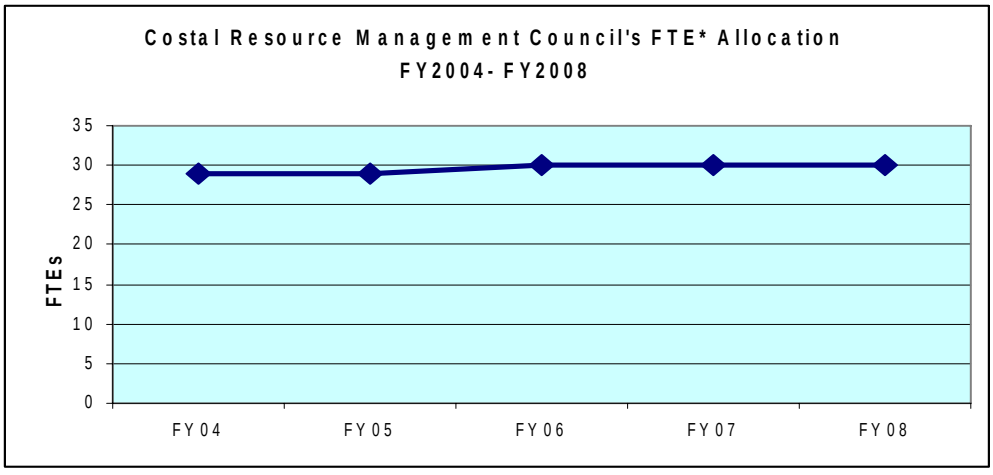
Serve as statutorily designated lead state agency for dredging and aquaculture.

Major Offices:

Executive and Deputy Directors
Public Educator and Information
Policy and Planning
Permitting and Enforcement







*FTE: “Full-time equivalent”. Equals one full-time position

Rhode Island Department of Administration's Division of Planning

Headquarters:

Rhode Island Division of Planning,
One Capitol Hill,
Providence, RI 02908
http://www.planning.state.ri.us

Mission:

Responsibilities:

Prepare and maintain plans for the physical, economic, and social development of the state and endorse their implementation.

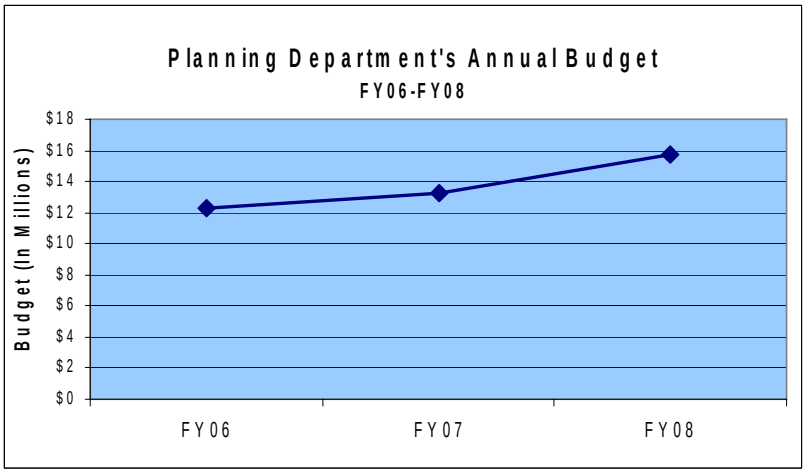
Coordinate the actions of state, local and federal agencies and private individuals within the framework of the state's development goals and policies.

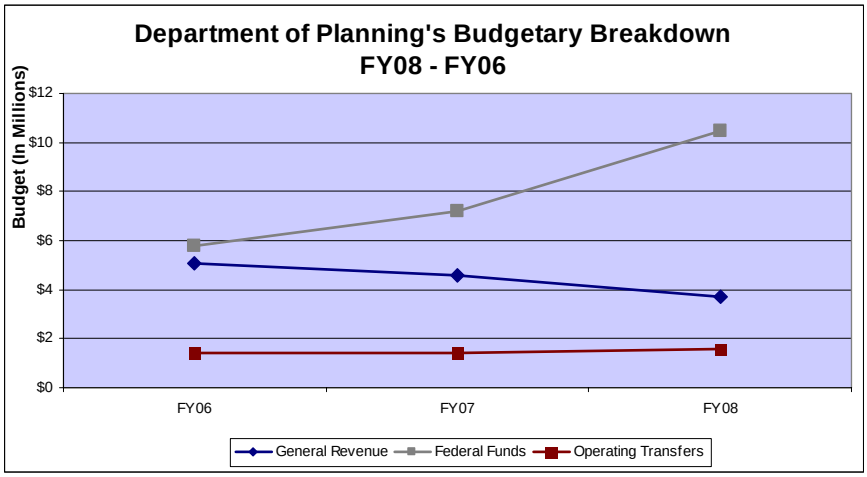
Assist local governments by maintaining a data center of information relating to the cities and towns of Rhode Island.

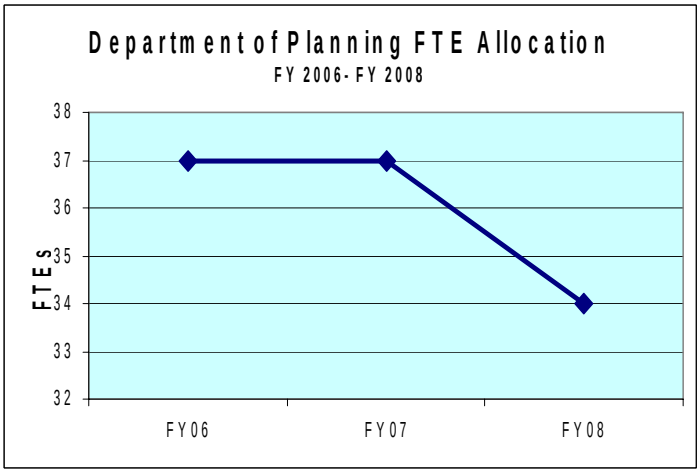
Actuate the development of communities by providing decent, safe, affordable housing opportunities; create a suitable living environment and expand economic opportunities principally for low- and moderate- income Rhode Islanders.

Major Offices:

Statewide Planning Program
Local Government Assistance
Housing & Community Development
Strategic Planning, Monitoring and Evaluation







Rhode Island Department of Environmental Management

Headquarters:

235 Promenade Street
Providence, RI 02908
www.dem.ri.gov

Mission:

Preserve the quality of Rhode Island's environment, maintaining the health and safety of its residents, and protecting the natural systems upon which life depends. Together with many partners, the department offers assistance to individuals, businesses and municipalities, conducts research, finds solutions, and enforces laws created to protect the environment.

Responsibilities:

To enhance the quality of life for current and future generations by protecting, restoring, and managing the natural resources of the state; enhance outdoor recreational opportunities; protect public health; and prevent environmental degradation.

Achieve a sustainable balance between economic activity and natural resource protection.

Motivate citizens of the state to take responsibility for environmental protection and management, based on an understanding of their environment, their dependence on it, and the ways their actions affect it.

Major Offices:

Office of the Director

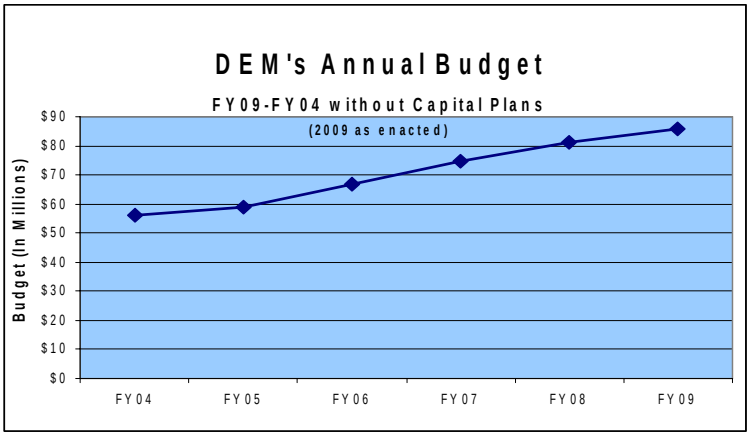
The Director, an Associate Director and three Assistant Directors oversee the implementation and administration of DEM's diverse programs dedicated to the protection of Rhode Island's natural environment and living public trust resources; threats to public health and well-being resulting from pollution; and the maintenance and operation of state facilities dedicated to a diversity of outdoor recreational activities.

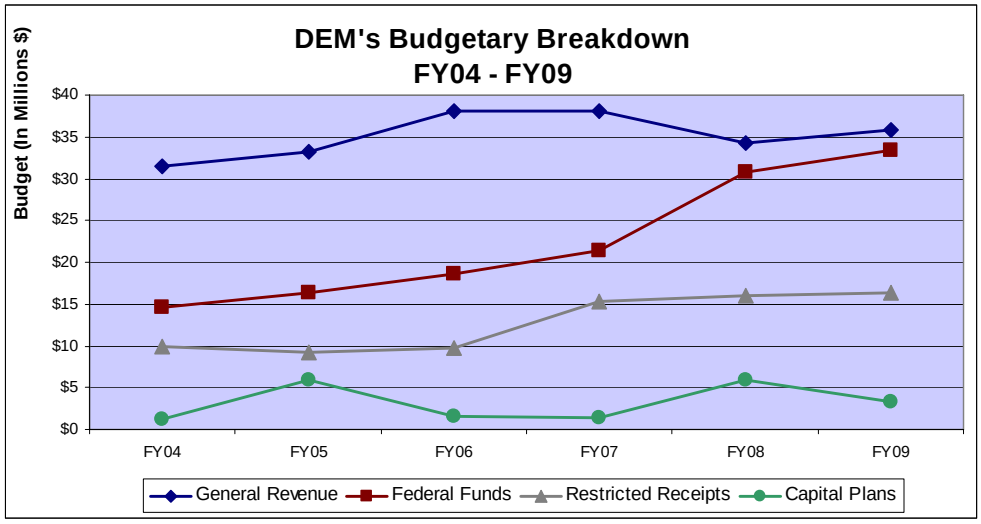
Bureau of Natural Resources

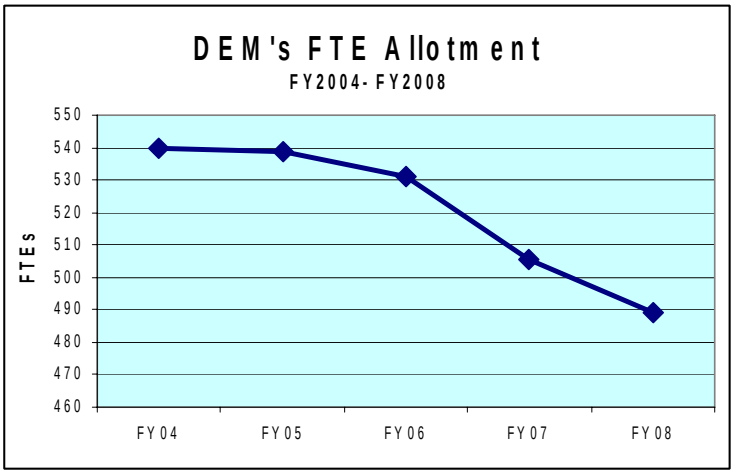
The Bureau of Natural Resources includes the Divisions of Agriculture & Resource Marketing, Coastal Resources, Fish & Wildlife, Forest Environment, Law Enforcement, and Parks & Recreation. These programs collaborate with citizens, legislators, environmental advocacy organizations, and the private sector to sustainably develop, manage, and protect Rhode Island's natural resources, and ensure public safety.

Bureau of Environmental Protection

The Bureau of Environmental Protection includes the Divisions of Air Resources, Compliance & Inspection, Technical & Customer Assistance, Waste Management, & Water Resources. The overall purpose of this bureau is to ensure compliance with state and federal environmental policies, laws, and regulations, and environmental quality standards. It is responsible for the preservation, protection and improvement of the air quality and water resources of Rhode Island. In addition, it oversees the investigation and remediation of hazardous waste and hazardous material releases.







Rhode Island Economic Development Corporation

Headquarters:

315 Iron Horse Way
Suite 101.
Providence, RI 02908
http://www.riedc.com/r/index.html

Mission:

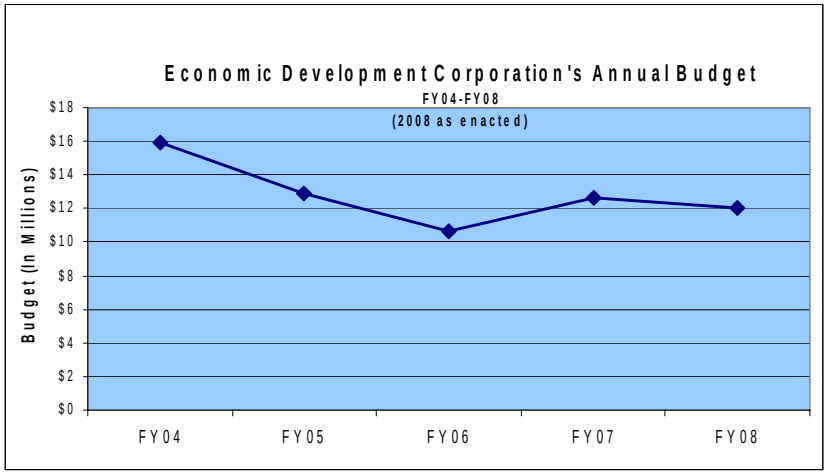
Rhode Island Economic Development Corporation (RIEDC) works to create jobs, attract and retain businesses to the state, and provide professional consultation and related services to encourage and enhance the business climate in the state.

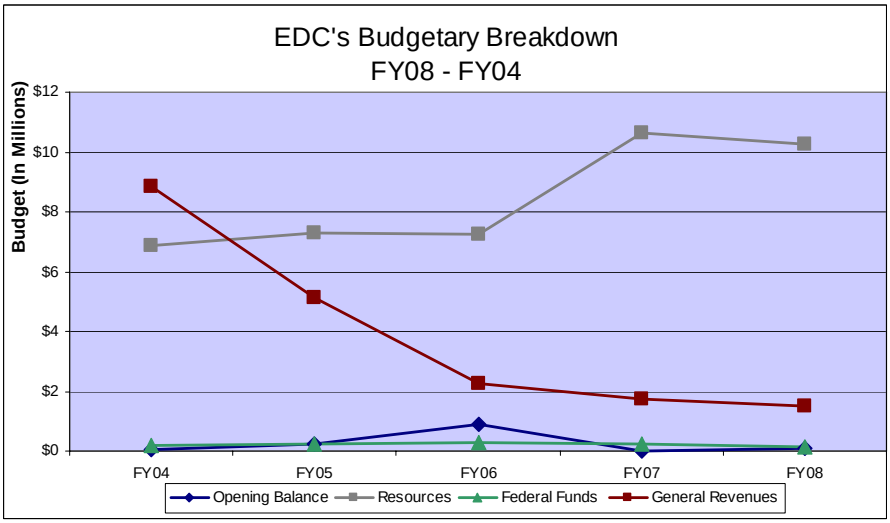
Responsibilities:

To strengthen the Rhode Island economy through policies, programs, and projects, which enhance and enrich the business environment for public and private sectors in order to create prosperity for all the citizens of Rhode Island.

Major Offices:

Management Operations & Services
Community & Government Relations
Accounting & Finance
Human Resources
Policy & Research
Rhode Island Tourism
Business Development
Communications and Market Development





Narragansett Bay Commission

Headquarters:

One Service Road,
Providence RI, 02905
http://www.narrabay.com

Mission:

To maintain a leadership role in the protection and enhancement of water quality in Narragansett Bay and its tributaries by providing safe and reliable wastewater collection and treatment services to its customers at a reasonable cost.

Responsibilities:

To ensure compliance with state and federal clean water legislation in the treatment of wastewaters from the Narragansett Bay region consisting of the cities of Providence, Pawtucket, Central Falls, East Providence, Cumberland, and Lincoln.

Operate and maintain the Field's Point and Bucklin Point Wastewater Treatment facilities, as well as the NBC"s sewerage infrastructure of interceptors, pump stations, tide gates and combined sewer overflows.

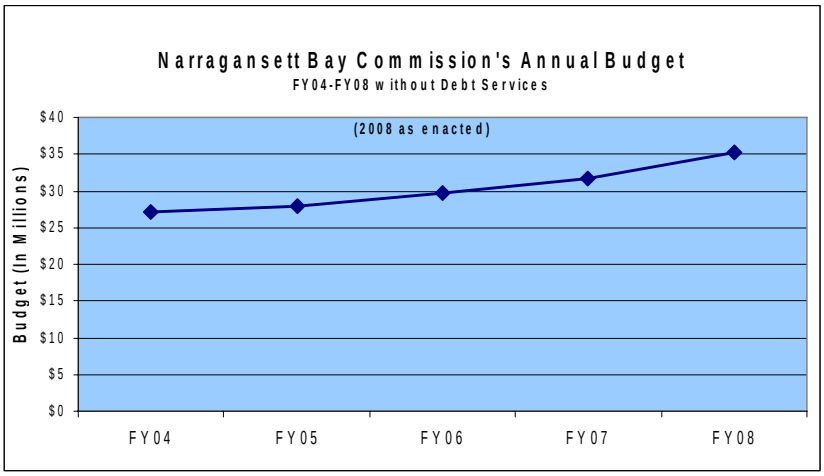
To provide reliable, cost-effective wastewater collection and treatment services to the residents and businesses of the majority of the Providence Metropolitan area.

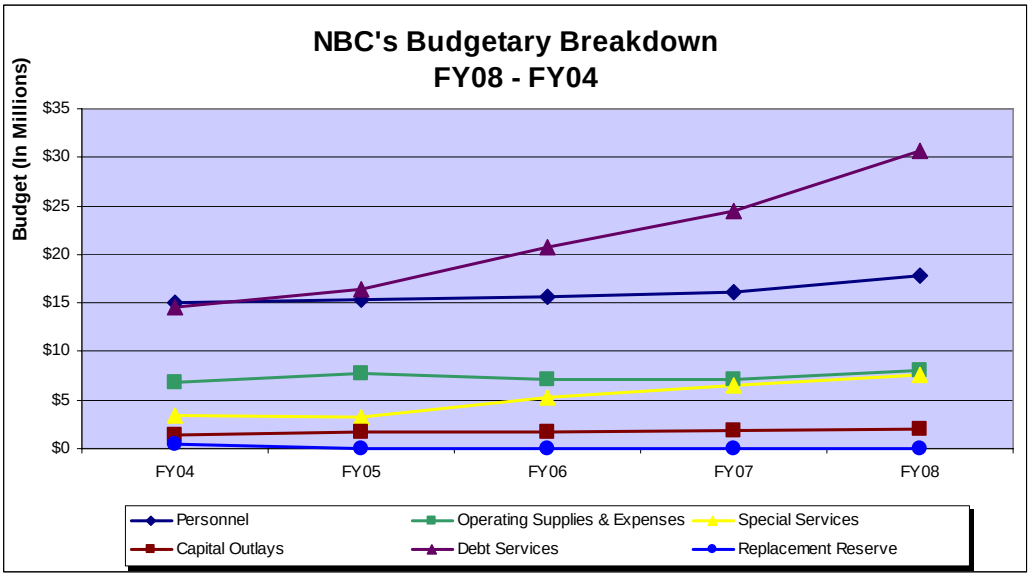
To implement a federally mandated Combined Sewer Overflow (CSO) program.

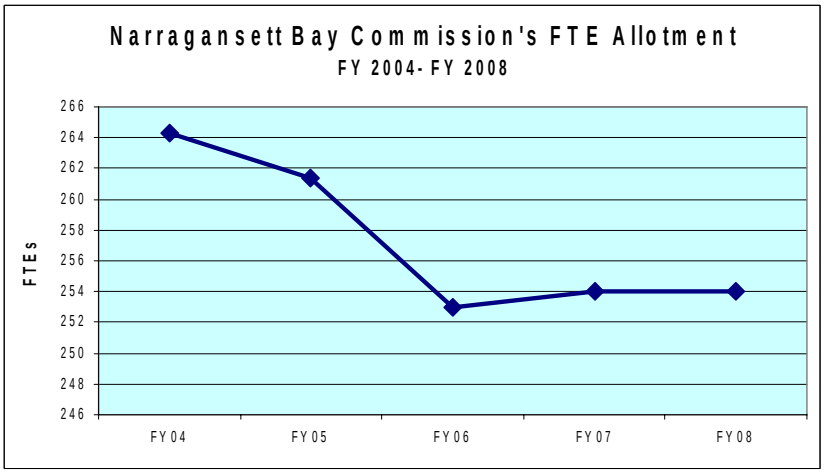
Assume a leadership role and stewardship responsibilities in the ongoing effort to keep Narragansett Bay's water clean.

Major Offices:

Administration & Finance
Planning, Policy & Regulation
Engineering & Operations







Rhode Island Rivers Council

Headquarters:

Justice William E. Powers Building, 3rd Floor
One Capitol Hill
Providence, RI 02908
http://www.ririvers.org

Mission:

The RI Rivers Council coordinates, oversees, and reviews efforts to improve and preserve the quality of the state's rivers and other water bodies and to encourage river-based recreation. The Rivers Council seeks to address the fact that "state jurisdiction over rivers, environmentally, culturally and economically,

is scattered among state agencies and that, in some instances, state policies and plans [concerning rivers] are conflicting." The Council works to strengthen local watershed councils as local partners in river and watershed protection. In 2004, the Rivers Council became an associated function of the Rhode Island Water Resources Board.

Responsibilities:

Develop and guide implementation of the Rhode Island State Rivers Policy and Classification Plan.

Advise State Agencies and municipalities concerning programs and measures to improve and protect river and watershed quality and to promote river use consistent with the Rivers Plan.

Foster public involvement in river planning and decision-making through public education and promotional activities

Designate watershed councils as bodies corporate and politic with specific powers, duties and responsibilities.

Rhode Island Water Resources Board

Headquarters:

One Capitol Hill, 3rd Floor,
Providence, RI,
02908
http://www.wrb.ri.gov/index.htm

Mission:

The Rhode Island Water Resources Board manages the proper development, utilization and conservation of the state's freshwater resources. Its primary responsibility is to ensure that sufficient water supply is available for present and future generations, apportioning available water to all areas of the state, if necessary.

Responsibilities:

Manage and develop a high quality drinking water supply in the Big River Management Area.

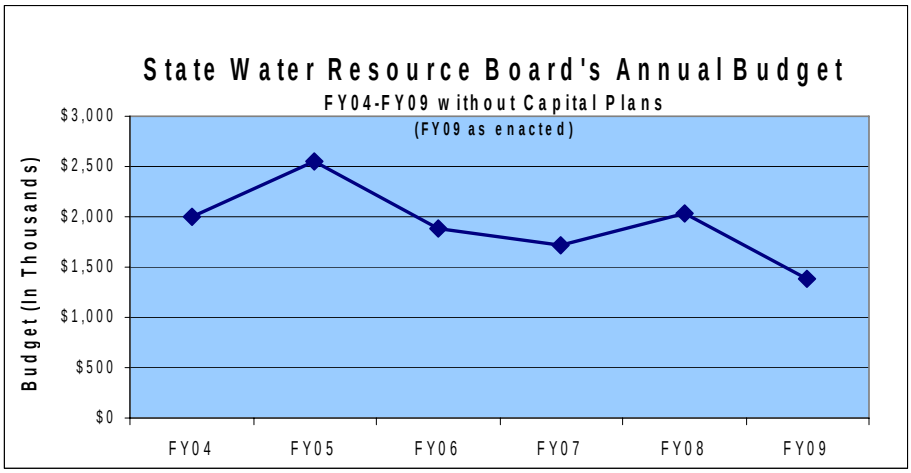
Establish a robust scientific foundation for statewide freshwater management, including resources inventories, hydrologic models, comprehensive database design and development, assessments of water availability, water supply planning, and science outreach and education for the general public.

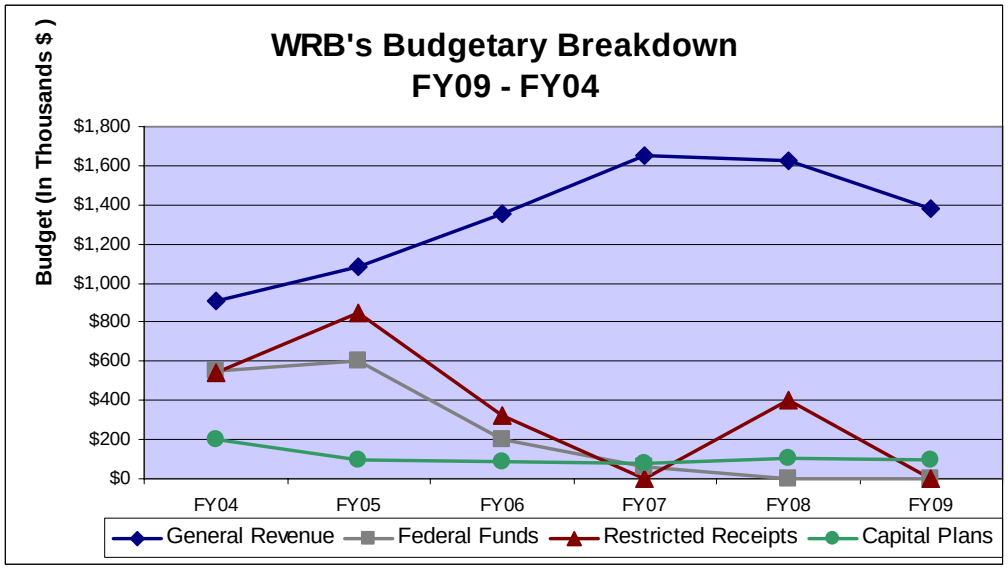
Oversee the development and implementation of Water System Supply Management Plans for all major water suppliers in the state.

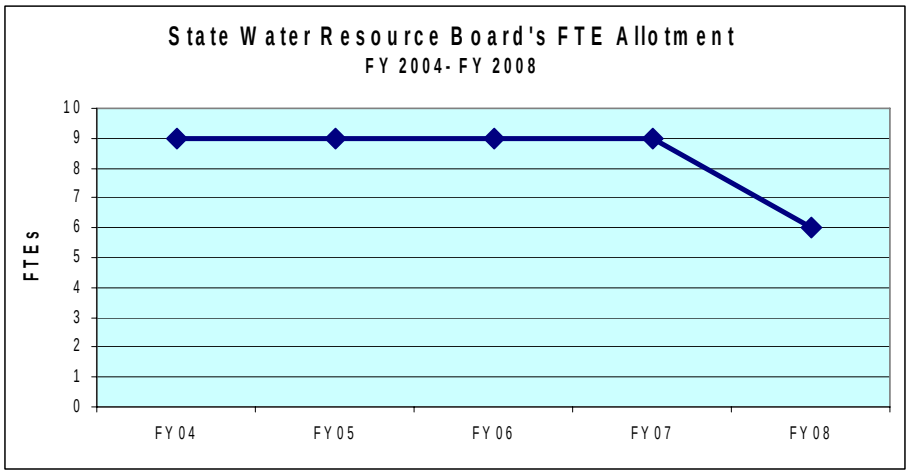
Identify potential high yielding sites to preserve for contingency and/or additional supply sources and has entered into negotiations for acquisition.

Conduct drought planning, conditions monitoring and response.

Implement the Emergency Interconnection Program to identify needed connections between water suppliers fund infrastructure development necessary for connecting systems so that water supplies can be shared during emergencies.






State Water Resource Board's FTE Allotment
FY 2004- FY 2008
FTEs
10
9
8
7
6
5
4
3
2
1
0
FY 04
FY 05
FY 06
FY 07
FY 08

APPENDIX II: ECOSYSTEM-BASED MANAGEMENT

EBM requires integration of multiple system components and uses, identifying and striving for sustainable outcomes, precaution in avoiding deleterious actions, and adaptation based on experience to achieve effective solutions.
-Donald Boesch, 2006

Mankind may the most coastally dependent species in the biosphere.
- Weinstein, 2005

As a model for environmental and resources governance, ecosystem-based management (EBM) has been emerging over the past one hundred years from the environmental sciences and the study of environmental law, policy, and management. EBM stipulates that managers should focus on the health, productivity, and resilience or adaptivity of ecosystems as the best means for achieving short- and long-term policy objectives. Its definition of ecosystem incorporates both human and natural components; i.e., human communities are considered essential (and often dominant) components of natural ecosystems.

The power of the original Coastal Zone Management Act was its acknowledgement of the need for land-use planning that considers multiple objectives and competing needs. This was essentially an early expression of the concept that is now discussed as ecosystem-based management (EBM). Despite years of discussion and work, EBM is still a concept for which we have yet to reach consensus on how it should be defined. Nor do we have robust examples of how EBM can be implemented. As such, state and local CZM decision-making often focuses on individual uses and threats. A renewed commitment to multi-objective planning for coastal lands and waters is necessary to ensure future decisions better protect coastal and marine environments while encouraging appropriate economic activities. Further, incentives should be provided to assist states and federal agencies to develop and apply more multi-objective planning tools.
- Lynne Hale, 2008

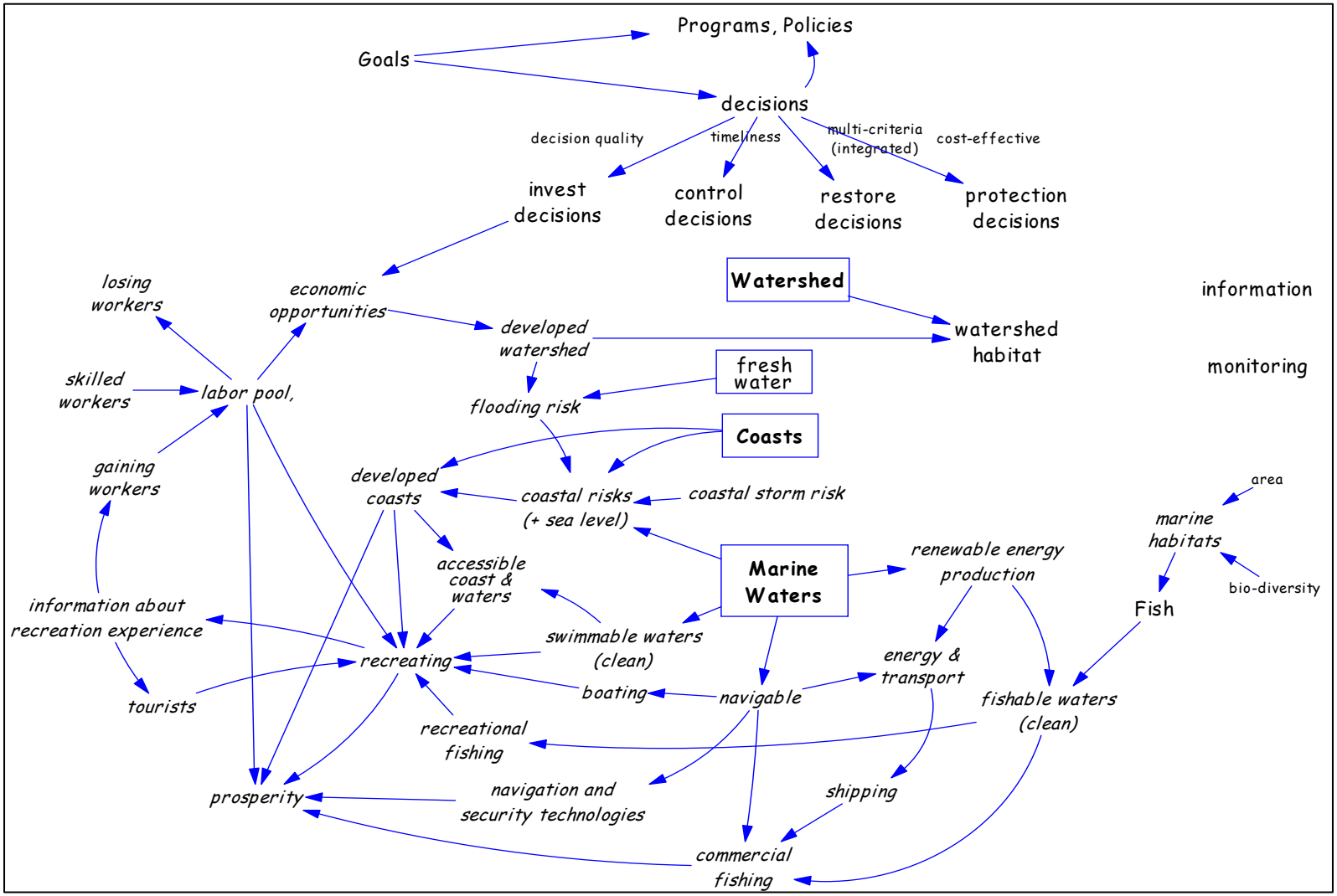
The application of EBM principles to real-world environmental and economic issues strongly implies the delineation at multiple temporal and geographic scales the complex adaptive functions and structures of natural and socio-economic systems, and the linkages between them. In addition, EBM requires rigorous definitions of ecological and socio-economic health, integrity, and resilience, also a daunting technical and political challenge. Current models of complex adaptive systems emphasize “resilience”: the ability of a system to bounce back from or resist external perturbations as the key for maintaining the viability of ecosystems and sustaining their socio-economic values. The systems approach inherent to EBM provides a framework for integrating environmental, cultural, and socio-economic dimensions in public sector planning and management for aquatic environments, watersheds, and the economic activities that derive from them. Theoretically, the EBM framework enhances the scientific and empirical basis of management and policy, and enables balanced recognition of ecological, social and cultural considerations and values in environmental and economic development decisions.

Table 1 and Figures 1 and 2 demonstrate the imperative for EBM. Table 1 captures how particular uses or economic activities can negatively or positively affect each other depending upon how those uses are governed in relation to each other. Figure 1 shows how URI's Donald Robadue has mapped out the systems interactions between the coastal resources and values identified in the BRW SLP's vision statement utilizing systems dynamics theory (Robadue, 2005). Figure 2 reflects the WRB's thinking on the "systems framework" that it must operate within, that establishes the overall context for the management goals it must pursue.

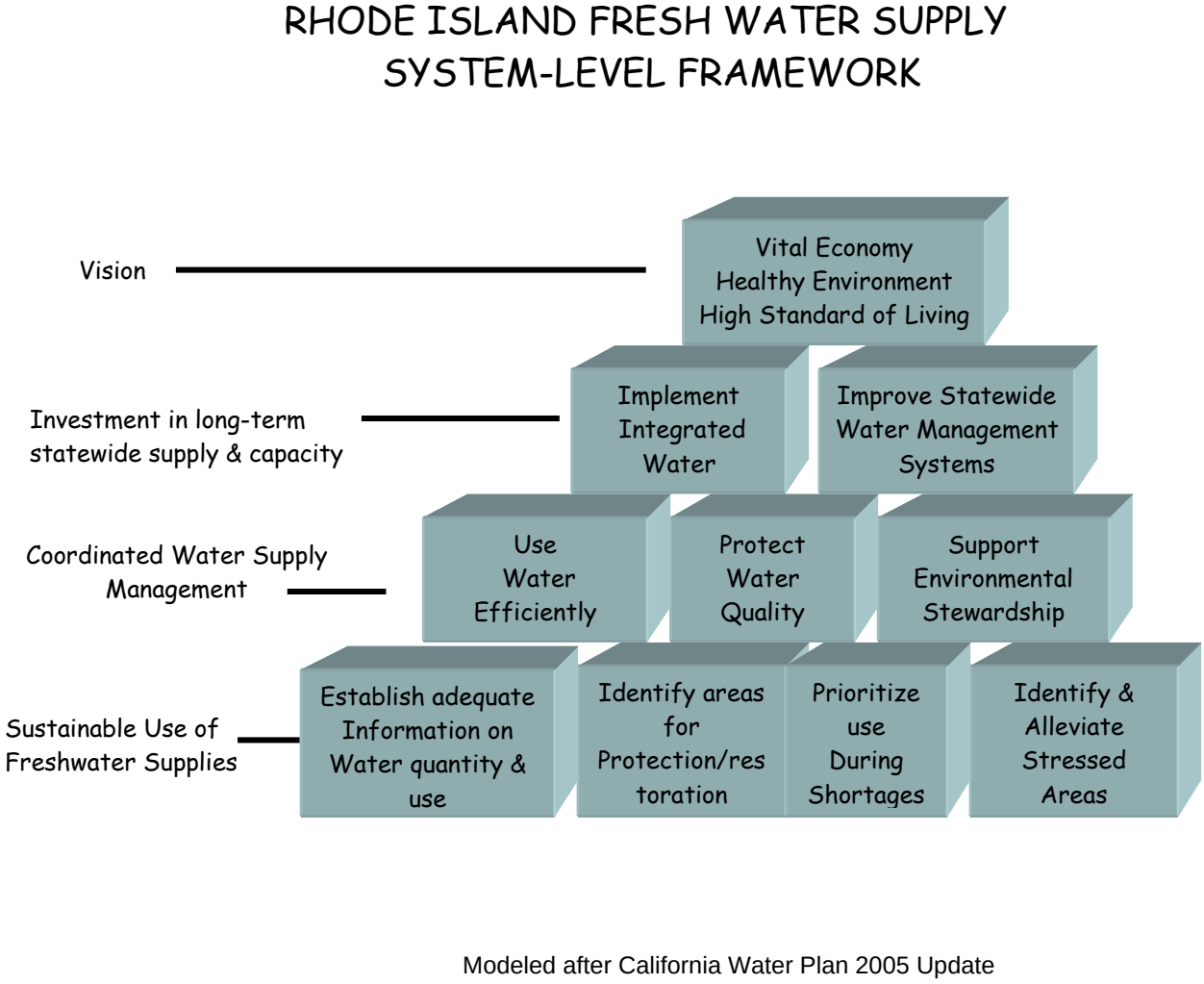
	Ports and Shipping	**Transportation**	**Public Works**	**Fisheries**	**Tourism**
+ TOURISM	Passenger liner facilities	Airports and roads to tourist areas	Infrastructure for tourism development	Conservation of habitat areas vital to both recreational and commercial species.	
—	Ship pollution in beaches and swimming areas	Encroachment of urban dev. produced by roads	Encroachment of urban dev. produced by public works	Air & Water pollution from fish processing industries & boats.	
+	Harbors and processing facilities	Roads and railroads to ship products	Sewage from processing		Sport-fishing opportunities
FISHERIES —	- Ship pollution - Wetland fill	- Wetland fill - Estuary fragmentation	Wetland fill for development produced by provision of public works		- Pollution from fish processing - Fill of wetlands for tourist facilities
+	Docks & channels enabling evacuation before storm and flooding	Roads & bridges for evacuation before storm and flooding	Public works such as dams & revetments to reduce or eliminate hazards	Fisheries development increases both amount & healthfulness of product.	Improvement in public water supply &/or sewage treatment
PUBLIC HEALTH & SAFETY —	Port development in hazard-prone areas	Provision of transportation stimulates development of hazard-prone areas	Provision of public works stimulates development of hazard-prone areas	Water pollution from fish processing industries & boats	

+ Sector reinforces or has positive Impacts on another sector.
— Sector has negative impacts on another sector.

App. II Table 1: *Positive and Negative feedbacks and interactions between coastal economic sectors.* (Adapted from Sorensen and McCreary, 1990)



App. II Figure 1: Implied relationships between values and resources identified in the Bays, Rivers, and Watersheds Systems-Level Vision (Robadue, 2008)



App. II Figure 2: A systems perspective for managing Rhode Island's freshwater resources produced by the RI Water Resources Board.

There is a large and rapidly growing knowledge base regarding the continuing development of EBM principles and progressive experiences with their application. The BRW SLP represents a concerted effort by seven Rhode Island state agencies and programs to establish an EBM framework and strategic priorities and recommended actions for the state's fresh and marine waters and watersheds.

Planning Rationality and Political Rationality

EBM can be seen as the latest iteration of "rational planning" efforts to the execution of federal, state, and local policies, laws, and regulations. But experience amply demonstrates that governance cannot be improved solely through a focused pursuit of empirical rationality and more quantitative data relevant to difficult governance decisions. It is just as important to acknowledge and work to inform the "political

rationalities" inherent to environmental governance and economic development and well-being.

> *"[Many] management innovations have tried to improve government decision making and operations by imposing a formal rationality on systems that are not rational . . . in the conventional meaning of the word. Public and nonprofit organizations (and communities) are* politically rational*. Thus, [strategic planning] that is likely to work well in such organizations must accept and build on the nature of political rationality.*
>
> *"The political decision making model is inductive, not rational-deductive. It begins with* issues*, which by definition involve conflict, not consensus. The conflicts may be over ends, means, timing, locations, political advantage, reasons for change, or philosophy, and the conflicts may be severe. As efforts proceed to resolve these issues, policies and programs emerge to address them that are politically rational; that is they are politically acceptable to involved or affected parties. Over time, more general policies may be formulated to capture, frame, shape, guide, or interpret the policies and programs developed to deal with the issues. The various policies and programs are, in effect, treaties among the various stakeholder groups.*
>
> *"The [more effective strategic planning] process, in other words, accepts political decision making's emphasis on issues and seeks to inform the formulation and resolution of those issues."*
>
> *(Byron, 1995)*

Therefore, in addition to promoting planning rationality through expanded monitoring, systems analyses, and strategic planning, a credible application of EBM requires that the BRWCT and its SLP planning cycle function effectively within the political rationalities inherent to Rhode Island state and local government. The first step to linking planning rationality and political rationality in order to "inform the formulation and resolution of issues", was to organize the SLP around issue areas or domains inherent to Rhode Island, and to characterize those domains in a manner that will clearly direct monitoring, knowledge development, and strategic planning toward cost-effective, timely, and truly collaborative solutions best suited to Rhode Island.

An "issue" of course can be defined or characterized in many ways and at multiple scales. As the basis for a four-year strategic planning cycle, the SLP focuses on core long-term issue domains such as coastal waterfront development and water quality, rather than tangible issues that arise from a specific project or human use; projects that often crystallize controversy and public attention. State and local agencies have developed administrative and regulatory processes to reach specific project or development decisions in conformity with the constraints, incentives, and frameworks established by federal, state, and local law and regulation.

For issue domains for which there is strong consensus on how to move forward, the BRW SLP identifies unambiguous actions and frequently the means to pursue them. Through a variety of stakeholder collaborations, the BRWCT agencies have developed numerous strategic plans and findings that establish consensual bases for solving resource use conflicts, protecting resources vulnerable to over-use, and restoring

degraded environments or resources. The BRW SLP draws as much as possible from previous efforts to define collaboratively strategic priorities, and in so doing clarifies and links them.

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APPENDIX III: BRWCT SUBCOMMITTEES

Economic Monitoring Collaborative

(As of July 2008)

Name	Affiliation
Ames Colt (Interim Chair)	RI BRWCT
James Boyd	RI Coastal Resources Management Council
Michael Doherty	RI Econ. Development Corporation
David DePetrillo	RI Econ. Development Corporation
Andrew Dzykewicz	RI Office of Energy Resources
John Gates	URI Depart of Environ & Nat. Rsce Economics
Michael Keyworth	Brewer Cove Haven Marina
Steven King	RI Econ. Development Corporation, Quonset Development Corp.
Kenneth Kubic	Kubic & Conradi Consultants
Beth Laney	General Dynamics Electric Boat
Michael McGiveney	RI Shellfisherman's Assocation
E. Howard McVay Jr.	Northeast Pilots Assocation
Steven Medeiros	RI Saltwater Anglers Association
Richard Nadolink	Energetics Technology Center
Marisa Paul	Raytheon IDS
Eric Reid	Deep Sea Fish of RI
Tom Rich	New England Boatworks

Environmental Monitoring Collaborative

(As of July 2008)

Name	Affiliation
Peter August (Chair)	URI Coastal Institute URI Depart. of Nat. Resources Science
Thomas Uva (Vice- Chair)	Narragansett Bay Commission
Sue Kiernan (Vice-Chair)	RI Depart. of Environ. Management, Office of Water Resources
James Boyd	Coastal Resources Management Council
Marci Cole	Save the Bay
Chris Deacutis	Narragansett Bay Estuary Program
Walter Galloway	EPA Atlantic Ecology Division
Linda Green	URI Watershed Watch
David Gregg	RI Natural History Survey
Beth Johnson	The National Park Service
Ernest Julian	RI Department of Health
John King	URI Grad. School of Oceanography
Charles LaBash	URI Environmental Data Center
Najih Lazar	RI Depart. of Environ. Management, Div. of Fish & Wildlife
Chris Powell	Citizen
Margherita Pryor	EPA Region 1
Robert Stankelis	Narragansett Bay National Estuarine Research Reserve
Richard Ribb	Narragansett Bay Estuary Program
Kathleen Wainwright	The Nature Conservancy
Jeff Willis	RI Coastal Resources Management Council
Chip Young	URI Coastal Institute URI Coastal Resources Center

Public Advisory Committee

(As of June 2008)

Name	Affiliation
Chip Young (Chair)	URI Coastal Resources Center URI Coastal Institute
Jane Austin (Vice-Chair)	Save the Bay
Matt Auten	Environmental Rhode Island
Robert Billington	Blackstone Valley Tourism Council
Jeff Broadhead	Washington County Regional Planning Council
Janet Coit	The Nature Conservancy
Rupert Friday	RI Land Trust Council
Gregg Gerritt	Friends of the Moshassuck
Steve Insana	Buckeye Brook Coalition
Linda Jzyk	RI Department of Education
Kenneth Kubic	Kubic & Conradi Consultants
Meg Kerr	Narragansett Bay Estuary Program
Alicia Lehrer	Woonasquatucket River Watershed Council
Michael Lewis	RI Department of Transportation
Michael McGiveney	RI Shellfishermen's Association
Steven Medeiros	RI Saltwater Anglers Association
Jennifer Pereira	The Rhode Island Foundation
B. Michael Rauh Jr.	The Washington Trust Company
Richard Ribb	Narragansett Bay Estuary Program
Michael Ryan	Narragansett Electric
Jamie Samons	Narragansett Bay Commission
Jack Schempp	Environmental Council of RI
Keith Stokes	Newport County Chamber of Commerce
Judith Swift	URI Depart. of Communications
Lawrence Taft	RI Audubon Society
Scott Wolf	Grow Smart RI
David Zoglio	Classical High School

Science Advisory Committee

(As of September 2006)

Name	Affiliation
Donald Pryor (Chair)	Brown University Center for Environmental Studies
David Bengston	URI College of Environment and Life Sciences
Jeremy Collie	URI Graduate School of Oceanography
Chris Deacutis	URI Narragansett Bay Estuary Program
Laura Ernst	ESS Group, Inc.
Mark R. Gibson	RI Depart. of Environ. Management, Division of Fish and Wildlife
Art Gold	URI College of Environment and Life Sciences
Frank Golet	URI Dept. of Natural Resources Science
Julie Lundgren	The RI Nature Conservancy
Candance Oviatt	URI Graduate School of Oceanography
Saul Saila	URI Graduate School of Oceanography
Craig Swanson	Applied Science Associates, Inc.

The Ad Hoc Strategic Planning Work Group & Plan Contributors

(As of March 2008)

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Caitlin Chafee	RI Coastal Resource Management Council
Jeff Willis	RI Coastal Resource Management Council
Jared Rhodes	RI Depart. of Admin., Div. of Planning
Kevin Nelson	RI Depart. of Admin., Div. of Planning
Mike Walker	RI Economic Development Corporation
Juan Mariscal	RI Water Resources Board
Kathleen Crawley	RI Water Resources Board
Tom Uva	Narragansett Bay Commission
Guy Lefebvre	RI Rivers Council
Richard Ribb	Narragansett Bay Estuary Program
Kip Bergstrom	RI Economic Policy Council
Ariana McBride	RI Economic Policy Council
Walt Galloway	US Environmental Protection Agency
Jennifer West	Narragansett Bay National Estuarine Research Reserve
Katherine Flynn	RI Economic Development Corporation
David Depetrillo	RI Economic Development Corporation
Chris Deacutis	Narragansett Bay Estuary Program
Don Robadue	URI Coastal Resource Center
David Gregg	RI Natural History Survey
Tom Getz	RI Depart. of Environ. Management, Office of the Director
Melissa Stanziale	RI Depart. of Environ. Management, Office of the Director
Bob Ballou	RI Depart. of Environ. Management, Office of the Director
Dave Alves	RI Coastal Resource Management Council
Jane Austin	Save the Bay

APPENDIX IV: REFERENCES

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APPENDIX V: GLOSSARY

Angler	A fisherman who fishes with a hook.
Anoxia	1. Absence of dissolved oxygen in a natural waterbody. 2. A pathological deficiency of dissolved oxygen.
Anthropogenic	Caused by human beings.
Aquaculture	The science, art and business of cultivating marine or freshwater food fish or shellfish, such as oysters, clams, salmon, and trout, under controlled conditions.
Aquatic Macrophytes	Aquatic plants, growing in or near water that are emergent, submergent, or floating.
Arterial	Of, like, or in an artery or arteries.
Benthic Habitats	The habitats of sea or lake bottoms.
Biodiversity	The variability among living organisms on the earth, including the variability within and between species and within and between ecosystems.
Biosolid	Solid or semisolid material obtained from treated wastewater, often used as fertilizer.
Brownfield	A piece of industrial of commercial property that is abandoned or underused and often environmentally contaminated, especially one considered as a potential site for redevelopment.
CAD Cell	Confined aquatic disposal cell used to dispose of safely sediments which contaminated with anthropogenic pollutants such as trace metals.
Carbon Cap	An approach to mitigate global warming by capturing carbon dioxide (CO2) from large point sources such as fossil fuel power plants and storing it instead of releasing it into the atmosphere.
Detention Basin	A storm water management facility installed on, or adjacent to, tributaries of rivers, streams, lakes or bays that is designed to protect against flooding and, in some cases, downstream erosion by storing water for a limited period of a time.
Dredge	An excavation activity or operation usually carried out at least partly underwater, in shallow seas or fresh water areas with the purpose of gathering up bottom sediments and disposing of them at a different location.
Estuary	A semi-closed coastal body of water with one or more rivers or streams flowing into it, and with a free connection to the open sea.
Eutrophication	An increase in chemical nutrients – typically compounds containing nitrogen or phosphorus – in an ecosystem.

Fishery	An area with an associated fish or aquatic population with is harvested for its value (commercial, recreational, subsistence).
Fish Ladder	Structures on or around artificial barriers (such as dams and weirs) to facilitate diadromous fishes' natural migration.
Flood Plain	Flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding.
Groundwater	Water located beneath the ground surface in soil pore spaces and in the fractures of lithologic formations.
Hydrodynamics	The study of liquids in motion.
Hydrology	The study of the movement, distribution, and quality of water throughout the Earth.
Hypoxia	A phenomenon that occurs in aquatic environments as dissolved oxygen (DO; molecular oxygen dissolved in the water) becomes reduced in concentration to a point detrimental to aquatic organisms living in the system.
Infill Development	
Infiltration Basin	A type of best management practice (BMP) that is used to manage storm water runoff, prevent flooding and downstream erosion, and improve water quality in an adjacent river, stream, lake or bay.
Infrastructure	The assets that support an economy, such as roading, water supply, wastewater, stormwater, power supply, flood management, recreational, and other assets.
Marsh Benthos	
NGO	Non-government organization.
Non-Point Source	Pollution (water) affecting a water body from diffuse sources, rather than a point source which discharges to a water body at a single location.
Nor'easter	A macro-scale storm along the East Coast of the United States, so named because the winds come from the northeast, especially in the coastal areas of the Northeastern United States and Atlantic Canada.
Pathogen	An infectious agent, or germ, that causes disease or illness to its host.
Phragmites	A large perennial grass found in wetlands throughout temperate and tropical regions of the world.
Plankton	Any drifting organisms (animals, plants, or bacteria) that inhabit fresh and marine natural waters.
Point Source	A single identifiable localized source of pollutant discharge into a natural waterbody..
Riparian Vegetation	Plant communities along the margins of a river.

Runoff	The flow of water, from rain, snowmelt, or other sources, over the land.
Spikes	The spreading of a city and its suburbs over rural land at the fringe of an urban area.
Sustainable Tourism	Tourism committed to making a low impact on the natural environment and local culture, while helping to generate income and employment for locals.
Systems Theory	An interdisciplinary field of science and the study of the nature of complex systems in nature, society, and science.
Topography	The study and delineation of Earth's surface features.
Trawl	A method of fishing that involves actively pulling a large fishing net through the water behind one or more boats.
USGS	United States Geological Survey
Vernal Ponds	Also called ephemeral pools, are temporary pools of water.
Waterfront	Any developed estuarine, riverine, lakefront, or coastal shoreline.