Needs Assessment of the New England Coastal Resource Management Community: Management of Ecosystems and Natural Hazards

Coastal Resources Center at the University of Rhode Island
and
National Oceanic and Atmospheric Administration (NOAA)
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Table of Contents

Acknowledgments 2
Executive Summary 3
Introduction 5
The Needs Assessment Process 5
New England Facts 8
Introduction to the Literature Review 8
Management of Coastal Ecosystems 10
Defining Marine Ecosystem-Based Management 10
Overview of Ecosystem-Based Coastal Management Initiatives in New England 13
Water Quality and Nutrient Reduction 15
Habitat Protection 17
Restoration of Nearshore Habitat 18
Ocean Resources and Living Resources 19
Education 20
Tools 21
Coastal Hazards Resilience 22
Overview of Federal and Regional Programs 24
Regional Hazard Risks 26
Vulnerability Assessment 28
Planning and Regulation 32
Mitigation 35
Response and Rebuilding 37
Education 38
Tools 39
Cross-Cutting Issues of Data and Information Access and Usability 40
Communication and Coordination 40
Access 42
Usability 42
Introduction to Interview Results 44
Needs to Implement Ecosystem-Based Management 44
Cross-Jurisdictional Management Needs 44
Social Science Tools and Information Needs 45
Ocean Observing Data and Applications 46
Mapping and Decision-Support Tools Are Needed 46

Needs to Increase Community Resilience to Coastal Hazards 47
Building Local Planning Capacity 47
Preparing an Inexperienced Population 48
Accessible Visualization Tools 48
Information Sharing Across Organizations 49
Next Steps: Using the Needs Assessment Results 49
Appendix A 53
Appendix B 54
Appendix C 55
Appendix D 62
References 63

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Executive Summary

In 2005, the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center established a regional presence in New England. In 2007, the Center initiated a formal needs assessment for New England to better understand the region's specific issues and needs. This report summarizes information gathered during the yearlong assessment process. The assessment examined efforts in regional ecosystem-based management and hazards mitigation planning to identify high-priority regional needs and specific issues and processes where the services and expertise of NOAA and the Coastal Services Center could be particularly useful.

The needs assessment will guide the strategic planning of the New England region and shape future products, services, and regional partnership of the Charleston-based NOAA Coastal Services Center. The Center will work with NOAA and other external partners to address the high-priority needs in the region.

Goal and Methodology

The goal of the needs assessment was to gather information about audiences concerned with coastal management issues in New England for the purpose of informing the design of products and services that support regional ecosystem management and foster community resilience.

The needs assessment process consisted of seven basic steps:

1. Establish a cross-NOAA Steering Committee
2. Identify target audiences
3. Conduct a literature review
4. Analyze results of the 2006 NOAA Coastal Services Center Customer Survey
5. Convene focus groups of key audiences
6. Conduct interviews
7. Analyze and assemble data

The draft report was reviewed by the NOAA Steering Committee and Center staff members.

Findings: Needs in the New England Region

The assessment's findings fall into three general areas of need:

1. Needs for supporting and fostering an ecosystem-based approach to the management of coastal resources
2. Needs for increasing community resilience to coastal hazards
3. Needs and drivers that contribute to interest in and access to information, training, and technical assistance

The needs in each of these categories are summarized below.

Supporting and Fostering an Ecosystem-Based Approach to Management

- A key to implementing an ecosystem-based approach to management on the ground is increased coordination and collaboration across state and jurisdictional boundaries. Participants need a better understanding of how to connect with existing venues available for cross-jurisdictional collaboration.
- Participants identified economic data needs as a major gap, including valuation of coastal and ocean resources, the economic value that coasts and oceans bring to neighboring, non-coastal communities, and cost-benefit analysis information.
- Understanding and navigating political processes and policy is an important component for implementing ecosystem-based management. A significant challenge identified by participants was engagement within the complex institutional structures of local, state, and federal government.
- Habitat data are widely useful, but the coastal management community is interested in taking the data further by visually connecting habitat areas, stressors, and potential impacts. Habitat maps and baseline information are necessary for this analysis.

Increasing Community Resilience to Coastal Hazards

- New England enables local governments to make development decisions. Participants identified a lack of local planning capacity and resources as a barrier to increased community resilience.
- Information describing the increased risk associated with various development options needs to be communicated to local planning boards and other elected officials.
- Participants identified a need for improved risk communication for coastal storm impacts. Visualization tools are needed to help managers and the public understand their risk associated with storm events, especially for regional storms such as nor'easters.
- Localized climate science is needed to support community-level planning
- Participants identified a need for a regional venue to share information related to coastal hazard issues.
- Managers understand historical data from NOAA tide gauges that indicate sea level is rising in New England. Managers need more certainty in the sea level rise predictions for the future.

Next Steps: Using the Needs Assessment Results

The needs assessment provides a wealth of information about specific needs related to resource issues and management activities. It provides a snapshot of current activities and capacity in the region and highlights common needs. The assessment will guide the efforts of the NOAA Coastal Services Center's Northeast region. The findings will shape strategic planning efforts and influence how Center resources are utilized in the region. The NOAA Coastal Services Center in Charleston, South Carolina, will also use the information to shape its future activities and will share the assessment results with all line offices.

Introduction

NOAA Coastal Services Center Regionalization

The Regional Coastal Services (RCS) branch of NOAA's Coastal Services Center (Center) works through a nationwide network to create an informed and inspired coastal community that has a comprehensive understanding of coastal and ocean-resource-management issues and accomplishes sound social and economic decisions. The goal of RCS is to provide convenient and timely access to reliable information, as well as technology and training, and to connect the Center and other NOAA programs to partners and end users in regions. The Center has deployed individuals and built capacities in five regions presently: Gulf of Mexico, Mid-Atlantic, New England, Great Lakes, Pacific Islands, and West Coast.

By strategically placing staff members and resources in various regions, the Center ideally gains an enhanced ability to communicate and collaborate with federal, state, and local resource management organizations. Regional employees coordinate with other NOAA programs to foster a One-NOAA network for local constituents and agencies. A key dimension of the Center's regional purpose is to participate in and support federal and nonfederal regional bodies, assist with organizing NOAA regional activities, and facilitate partners' participation in these efforts.

The Needs Assessment Process

In the fall of 2007 the NOAA Coastal Services Center initiated a formal needs assessment for the Northeast region. This report summarizes the information gathered during the ten-month process. The assessment considered the Northeast Regional Ocean Council's Ocean Congress Report and other regional efforts. It confirms priority New England regional needs previously identified, identifies specific issues and processes where the services and expertise available from NOAA and the Center can be particularly useful, and suggests ways in which communication and coordination can be enhanced.

The assessment will guide the strategic planning of the NOAA Coastal Services Center's Northeast region, which is headquartered at the University of New Hampshire. It will also inform future products, services, and regional partnership efforts of the Charleston-based Center. The assessment will be shared with partners across NOAA so the information gathered can be used by the many programs providing assistance in the New England region. Finally, it will be shared with external organizations that can help address priority needs directly and by leveraging resources and partnerships across the region.

Goal and Objectives

The following goal and objectives guided the needs assessment process.

> Goal: Gather information about audiences concerned with coastal management issues in the Northeast to inform the design of products and services that support regional management of coastal ecosystems and foster resilient communities.

Objectives:

- Identify the gap between existing and necessary information and capabilities supporting an ecosystem approach to management.
- Identify coastal-related information and tools that can enhance and promote community resilience.
- Identify needs and drivers that contribute to interest in and access to information, training, and technical assistance by the Northeast coastal management community.

Methodology

Below is an overview of the steps in this needs assessment process.

1. *Cross-NOAA Steering Committee established*: A steering committee was formed in October 2007 and included representatives from NOAA programs that are positioned to assist with solutions to the needs identified in the assessment. The committee includes representatives from the Office of Ocean and Coastal Resource Management, the National Marine Fisheries Service, the National Weather Service, the National Geodetic Survey, the National Centers for Coastal Ocean Science, the Office of Coast Survey, the Stellwagen Bank National Marine Sanctuary, and the Office of Response and Restoration. The first meeting of the steering committee took place October 2007. See Appendix A for a list of steering committee members and the NOAA Coastal Services Center needs assessment team.

2. *Target audiences identified*: Appendix B provides a list of primary and secondary target audiences. Primary audiences are customers and partners who use, or have the potential to use, NOAA information, products, and services. Secondary audiences include internal NOAA partners and the public. NOAA partners may be both customers of and contributors to Center regional efforts, and members of the public are "end users" who may access NOAA information, products, and services directly, or through partners. Identifying these audiences helped determine groups and individuals to include in interviews, and informed the selection of references for the literature review.

3. *Literature review conducted*: A foundation piece for the assessment, the literature review summarized existing information about audience needs. The University of Rhode Island's Coastal Resources Center was contracted to research documents that spoke to issues, activities, and needs of the identified target audiences, and sought out references in three topic areas thought to be of major concern in the Northeast:
    - Management of coastal ecosystems, which includes topics that relate to ecosystem-based management, water quality and nutrient reductions, coastal conservation and restoration, and characterization of habitat.
    - Hazards and community resilience, which includes topics that relate to planning for, mitigating, and responding to coastal hazards.
    - Data information access and usability, which includes topics that relate to application and use of data, models, and tools.

The literature review was completed in the spring of 2008, and results of that review are presented in this report.

4. *Results of the 2006 NOAA Coastal Services Center Customer Survey analyzed*: The Center conducts a periodic customer survey to better understand the issues and needs of the nation's coastal management community, including state regulatory and natural resource management agencies, coastal and marine protected areas, emergency managers, and others concerned with the management of coastal resources. Results from the most recent survey were analyzed as part of the needs assessment. Of the more than 400 respondents, 49 were from the Northeast region, and these respondents represented a wide variety of organizations and position types, providing a good cross-section of our target audiences. Survey results for the Northeast respondents are summarized in Appendix C, with findings highlighted within the report.

5. *Interviews conducted:* Eleven one-on-one interviews were conducted to augment the information gathered in the literature review. There is a high level of survey fatigue within the coastal management community caused by continual projects and assessments. With this in mind, steps were taken to minimize intrusion and conduct interviews with those who were identified as a primary audience but not well represented in the literature review. Some interviews were conducted by phone, while others were conducted at regional constituent meetings, workshops, and conferences. Appendix D provides a list of individuals interviewed. Needs identified during the interviews are presented in this report following the literature review results.

6. *Data analyzed and assembled, steering committee asked to review*: Information collected was analyzed and synthesized for inclusion in this report, and a draft report was circulated to the steering committee for review. Literature review findings, ideas raised during one-on-one interviews and at meetings, and steering committee input all contributed to this final report.

Figure 1. Map of New England States

New England Facts

- New England has six states, five of which have borders along the Atlantic coastline – Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut.
- New England has a population of nearly 14 million (including Vermont), with 67% (just over 9 million) living in coastal counties. (2000 census data) 74% live in urban areas.
- There are 751 municipalities in the coastal counties of New England. Nearly half of all coastal municipalities are in Massachusetts.
- There are two distinct ecosystems within New England's coastal waters – the Gulf of Maine and the Southern New England Sounds.
- The Gulf of Maine watershed includes much of Nova Scotia (Canada), New Brunswick (Canada), Maine, New Hampshire, and Massachusetts, and a small portion of Quebec (Canada), with a total watershed area of 69,115 square miles.
- The Bay of Fundy has the highest tides in the world, with a tidal range of nearly 50 feet.
- Fishing in the Gulf of Maine supports about 20,000 fishermen who harvest 530,000 metric tons of shellfish and finfish worth about $650 million.
- Over 10 million tourists visit the Gulf of Maine each year to enjoy its natural and cultural history and recreational opportunities.
- 63% of New England residents own their home, while the remaining 37% rent.
- 5% of the nearly 5.6 million homes in New England are second homes. In Maine, 15% of the housing stock in Maine is second homes.

Introduction to the Literature Review

The primary purpose of this review was to provide a foundation from the literature to effectively direct the efforts of the NOAA Coastal Services Center in the Northeast. As outlined above, the literature review was one of several methods used to obtain specific information on New England's coastal management needs that the Center and other NOAA offices might address.

A substantial volume of information has been published about the coastal management needs and issues of the Northeast. Such reports and publications have been produced by various sources, including governments (federal, state, local), regional governance groups, private-sector organizations, and academic institutions. While this literature review is not a comprehensive synthesis of all literature within the scope of the study, the references selected are representative of issues and groups directly involved in working toward common solutions for the greater

coastal management community. (A list of references reviewed appears at the end of the needs assessment report.)

The literature review is categorized by the issues and needs related to two broad topical areas: ecosystem-based management and coastal hazards resilience. A final section identifies crosscutting needs related to these issues, including information access and usability.

The review demonstrated that although specific needs vary across the five coastal New England states, there are a number of common issues of concern across the Northeast region. Issues mentioned in documents from all five states include

- Coastal growth and development,
- Habitat mapping,
- Conservation of living resources
- Habitat restoration, and
- Hazard mitigation.

Table 1 presents priority issue areas repeatedly raised in the literature.

Table 1. Priority Issues Identified in Literature Search

Literature Cited Note: Not all reviewed documents and identified issues are referenced in this table.	Habitat Mapping	Coastal Growth & Development	Water Quality	Conservation of Living Resources	Public Education & Outreach	Natural Hazard Mitigation	Habitat Restoration
Northeast Regional Ocean Council – 2007 Annual Report to the Governors of New England	*	*	*			*	
Gulf of Maine Council on the Marine Environment 2006 Action Plan	*	*	*	*			
New Hampshire Estuaries Program	*		*		*		*
Waves of Change: The Massachusetts Ocean Management Task Force	*	*		*	*		
Massachusetts Bay Program	*	*	*	*			
Managing Maine's Nearshore Coastal Resources: Final Report of the Bay Management Study	*	*		*			
Waquoit Bay National Estuarine Research Reserve	*	*	*		*	*	
Buzzards Bay National Estuarine Program	*		*	*			
Long Island Sound Study Plan	*	*	*	*	*		
Massachusetts Hazards Commission		*			*	*	
Greenwich Bay SAMP	*		*	*			*
Include CSO Survey from 2004		*	*			*	

Table 2 displays the priority issues for the state coastal management programs in the Northeast based on a review of the 2006 NOAA 309 Grant Assessment Reports.

Table 2. Priority Issues Identified by Northeast State Coastal Programs

	Cumulative & Secondary Impacts	Ocean Resource Management	Wetland Protection	Hazards Mitigation	Ocean Energy Siting	Public Access	Special Area Management Plans	Aquaculture	Marine Debris
Maine	High	High	Med.	High	Med.	High	High	Med.	Low
New Hampshire	High	High	High	Med.	Med.	Med.	Low	Med.	Low
Massachusetts	High	High	High	High	Med.	High	Med.	Low	Low
Rhode Island	High	Med.	High	Med.	High	Med.	High	Low	Low
Connecticut	High	High	Med.	Med.	High	Med.	Low	Med.	Med.

Management of Coastal Ecosystems

Defining Marine Ecosystem-Based Management

Part of this literature review focused on initiatives, programs, and needs in the Northeast for marine ecosystem-based management (EBM). There is an increased call and political support for EBM after the U.S. Commission on Ocean Policy released its report calling for a more comprehensive and integrated ecosystem-based approach to address the current and future management challenges (COMPASS 2007). In the box below is a definition of marine EBM by the Communication Partnership for Science and the Sea (COMPASS). This group also produced a list of specific actions that are consistent with the EBM approach. This definition and exemplary actions provided a foundation and point of reference for reviewing documents from New England's coastal management community.

Definition of EBM

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

"Specifically, ecosystem-based management:

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

(Adapted from COMPASS 2007)

Actions Associated with Marine EBM as Identified in the COMPASS Scientific Consensus

The Scientific Consensus Statement on Marine EBM highlighted key overarching actions that are consistent with an ecosystem-based approach to management. The literature review will show that some if not all of these actions are being applied to varying degrees already in the Northeast. However, they are not being implemented in a fully integrated and comprehensive manner that is called for and required for successful EBM.

- Initiate **ecosystem-level planning** that involves multiple stakeholders and takes into account the cumulative impacts of multiple important human activities on ecosystems, as well as the effects of long-term environmental changes.

- Establish **cross-jurisdictional management goals** through formal agreements and mechanisms across local, state, federal and tribal authorities.

- Initiate **zoning** of regions of the ocean, for example Large Marine Ecosystems, by designating areas for particular allowable uses in both space and time, including networks of fully protected marine reserves and other types of marine protected areas.

- Expand and improve the coordination of **habitat restoration** in coastal ecosystems such as wetlands and seagrass beds.

- Adopt **co-management** strategies in which governments and diverse stakeholders share the responsibility for management and stewardship.

- Incorporate **adaptive management** into ecosystem plans as an approach to learning from management actions.

- Establish long-term ocean and coastal observing, monitoring and research programs.

(Adapted from COMPASS 2007)

Overview of Ecosystem-Based Coastal Management Initiatives in New England

Multiple initiatives and programs in New England, from the regional to the local scales, incorporate the concept of ecosystem-based management (EBM). Some of these programs have been operating for several decades like Rhode Island's Special Area Management Plans (Rhode Island CRMC 2007). Others have developed more recently like the Massachusetts Oceans Act. These localized efforts are increasing throughout the region.

There has also been significant progress at the regional level, where several interstate and multistate initiatives are firmly established. These include the Gulf of Maine Council on the Marine Environment and the Long Island Sound Study. While the scale and boundaries of these initiatives vary, they are all based on EBM principles. Improved technology capacity is increasing the ability to collect and analyze data at the ecosystem level. However, there continues to be limited financial, technical, and political capacity at the local level to implement ecosystem-based coastal management programs (Massachusetts Office of Coastal Management 2006, New Hampshire Coastal Program 2006).

The Center for Sponsored Coastal Ocean Research (CSCOR 2006) has documented the Northeast region's many organizations, partnerships, and institutions active in coastal management with a focus on research and technological needs for regional ecosystem research. The CSCOR document also provides a thorough timeline of progress between all the individual surveys and needs assessments for the region. This literature review complements the CSCOR report by summarizing the major elements.

The Northeast Regional Ocean Council (NROC) was established by the New England Governors' Conference in 2005 with the purpose of identifying regional goals and priorities and linking regional ocean management and scientific institutions. NROC helps to link sub-regional programs in New England. This includes longstanding initiatives such as the Gulf of Maine Council and the Long Island Sound Study. In its 2006 work plan, NROC identified keys to successful EBM as "possessing adequate information to understand the interrelated nature of ocean and coastal systems, linking that information through modeling and analysis to management and policy decisions, and creating the governance structures to carry out and sustain those decisions." NROC's four priority issue areas for 2007 are ocean energy planning and management, ocean and coastal ecosystem health, maritime security, and coastal hazards resilience (NROC 2007a).

Recognizing that the northern section of the New England region has been organized through the Gulf of Maine Council on the Marine Environment (GOMC), the southernmost states have initiated a comparable partnership called the Southern New England and New York Ocean Partnership (SNENYOP). The partnership will work from the western Long Island Sound to the Southern Cape Cod and Islands region. Southern New England will focus on coastal hazard resilience and regional responses in collaboration with NROC.

The GOMC is continuing its regional work to improve ecosystem-based management through data and mapping initiatives, regional coordination, and outreach to coastal decision makers. GOMC has identified a need to develop a baseline assessment to better understand the

interconnections between human activities and ecosystem goods and services (GOMC 2005). Other data gaps at the regional and local levels include economic valuation of ecosystem services, impacts of climate change, invasive species distribution, patterns of human uses, and critical habitats. These data gaps suggest there is a larger need for social science than biological and physical sciences.

New England states are also establishing ecosystem-based governance and management regimes to match regional initiatives. Stemming from the recommendations for EBM by the U.S. Commission on Ocean Policy and the Pew Oceans Commission, Massachusetts led the way with the Oceans Report (Massachusetts Ocean Management Task Force 2004) and the ensuing Oceans Partnership Fund (Massachusetts Ocean Partnership Fund 2007) to coordinate the state's coastal and ocean management activities. This effort is a public-private partnership with the goal of developing an integrated ocean management plan in response to the Oceans Act legislation passed in 2008. Tasks include developing and piloting planning frameworks; coordinating the development of scenario analyses, models, and other tools to support decision making; improving the integration, interoperability, and information management of ocean data, research, and monitoring; and communicating to non-science audiences about ocean ecosystem services. The data network needs include baseline maps of the seafloor, the ecosystem, and human uses. While there is great interest and political will at the state level, there seems to be a lack of funding or expertise at the local level to implement EBM projects (Massachusetts Office of Coastal Management 2006).

Building from Massachusetts' progress, Maine released its Maine Bays Study (Maine State Planning Office 2007) to evaluate how to improve its nearshore coastal management programs. Results of the study identify a large gap between the ocean work of the GOMC and the local municipality-based coastal planning. There is a great need for improving regional nearshore management since the current coastal program is not effective for watershed and cross-jurisdictional issues. Maine conducted two pilot programs in Muscongus Bay and Taunton Bay to test the applicability and needs for a new EBM coastal program. The pilots proved successful in generating interest and in specifying needs. The Maine study found a major gap in nearshore data and information. Locating and gathering the limited data that did exist presented significant challenges. The Maine study sees the potential for the state's watersheds to act on their own issues, thus avoiding the one-size-fits-all approach of traditional state programs.

The Rhode Island Coastal Resources Management Council (CRMC), the states coastal management agency, continues to expand its special area management plan (SAMP) program. SAMPs are ecosystem-based management strategies that are consistent with the council's legislative mandate to preserve and restore ecological systems. The CRMC coordinates with local municipalities, as well as government agencies and community organizations, to prepare the SAMPs and implement the management strategies. The SAMP process has been applied to six areas of the coast. In 2008, CRMC announced its intent to develop its seventh SAMP, an Ocean SAMP to manage the state's offshore waters. The Ocean SAMP will define use zones for Rhode Island's offshore waters through a research and planning process that integrates the best available science with open public input and involvement (RI CRMC Fact Sheet). Rhode Island also established the Rhode Island Bays, Rivers, and Watersheds Coordination Team in 2004 to coordinate and integrate policies and plans across state lines (Mastrati and others 2004). The

overarching goal of the Coordination Team is to apply EBM tools and concepts to improve resource health.

Connecticut's core EBM initiative is the Long Island Sound Study in partnership with New York (New York State Coastal Management Program 1999). However, the state recognizes that a need remains for expanding their EBM approach. Connecticut's key needs are a central agency for the sound, a submerged lands leasing program, and an ocean governance strategy (Connecticut Department of Environmental Protection 2006). They see a regional ocean governance plan as critical to the issue of managing energy facility siting.

In addition to these state and regional initiatives in EBM, there are the site-based programs of the federal government. The National Estuary Program (NEP) is administered by the U.S. Environmental Protection Agency. These sites encompass large nearshore coastal areas in the region. Each site has a management plan that employs watershed-based planning, research, and analysis to address EBM issues. NEPs are located in each New England state and cover Casco Bay in Maine, the New Hampshire Estuaries, Mass Bays and Buzzards Bay in Massachusetts, Narragansett Bay in Rhode Island, and the Long Island Sound in Connecticut and New York.

The National Estuarine Research Reserves Program (NERR) is administered by the National Ocean and Atmospheric Administration. NERR sites cover less area than the NEPs, but complement them in their research of cumulative and secondary impacts within an ecosystem-based framework. They have a strong public outreach program and coastal training program that is focused on training local decision makers on EBM concepts and application. NERR sites are located in Maine, New Hampshire, Massachusetts, and Rhode Island.

The National Marine Sanctuaries Program (NMSP) is another national program administered by the National Oceanic and Atmospheric Administration. The NMSP manages a system of marine protected areas including the Stellwagen Bank National Marine Sanctuary off the coast of Massachusetts. Stellwagen Bank has a management plan that provides a framework for protection and management of marine resources.

Needs highlighted by these regional and state EBM initiatives include:

- Limited financial, technical, and political capacity at the local level to implement EBM
- Social science data gaps including human uses and values of ecosystem services
- Biological and physical science data gaps including baseline seafloor maps and nearshore data

More specific issues, capacity, and needs to implement ecosystem-based management in New England are discussed in detail in the following sections.

Water Quality and Nutrient Reduction

Water quality continues to be a major issue identified by all state coastal programs, NEPs, and NERRs. The Northeast coastal corridor is heavily developed, leading to excess nutrients and bacterial and toxic contaminants, mostly from land-based sources. Despite continued development of coastal watersheds, some areas have improved their water quality over the past

couple of decades (New Hampshire Coastal Program 2006, Rhode Island Metro Bay SAMP, Massachusetts Office of Coastal Management 2006). Most of this can be attributed to the decline of the manufacturing industry and improved point source pollution control. In the U.S. Environmental Protection Agency's (EPA) national assessment of NEPs, the Northeast had, on average, fair water quality (US EPA 2007).

Excess nutrients, specifically nitrogen, stem from a combination of sources including wastewater treatment plants in urban areas, stormwater runoff, septic systems, and atmospheric deposition of nitrogen. The management strategy for most of the region has been to reduce nitrogen levels in wastewater treatment plant effluent, employ alternative septic systems, reduce stormwater runoff, and implement low impact development practices (CICEET 2004, University of Rhode Island Cooperative Extension). Increased nitrogen loadings have resulted in eutrophication in many nearshore embayments. Eutrophic symptoms increasingly being seen in the region include low dissolved-oxygen levels, hypoxia, fish kills, eelgrass loss, macroalgae blooms, and benthic community changes (US EPA 2007). On an ecological level, changes in water quality and temperature have had significant impacts on Long Island Sound and Narragansett Bay, in which scientists are noticing phase shifts in the dominant fish community from bottom-dwelling to water-column species (NBNEP 2007, Connecticut Department of Environmental Protection 2006).

Bacterial contamination continues to be a major issue for nearshore embayments, causing closures to shellfish beds and public swimming beaches (US EPA 2007). For instance, 22 of Buzzard Bay's 32 major embayments are listed as impaired because of fecal coliform bacteria (Buzzards Bay Program Committee 1992). Water quality in the central part of the bay is in good condition. Stormwater runoff from nonpoint sources is the principal cause for this in Buzzards Bay and most other sites.

Management of these cumulative and secondary impacts is a common challenge across the region and nationally. Despite new regulations on stormwater management, continued development is increasing the volume of runoff in coastal watersheds. Some states like New Hampshire do not have the authority for site runoff permits and there is little capacity to help local communities develop their stormwater management plans (New Hampshire Coastal Program 2006). Resources to help with enforcement are also limited. Implementation is dependent on the skills, knowledge, and resources of each individual municipality. In response, New Hampshire is developing a wetland assessment and monitoring program to understand the impact of stormwater on wetland function and creating wetland water-quality standards (New Hampshire Coastal Program 2006).

Regionally, the Gulf of Maine Council's Gulfwatch program monitors water quality and contaminants from over 60 sites (GOMC 2007). The Gulf of Maine Council would like to use these data to educate the public about the effects of lifestyle choices on the Gulf. The data will also provide managers with excellent environmental reporting and ecosystem indicators.

With an increasing call for EBM, research and monitoring of water circulation in nearshore areas is a primary focus across the region. Volunteer monitoring programs, which originated in the Northeast, are prime candidates to assist in this costly endeavor. Needs cited include improved

nitrogen-loading and eutrophication models (NEARCOOS 2006, Valentine and others 2006, Costa-Pierce and others 2005) and assessments of redevelopment impacts on water quality in build-out scenarios (Valentine and others 2006). Research is also needed in assessing the impacts of nitrogen reduction on ecosystems now that governments are focusing their funding on combined sewer overflow issues and wastewater treatment plants (Costa-Pierce et al 2005).

Habitat Protection

Coastal habitat health and coverage are continuing to decline in the Northeast region despite stronger regulations and enforcement. Causes of habitat loss are attributed to eutrophication, hypoxia, altered hydrology, development, wetland filling, invasive species introductions and invasions, sudden marsh dieback, and sea level rise. In Massachusetts Bay, runoff and other impacts cause approximately 1,000 acres of coastal and inland wetlands to be lost each year (Massachusetts Bays Program 2003). In Long Island Sound, the loss of tidal marshes to sea level rise is far greater than previously estimated (LISS 2003b).

The key management challenge is that most of the impacts to nearshore habitats are from cumulative and secondary sources of pollution. Therefore, most of the state coastal programs rate cumulative and secondary impacts as their highest management priority. Strategies are a mixture of addressing the sources and protecting the habitat area. For instance, Rhode Island is revising its buffer policy to better suit the context of urban areas, since they were not designed to accommodate the large-scale redevelopment activities (Rhode Island Coastal Resources Management Program 2006).

Most of the coastal programs are citing the need for more baseline data on the health and spatial distribution of habitat resources. The Gulf of Maine developed ecosystem health indicators in 2003 in an effort to collect data using a Web-based reporting system. Major categories of indicators include coastal development, pathogens and contaminants, eutrophication, aquatic habitat, fisheries and aquaculture, and climate change (GOMC 2007).

Scientists are developing cost-effective methods for delineating wetland coverage and condition using remote-sensing satellite imagery with in-situ radiometry and field data (Rozsa 2007). The Long Island Sound Study has funded a long-term program to monitor the elevation dynamics of the wetlands using surface elevation tables (LISS 2003b). These tools will help measure the changes in wetland surface elevation and sedimentation. These data could also be used by states to develop targeted restoration plans (Rhode Island CRMC 2006). Data are also needed on the presence and impact of aquatic nuisance species (Rhode Island CRMC 2006).

Most of the coastal programs have identified their key data and mapping needs in relation to coastal habitat. As recommended by Maine after the state attempted pilot EBM programs for nearshore waters, the needs could be integrated by a long-term science plan for nearshore waters organized using geographic information system (GIS) tools (Maine State Planning Office 2007). The priority needs most shared across the region (GOMC 2005, NERACOOS 2006, Valentine and others 2006) include

- Spatial data on benthic habitat, ecological units, and human uses such as fishing, runoff, and habitat alterations;

- Understanding natural variability and its causes in estuarine ecosystems;
- Trajectory models of harmful algae blooms;
- Mesoscale hydrodynamic models for Northeast estuaries and embayments;
- Nitrogen attenuation/loss coefficients by source for wetlands and groundwater transport;
- Assessment of overall eutrophic condition and human influences; and
- Assessing long-term shoreline change in the region to develop mitigation strategies

Restoration of Nearshore Habitat

As part of the larger strategy to protect and restore coastal ecosystem services, the region has invested significant resources in the restoration of nearshore habitats. Most of the focus and success has been on salt marsh restoration (New Hampshire Coastal Program 2006, Rhode Island CRMC 2006). Salt marsh restoration programs have been effective in combining knowledge, skills, and partnerships, resulting in increased coverage area. Eelgrass habitat restoration is a new target area, though less knowledge and skills exist (Rhode Island CRMC 2006, Massachusetts Office of Coastal Management 2006). Additional research and small-scale restoration pilots are needed to determine which techniques are most effective (Massachusetts Office of Coastal Management 2006).

New Hampshire is shifting its successful restoration program inland to rivers and freshwater wetlands draining into the estuaries (New Hampshire Coastal Program 2006). This would include dam removal to increase anadromous fish passages and allow tidal influences to extend further upstream. There is a need in that state to expand restoration technical assistance to all coastal watersheds by working with watershed groups on implementing river restoration projects (New Hampshire Sea Grant 2007). In the coastal zone, the New Hampshire Coastal Invasives Program was created to control invasive species at sites of high ecological value by evaluating their impact on restoration sites (New Hampshire Coastal Program 2006).

Despite the great successes in the recent past with salt marsh restoration programs, challenges still remain. Massachusetts is witnessing a continuing trajectory of decline in the quality or condition of the wetlands. While the aerial coverage remains relatively stable, their cumulative functions are in decline because of the impact of tidal restrictions, nitrogen eutrophication, and invasive species (Massachusetts Office of Coastal Management, 2006). Improved assessment methodologies and resources are needed to identify the areas of functional loss and their impacts on the ecosystem. The other challenge is that the regulatory and permitting system does not encourage proactive wetland restoration or reflect an understanding of how wetlands function (Massachusetts Bays Program 2003). A formal restoration policy was issued but never implemented.

Rhode Island is facing an urgent need to develop low-cost methods to dispose of dredged materials (Costa Pierce and others 2005). Research is needed to determine the feasibility of using dredged materials in ecosystem restoration projects.

After several hundred years of increasing human impacts in the Gulf of Maine, salt marshes, eelgrass beds, and rivers for anadromous fish have been designated by the Gulf of Maine Council

as priorities for habitat restoration. The Gulf of Maine Council has a restoration-grant partnership program with the NOAA Restoration Center to support a strategic approach to marine, coastal, and riverine habitat restoration in Maine, Massachusetts, and New Hampshire. The NOAA-Gulf of Maine Council Habitat Restoration Grants Program distributes over $400,000 per year for restoration projects in the Gulf of Maine that will result in on-the-ground restoration of habitat to benefit living marine resources.

Ocean Resources and Living Resources

From an EBM perspective, there are significant changes to the health and allocation of coastal and ocean resources. Most states are experiencing reductions in shellfish populations because of a combination of overharvesting, bacteria contamination, and hypoxia (Massachusetts Bays Program 2003, New Hampshire Estuaries Project 2007, and Narragansett Bay Estuary Program 2007). In Connecticut, diseases have caused widespread economic losses with the transmittal of marine pathogens from cultured shellfish to native stocks (Connecticut Sea Grant 2006). There have also been large lobster die-offs (Connecticut Department of Environmental Protection 2006).

Warming waters and hypoxia have also had an effect on the types of finfish dominating nearshore waters. Long Island Sound and Narragansett Bay have both recognized a phase shift to warmer-water and water-column finfish species (LISS 2003b, Rhode Island DEM 2003).

For fisheries data and observations, coastal managers stated two central needs in the Northeast Regional Association of Coastal Ocean Observing Systems (NERACOOS) assessment (2006):

1. On-line tools that integrate known migratory patterns, aerial surveys, and the real-time presence of phytoplankton to identify prime frontal boundary conditions; and
2. Data to predict migratory paths and timing in support of fisheries surveys for stock assessments and management plans.

Energy siting and ocean uses have become major issues across the region (NROC 2007a, New Hampshire Coastal Program 2006, Massachusetts Ocean Management Task Force 2004) Several offshore wind farm proposals have been submitted (Massachusetts Office of Coastal Management 2006, Rhode Island CRMC 2006), as well as permits for underwater cables (Connecticut Department of Environmental Protection 2006). The regional and state programs have used this issue to reinforce the value and need for EBM programs (SNENYOCWG 2007). And the industry is supportive of these regional efforts to bring regulators and stakeholders together (Jones 2006). Several needs have been identified for this issue. Social research is needed to understand the public's attitudes and preferences for siting of energy infrastructure offshore (New Hampshire Coastal Program 2006). There also needs to be some calculation of the trends in ocean resource uses and demands across all sectors via time and space (Massachusetts Office of Coastal Management 2006). Once this information is available in GIS, there needs to be training opportunities for local decision-makers to evaluate these permit applications in an informed and comprehensible manner (New Hampshire Coastal Program 2006). Coupled with these data and capacity issues are the need for new policies that provide enforcement capabilities

and common assessment methodologies (New Hampshire Coastal Program 2006, Massachusetts Oceans Task Force 2005).

Education

Education and outreach activities are commonly recognized as valuable components of coastal management. They are even more important when an EBM approach is taken. The Massachusetts EBM initiative calls for a formal commitment to develop a new ocean literacy and stewardship ethic among the public so that citizens can be fully engaged in problem solving (Massachusetts Oceans Task Force 2005, Massachusetts Ocean Partnership Fund 2007). Members of the public lack knowledge of EBM issues, such as the impacts of stormwater runoff to the ecosystem (Massachusetts Ocean Partnership Fund 2007, Buzzards Bay Project Committee 1992), and they fail to recognize their role in addressing these issues.

The national Sea Grant program has made EBM a high-priority educational goal. Rhode Island Sea Grant's strategic plan outlines a strategy for advancing EBM training (Costa Pierce and others 2005). Connecticut has set a goal of improving marine science literacy (Connecticut Sea Grant 2006). Other states have similar programs in their plans (Maine Sea Grant 2006, New Hampshire Sea Grant 2007, Massachusetts Sea Grant 2006).

The Gulf of Maine has several stated goals to educate the public and local decision-makers—including lawmakers and commercial and recreational users—of the invasive species threat (GOMC 2007). The Gulf of Maine wants to build the capacity of coastal managers for measuring cumulative impacts from runoff by developing decision-support tools on cumulative impacts. Gulf of Maine also needs to promote better communication of methods and case studies for applying natural capital valuation and socioeconomic concepts into EBM decision making.

The NERR sites have detailed needs assessments for local decision makers and conservation committee members. The issues, needs, and delivery preferences seem to be consistent for the most part across the region. Key issues identified by local decision-makers include erosion, development, water quality, invasive species, and tourism (Dale 2006, McCann 2003). Local decision makers are asking for assistance in understanding laws and regulations, in compliance and enforcement strategies, and in defining coastal resources. Respondents thought that a basic ecology course would be helpful to understand EBM issues. They also wanted to know the state's position on issues as a reference to their own jurisdictions. Their preferred method of learning was to be given practical guidance and examples from other towns. Fact sheets, websites, and workshops were also preferred. New Hampshire has documented its need for improved GIS capacity at the local level to make use of the improved databases and tools now available for decision-making (New Hampshire Coastal Program 2006). The New Hampshire coastal program has adjusted its technical assistance strategy from an ad hoc response to a targeted proactive initiative based on where they can have the greatest impact on resource health (New Hampshire Coastal Program 2006). Maine's Coastal Training Program is testing a collaborative knowledge network as a mechanism for addressing watershed issues. Expertise is first sorted by eight categories and then group knowledge is gathered using collaborative learning theory and applied to priority issues (Wells Estuarine Research Reserve 2007).

Tools

The Northeast Regional Ocean Council (NROC), the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), the Gulf of Maine, and the Massachusetts Ocean Partnership Fund are among many programs that have documented the need for improved EBM tools to assist managers and local decision-makers through state-of-the-art environmental reporting and indicators. NROC (2007a) has called for the expansion of the successful Gulf of Maine Data Partnership Program to all of New England. The Massachusetts Oceans Report (2005) identified a need to develop and implement a common methodology and standards of analysis for proposed ocean projects that consider the visual, cultural, and aesthetic impacts. This was in clear reference to the wind energy projects proposed for sites off Cape Cod but would be valuable to other states such as Rhode Island that will soon be confronted with the same challenges.

Gulf of Maine convened an EBM meeting for practitioners to identify their needs. The response was to make existing EBM tools more accessible through promoting other initiatives such as the EBM Tools Network and the Nature Conservancy EBM Toolkit (GOMC 2005). Areas where new tools would be needed included Web-based visualization and decision-support tools, assessment of watershed point and nonpoint sources, mass-loadings, and data integration techniques. Other reports state a need for land use analytical tools that complement the ocean observing system measurements (GOMC 2005). These tools would need to include non-monetary values of open landscapes and functioning ecosystems in the economic valuation techniques. The Gulf of Maine Advisory Panel proposes incorporating these techniques into state regulations and policies (GOMC 2007).

Several tools are currently in use around the region that focus on addressing EBM issues. In Southeastern Massachusetts, the government worked with the University of Massachusetts to develop a quantitative tool that links nutrients between the watershed and embayments (Howes and others 2006). In Long Island Sound, monitoring of the elevation dynamics of tidal marshes due to sea level rise and sedimentation is being conducted using surface elevation tables (LISS 2003b).

Researchers applied an ecosystem-based services decision-support tool to the Plum Island Long Term Ecological Site in Massachusetts (Farber and others 2006). This method analyses the trade-offs to ecosystem services among different management strategies and options. While this tool is still in development, it does provide some ideas and quantitative methods for calculating the costs and benefits of management decisions on an ecosystem level.

Connecticut Sea Grant developed a nationally recognized program called Nonpoint Education for Municipal Officials (NEMO), which promotes education over regulation as the most effective and cost-effective means for influencing local land use decisions (Connecticut Sea Grant 2006). Most states have adopted the NEMO program as well. There are also new partnership programs such as New Hampshire's Natural Resources Outreach Coalition, which is a multiorganizational initiative offering coordinated assistance to communities (New Hampshire

Coastal Program 2006). Most coastal programs realize that they must work with a larger array of partners, beyond the natural resources community, to effect change in local planning.

Finally, a few websites are excellent resources for EBM tools and case studies. Two particular examples that were referenced by New England practitioners were the Ecosystem-based Management Tools Network (*www.ebmtools.org*) and the Nature Conservancy's EBM Toolbox (*www.marineebm.org*). A case study of the Florida Panhandle shows how the Nature Conservancy, NOAA, and other partners have developed a tool to overlay biodiversity factors with hazard vulnerability assessments to identify key locations for protection. COMPASS provides reports and overviews of selected tools applicable to EBM (*www.compasson-line.org*).

Coastal Hazards Resilience

This section of the literature review summarizes the issues, capacities, and needs related to natural hazards resilience for the Northeast coastal region. There are many definitions and models for hazards resilience. This literature review uses the following definitions of hazards resilience:

From Grand Challenges for Disaster Reduction – Subcommittee on Disaster Reduction:
"Disaster Resilience is the capacity of a community exposed to hazards to adapt, by resisting or changing, to reach and maintain an acceptable level of functioning and structure. Resilience is determined by the degree to which the community is capable of organizing itself to increase its capacity for learning from past disasters." (National Science and Technology Council 2005)

From United Nations International Strategy for Disaster Reduction:
"The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures." (UN/ISDR 2006)

NOAA identifies the key capacities for coastal resilience as improved community capacity to prepare, mitigate, respond, and recover from coastal hazards (Nicholson 2006). Some common characteristics of a resilient coastal community have been identified and can be used for sorting through information (Nicholson 2006). These include:

- Communities with diverse economic bases; that is, they are not dependent on just one activity;
- Strong community self-management systems, including management zoning to regulate future development and resource development;
- Community members involved in significant community decisions;
- Organizations in the community with developed partnerships and collaborative working relationships;
- Effective management structures for sustainable resource use (e.g., local community, government agencies);

- Strong belief in, support for, and capacity for education at all levels;
- Infrastructure that provides for alternatives: e.g., multiple access roads, various water supply systems, and health systems located in safe areas;
- Areas of natural vegetation deliberately maintained under effective management plans;
- Areas of high risk identified and incorporated into land use plans; and
- Buffer zones re-established in areas of high risk where natural vegetation has been cleared.

These characteristics guide this literature review in identifying the issues and needs related to core resilience capacities, including vulnerability assessment, planning and regulation, mitigation, response and redevelopment, education, and technical tools. The review provides an overview of the federal laws and programs that apply across the Northeast region, as well as regional initiatives that address coastal hazards.

A summary of the regional needs for coastal hazards resilience in the Northeast was developed by NROC for the 2007 Ocean Congress. The findings build on several initiatives in the Northeast, including the state coastal programs' 309 reports, Gulf of Maine Council's surveys and assessments, Northeast Regional Association of Coastal Ocean Observing Systems (NERACOOS) user needs, and NROC's work. Table 3 mirrors the needs found in this literature review.

Table 3. Northeast Regional Needs for Better Coastal Hazards Response and Resilience: Handout at the 2007 Ocean Congress

Coastal Hazards	General Needs	Desired Outcomes = Better Response and Resilience
General	Provide outreach to the public on coastal hazards.	Increased support for coastal hazards mitigation.
General	Create incentives for homeowners to adopt mitigation measures.	Decreased vulnerability in high-hazard areas.
General	Develop and implement local hazard mitigation plans.	Communities eligible for grants and emergency assistance from FEMA.
Erosion	Calculate shoreline change rates.	Improved performance standards and regulations including setbacks.
Erosion	Track sediment loss from the beach system.	Improved management of erosion control structures such as seawalls and groins.
Erosion	Identify sources of sediment for beach nourishment.	Decreased timeframe for permitting and execution of beach nourishment projects.
Flooding	Update and modernize Flood Insurance Rate Maps (FIRMs).	Decreased development and losses in high flood-hazard areas. Improved performance standards and regulations including elevation requirements.
Storm Surge	Model potential inundation areas associated with tropical and extratropical storm surge using lidar and storm-event data.	Improved emergency management, evacuation routes, hazard mitigation plans, performance standards, and regulations.

Sea-Level Rise	Model potential shoreline positions and flood-prone areas given different sea-level rise scenarios.	Improved policies, hazard mitigation plans, performance standards, and regulations.

(Source: Northeast Regional Ocean Council 2007)

Overview of Federal and Regional Programs

All the state and local hazard programs are built and linked to several key federal programs that offer an assortment of technical assistance, grants, and insurance. They provide minimum standards upon which states can improve. The primary programs are listed below.

National Flood Insurance Program (NFIP) is a federal program under the Federal Emergency Management Agency (part of Department of Homeland Security) that offers property owners the opportunity to purchase flood insurance at below market rates in exchange for the state and municipality passing floodplain management regulations that reduce future flood damages (*www.fema.gov/business/nfip/*).

This review analyzes the following core elements of the NFIP (2002):

- Floodplain mapping – NFIP has produced maps for the entire country that identify the floodplain based on a 100-year storm event (or 1% annual chance for a storm of that magnitude). FEMA is now in the process of modernizing the maps into digital formats, although this does not change the maps until further floodplain studies are funded.
- Flood management – NFIP requires that the states and municipalities develop mitigation plans and adopt strict minimum standards for buildings.
- Flood insurance – Private insurance companies provide flood insurance on behalf of the federal NFIP. There are limits to the amount of insurance that is available for the structure and contents based on the type of structure.
- Community Rating System –CRS is a voluntary program that enables municipalities to reduce insurance rates for their property owners by reducing their risks through education, policies, and mitigation actions.
- Flood Mitigation Assistance Program – NFIP provides grants to the states and communities for implementing their mitigation plans at a cost share of 75% federal funding and a 25% state match.

Hazard Mitigation Grant Program (FEMA)
In 1988, FEMA established the Hazard Mitigation Grant Program (HMGP) to provide funding to states and communities following a disaster to conduct long-term mitigation activities for all hazard types, not just flooding. Funding is given based on 15% of the total federal funds distributed for the disaster. States can get up to 20% based on the Disaster Mitigation Act of 2000, if they follow stricter criteria.

Disaster Mitigation Act of 2000 – Pre-Disaster Mitigation Grant Program
In 2000, FEMA established a complementary program to the NFIP. The Pre-Disaster Mitigation Grant Program provides funding for states and communities to develop FEMA-approved

multihazard mitigation plans. The program also allocates pre-disaster mitigation grants to communities to implement their mitigation strategies. States that have an approved hazard mitigation plan can receive an increased amount of HMGP funding up to 20%.

NOAA Coastal Zone Management (CZM) Program
As part of the NOAA CZM 309 assessments, coastal hazards are one of the enhancement areas. Main objectives of this are to direct future development away from hazardous areas, preserve and restore protective functions of natural shoreline features, and prevent or minimize threats to existing populations and property.

U.S. Army Corps of Engineers
The U.S. Army Corps of Engineers (USACE) Civil Works Program is responsible for flood protection, navigation, or other water-related infrastructure at the behest of Congress. Common projects include hurricane barriers, beach nourishment projects, channel dredging and certain dam activities. Another important role that USACE plays is in developing storm surge maps for coastal areas – Sea, Lake, and Overland Surges from Hurricanes (SLOSH).

Coastal Barrier Resources System of the Fish and Wildlife Service
The Coastal Barrier Resources System (CBRS) is a federal program to protect areas such as undeveloped coastal barrier islands by prohibiting federal assistance, such as NFIP, to support development. There are 93 sites in the Northeast region that are protected under this program (Maine 22, Massachusetts 44, Rhode Island 15, and Connecticut 12) (*www.fws.gov/habitatconservation/coastal_barrier.htm*). In the Northeast, this program has varying levels of importance due to state policies. Where demand for development is weak, development is not likely to occur, but where demand is strong, developers will work to overcome the obstacles posed by the Coastal Barrier Resources Act (CBRA) (Salvesen, 2005). In Rhode Island, CBRA has very little impact primarily because the state's coastal regulations are so strict. In Connecticut and Massachusetts, CBRA has had little impact because the state's barriers are too narrow for development (less than 100 ft in some places). Maine, Massachusetts, Connecticut, and Rhode Island all restrict the use of state funds for infrastructure on undeveloped coastal barriers.

Northeast Regional Ocean Council (NROC)
NROC has established coastal hazards resilience as a major priority. Its strategy as a regional advisory organization is to provide state-of-the-art data and tools to advance planning and response to coastal hazards due to projected sea level rise (NROC 2007a). NROC is still developing its detailed work plans. Potential initial actions include partnering on a regional basis to implement inventories of coastal structures, and developing regional sediment management plans (NROC 2007a). NROC at its 2007 conference identified some of the existing key partnerships and activities in the region related to coastal hazards resilience (NROC 2007c):

- Emergency Watershed Protection Program
- Regional Response Teams
    - Plymouth to Salisbury Massachusetts Area Contingency Plan
    - Buzzards Bay Geographic Response Plan
    - Rhode Island/SE Massachusetts Contingency Plan
- National Assessment of Coastal Change

- Regional Association (Northeast Regional Association of Coastal Ocean Observing Systems, Massachusetts Coastal Ocean Observing Regional Association) focus on coastal inundation
- NOAA Coastal Services Center salons and needs assessment in Northeast.

Regional Hazard Risks

Hazards identified across the Northeast region are flood-related (such as riverine, coastal storm surge, erosion, and sea level rise) and wind-related (such as hurricanes and extratropical storms (nor'easters). All these hazards were ranked as either high or medium in each of the state's NOAA CZM 309 reports and multihazard mitigation plans (Pogue 2005, Inland Water Resources Division of Bureau of Water Management 2004, Southeast Region Planning Commission. 2002, Massachusetts Emergency Management Agency 2004, Maine Emergency Management Agency 2004).

Flood-related hazards are the greatest risk to the region because of their frequency and scale (Pogue 2005, Inland Water Resources Division of Bureau of Water Management 2004, Massachusetts Emergency Management Agency 2004, Southeast Region Planning Commission. 2002, Maine Emergency Management Agency 2004). Riverine flooding, due to precipitation levels and runoff volume, has increased mostly in urban areas as watersheds develop and runoff increases (Pogue 2005). The Northeast has many flood-control dikes and levees that were built over the past several decades. Their level of performance is expected to decrease because of age, lack of maintenance, increased runoff volumes, and sea level rise (NROC 2007a) (Pogue and others 1999).

Coastal flooding commonly results from storm surge, nor'easters, erosion, and other wind-driven waves (Pogue 2005). Storm surge is an increase in water levels above the normal tidal ranges due to increased wind and pressure forces caused by hurricanes and extratropical storms (Massachusetts Coastal Hazard Commission 2007). The greatest damage from storm surge is often from nor'easters because of their extended durations in the region (12 hours to 3 days) (Pogue 2005).

Erosion of coastal landscapes is caused by chronic and episodic events. Chronic erosion in the Northeast is often caused by daily or seasonal high wave energy that draws sediment permanently offshore. Episodic events are linked to a specific storm event or time period and impact barrier islands, inlets, and headlands. Although erosion is occurring in the Northeast, there is no sand storage available to replenish the beach profile (Farber and others 2006, Pogue 2005). This is often caused by roads, housing, and hardened shoreline structures. While erosion rates are often reported as an annualized rate of change, these changes are caused by both episodic and chronic events, in particular periodic storms such as nor'easters and hurricanes.

Wind-related hazards are often a result of tropical storms (such as hurricanes) and extratropical storms (such as nor'easters). Hurricanes are relatively infrequent events for the southern region (Connecticut, Rhode Island, Massachusetts) of the Northeast and even rarer for the northern states of New Hampshire and Maine. However, their impacts from high winds can be significant

for a large area and have the greatest influence on insurance premium rates. The region's largest hurricanes were in 1938 and 1954; however, very few of the current coastal residents can recall the events. Most recently, Hurricane Bob in 1991 caused the greatest damage in Cape Cod, southeast Massachusetts, and extreme southern Rhode Island to shoreline features, development, and marina facilities. Climate change and sea level rise is expected to increase the frequency and severity of wind-related hazard events in the coming decades (SNENYOCWG 2007). It has been estimated that if a hurricane equivalent to the 1938 hurricane were to strike the Northeast region in 2007, it would rank as the sixth costliest hurricane in U.S. history (NROC 2007a). The Northeast region has been spared from a devastating hurricane since the 1950s, but long-term records indicate a 60-year return period (Ginnis, 2006). Since then, some of the major events that led to disaster declarations for southern New England include the blizzard of 1978, Hurricane Gloria in 1985, and Hurricane Bob in 1991 (SNENYOP 2007).

Sea level rise is altering New England's coastal shorelines through inundation and shoreline erosion (NROC 2007a). Rise in relative sea level will increase the extent of flood damage over time, with lower elevation areas more susceptible to flooding. Any given storm event will surge higher on land because the relative sea level is higher than in the past. Erosion will continue and may increase because of the increased coastal flooding and frequency of storms resulting from climate change. Other risks associated with sea level rise include salt intrusion into aquifers and higher water tables (Rhode Island CRMC 2006). In speaking about the impact on the National Flood Insurance Program, "the increase in the expected annual flood damage by the year 2100 for a representative NFIP-insured property subject is estimated to increase by 36-58% for a 1 foot rise" (FEMA 2002). Smith and Lazo (2001) conclude that for the eastern coast "with 0.5 m sea level rise, about one-half of the land loss is due to erosion and one-half is due to inundation. At 1.0 m sea level rise, the portion of land lost from inundation is greater than the portion from erosion." The role of erosion is therefore significant and likely to be of greater relative importance for smaller and slower increases in sea level.

The potential impacts from the hazards listed above are anticipated to be significant across the coastal region because of the density of people and development. Development has rapidly expanded in southern Maine over the past five years and is expected to continue (Maine Emergency Management Agency 2004). In the densely built southwestern Connecticut area, new development is occurring in risky coastal areas. It is estimated that if the area was to experience a 100-year storm event there would be about $533 million in damages, mostly from property damages (SNENYOP 2007). NROC (2007a) considers the coastal infrastructure in the region such as highways, rail, and ports as being at significant risk from coastal storms and inundation. Damage to these systems would likely have major repercussions to the region's economy for the long term.

In light of the extensive development and the expansion into more vulnerable coastal areas, insurance coverage is a major issue for hazards resilience in the region. Across the region, there are a significant percentage of properties in the floodplain that are not insured against flood damages. In Norwalk, Connecticut, only 1,251 of its 3,000 buildings in the flood zone are insured (SNENYOP 2007). David Maurstad of the Federal Emergency Management Agency recently stated (Maurstad 2007) that "there is no question, areas in the Northeast are at real risk. . . . Even in the highest-risk areas—the Special Flood Hazard Areas (SFHAs)—where coverage

should be 100 percent, less than 30 percent of properties are covered by flood insurance." This statement is supported by a recent RAND Corporation study, which found that only 28% of single family homes in Special Flood Hazard Areas (A, V-zone) in the Northeast have policies (Dixon, Clancy, and Seabury 2006). And it may be harder and more expensive in the future to insure these homes, once new computer models show the increased risks. As "the relative exposure becomes more apparent through the models, companies may decide to non-renew coverage (Bowler 2006)." In addition to the vulnerability resulting from insurance gaps, the old building stock is of concern as well. In Rhode Island, there are over 3,000 structures that are grandfathered and don't meet current building standards (Pogue 2005).

Vulnerability Assessment

A core capacity required in hazard-resilient communities is to estimate which elements of the environment, economy, and community are vulnerable to natural hazards. In reviewing the state coastal programs and the hazard mitigation plans, there appears to be no standard methodology for conducting vulnerability assessments or agreement on which types of data to collect (Pogue and Lewis 1999). Specific areas where there are inconsistencies include erosion rates, subjective ranking of hazards, economic loss estimates, and social aspects of the community. At the local level, most communities can't afford to hire specialists needed to conduct detailed vulnerability assessments and instead follow a basic formula approach to meet federal and state mandates (Massachusetts Emergency Management Agency 2004, Southeast Region Planning Commission 2002, Maine Emergency Management Agency 2004). There is also a lack of detailed data across the region to produce accurate models at the local level to anticipate likely impacts from storm surges (Pogue 2005, Nicholson 2006).

Thieler and Hammar-Klose (1999) conducted a national assessment to develop a coastal vulnerability index for sea level rise. They used six physical variables to rank the vulnerabilities. These variables included geomorphology, shoreline erosion and accretion rates (m/yr), coastal slope (percent), rate of relative sea-level rise (mm/yr), mean tidal range (m), and mean wave height (m). Areas along the coast are assigned a ranking from low to high risk, based on the analysis of physical variables that contribute to coastal change. The index does not include socioeconomic variables that would change the final rankings for impacts to society. As Figure 2 shows below, the less populated southern portions of the East coast is ranked higher.

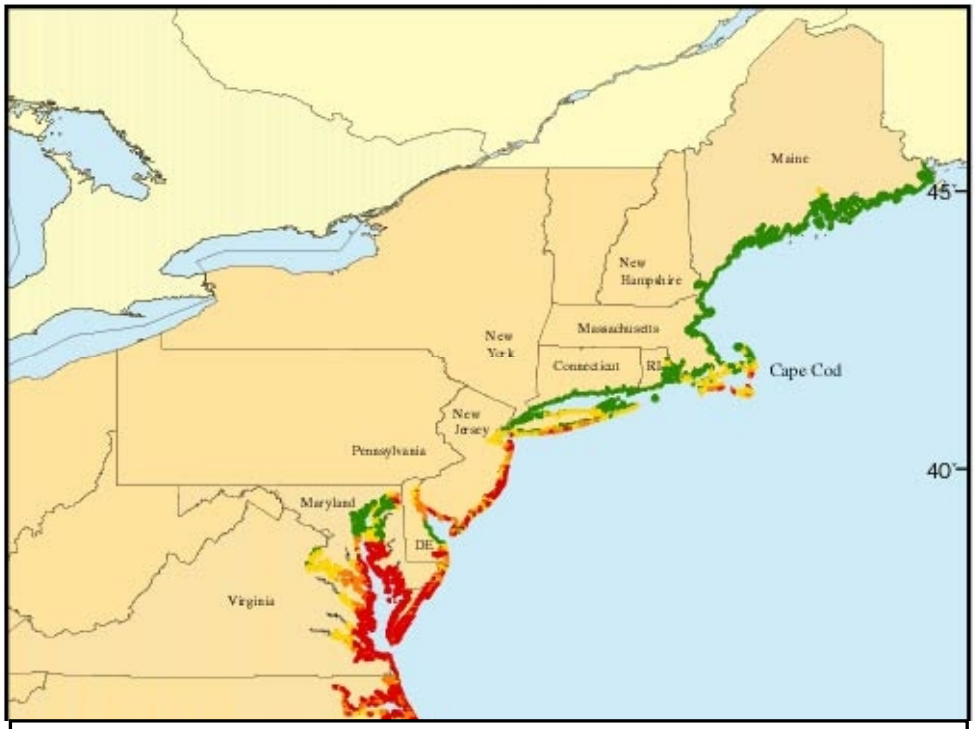

Figure 2. Map of the Coastal Vulnerability Index (CVI) for the U.S. Atlantic coast. The CVI shows the relative vulnerability of the coast to changes due to future rise in sea-level. Areas along the coast are assigned a ranking from low to high risk, based on the analysis of physical variables that contribute to coastal change. (Thieler and Hammar-Klose 1999.)

Currently, the state CZM programs conduct rapid vulnerability assessments for the NOAA 309 hazard enhancements. The state emergency management agencies conduct a more thorough but still broad assessment for the multihazard mitigation plans. Towns also conduct assessments for their multihazard mitigation plans. These plans all use the floodplain maps produced by the National Flood Insurance Program and the inundation and evacuation zones produced by the U.S. Army Corps of Engineers (USACE) SLOSH maps. Erosion data are not used by emergency or floodplain programs, except in Rhode Island (Pogue and Lewis 1999). Some special area management plans, such as those in Rhode Island, contain degrees of vulnerability assessment that cut across multiple jurisdictions. The Massachusetts CZM program produced the South Shore Coastal Hazard Characterization Atlas, which focused on the environmental vulnerability—erosion rates, flood map, and sea-level rise estimates. Wells NERR conducted an analysis of the vulnerability to sea level rise (Wells Reserve Staff 2007). There are no detailed regional hazard vulnerability assessments.

In general, for the region, there are some common capacity issues for conducting vulnerability assessments. There are skilled professionals to conduct detailed assessments, though most agencies and municipalities do not have the funds to hire them. (Maine Emergency Management Agency 2004) There is also limited engagement of the public in assessment and outreach, including the most vulnerable coastal population groups. Financial resources to get better data or expertise are limited. Most plans are written to an adequate degree in order to be eligible for federal and state aid. Technically, there is a need for more detailed data to update maps and conduct localized models to anticipate sea level rise impacts and changes to the floodplain due to

development and erosion (Pogue 2005). Most mapping does not include these dynamic elements. In Connecticut, the state needs updated mean-high-water shoreline maps since current data are from 1933 (Connecticut Department of Environmental Protection 2006). With these new data and 1- to 2-foot contour maps, the state could establish public trust boundaries and assess the impacts from sea-level rise (Connecticut Department of Environmental Protection 2006).

Many documents from the Northeast coastal community have identified the common needs for conducting various aspects of hazard vulnerability assessments. Major needs are listed below. To summarize, there are multiple data needs such as detailed terrestrial contours, shallow water bathymetry, and location of mean-high-water lines. Then there are needs for assisting decision-makers and managers to easily locate and analyze the data in user-friendly ways (NROC 2007a).

Infrastructure/Critical Facilities

NROC (2007a) identified several needs for assessing the vulnerability of coastal infrastructure and critical facilities:

- Identify and map all nearshore critical infrastructure important to the economy, such as power plants, ports, energy storage, and hazardous material sites.
- Partner on a regional level (and with federal agencies) to develop inventories of coastal structures (e.g., USACE beach erosion control studies) and culverts (to identify potential "levee" breach areas), and regional sediment management plans (to identify sand sources for beach nourishment).

Sea Level Rise

The needs for assessing sea-level rise include the following:

- Develop a standard methodology to measure and report sea level rise in the Northeast to be applied to flood maps and identify priority mitigation projects (Massachusetts Coastal Hazard Commission 2007, NROC 2007a)
- Map and model sea-level rise using lidar and other methods (Maine Emergency Management Agency 2004) (NROC 2007a)
- Initiate a regional dialogue to identify practical adaptation strategies for the effects of sea level rise, seeking broad-scale options where possible (NROC 2007a).
- Reassess coastlines each decade as sea level rises in order to update accurate flood and inundation maps (Rhode Island CRMC 2006).

Erosion

The needs for assessing erosion include the following:

- In the FEMA Map Modernization project, address the erosion potential for select areas and likely inland migration of the V zones. Currently, the project does not address erosion potential.
- Explore approaches to developing and implementing regional sediment management plans, especially where they cross state jurisdictions (NROC 2007a)
- Create map of nearshore environments in conjunction with the continued support for the beach profile network to provide important data for implementing setback policy and understanding sediment transport (Rhode Island CRMC 2006).
- Research:
    - Energy budget for sediments for better prediction of shoreline change

    - Oceanographic forces and shoreline response
    - Impact of sand mining on biological and physical resources
    - Coastal dynamics and erosion (spatially illustrated) (NROC 2007a, Rhode Island CRMC 2006)

Mapping Flood zones

The needs for mapping flood zones include the following:

- FEMA must assist the states in updating and maintaining the Flood Insurance Rate Maps (FIRMs), whose average age is nearly 20 years old. In Massachusetts, only $6 million out of the estimated $34 million needed for map modernization has been made available (Massachusetts Coastal Hazard Commission 2007). This is a common issue in the region and some attribute it to a perspective of the Northeast as a low risk area (Maine Emergency Management Agency 2004). Each community requires updated risk and vulnerability assessment maps (Massachusetts Coastal Hazard Commission 2007). This can be achieved through the FEMA Map Modernization project and the actions below.
- Flood data and modeling needs (NROC 2007c):
    - Terrestrial and shallow water lidar
    - Improved storm prediction capabilities with high-resolution atmospheric models (i.e., ocean Integrated Ocean Observing System (IOOS), Coastal Radar (CODAR), advanced surge models)
    - Flood hazard models
    - Scenarios for future growth, human setbacks, and displacement due to floods
- Improved map terminology, layout and education are needed to assist users and the public in understanding the differences between flood zones in FEMA FIRMs and storm surge maps (Safford and others 2005)
- Improved coordination with data collection and sharing among coastal managers, municipal planners, and emergency management officials are needed to ensure consistent protocols and standards are used for the data to be integrated with information collected by agencies such as FEMA and NOAA. (Safford and others 2005)
- NOAA could foster improved linkages between state and local emergency and land use planning agencies through its storm-surge-related programs and products (Safford and others 2005).

Storm Surge Modeling

- Results from the NOAA Storm Surge needs assessment (Safford and others 2005) indicate that updating storm surge data to account for changes in coastal conditions is one of the highest priority needs for the Northeast, as well as the nation.
- Storm surge data, models, and maps must have improved usability. In NOAA's storm surge focus group meetings, participants cited an overuse of technical terminology and language, unclear graphical outputs, and confusion regarding where to access data as factors that limit the ability of the public and elected officials to understand the potential impacts from storm surge. For managers themselves, inconsistency in the use of different vertical datums and the inability to precisely predict the locations that would be flooded during storm events constrain local and state agencies' efforts to make informed decisions about issues ranging from land use permitting to evacuation during storm

events. (Safford and others 2005). For example, in Maine there are two sets of storm surge maps, one using mean sea level and the other mean high tide.

- GIS maps, aerial photos, and satellite images are the preferred formats for displaying storm surge information.
- To improve the SLOSH models the following changes are recommended: include wave setup, include rainfall/river outflows, increase vertical precision to +/- 1 foot, model on uniform national grid, expand model to inland bays, expand extratropical forecasts, update data to account for physical and demographic changes over time and run 1-2 foot sea level rise scenarios (Safford and others 2005).
- Additional tide gauges are needed to provide the necessary baseline tide and water level data.
- Storm surge runs from historical storms could be an effective tool for highlighting risk and vulnerability.
- Better models exist that would improve wind and storm-surge forecasts (e.g., high-resolution atmospheric); the integration of atmospheric and ocean models and data will yield the most accurate forecasting. (NROC 2007a)
- Forecasting can be improved by integrating data from various models, providing them in a timely manner, such as 48 hours before landfall.
- A standard vertical datum (NAVD88) should be used to lessen users' confusion about the datum used for storm surge forecasts. VDATUM tool is a valuable short-term resource to convert different types of data.
- Information about the social and economic benefits of forecast and decision-support tools is needed.
- Improve delivery of storm-surge-related information by building on existing partnerships between FEMA, NOAA, USGS, and the USACE (Safford and others 2005)
- Create an Integrated Ocean Observing System (IOOS) that supports storm, storm surge, and inundation forecasting and response. This would need to be a partnership between academia, industry, and public agencies (NROC 2007a). Data collection efforts should take advantage of potential synergies and economies of scale through a federal-state partnership to acquire such data on a regional level.

Planning and Regulation

The Northeast's governance system is decentralized and is based on home rule, where local municipalities maintain high levels of independence in planning and regulation, within an overall state framework that provides for minimum standards (Pogue and Lewis 1999). Local government is composed of many boards and commissions that make most of the decisions for enforcing the laws or allowing variances. Therefore, local bylaws (e.g., floodplain ordinance) and plans (e.g., hazard mitigation plans) are different from town to town. Connecticut's coastal program is also decentralized, creating a challenging permitting system that varies between municipalities, in addition to the building codes and local zoning. Efforts have been made to regionalize planning through special area management plans (Rhode Island) and through regional planning agencies (Cape Cod Commission 2004), which are mechanisms that link coastal planning and hazards.

When states do establish regulations, they often are unable to enforce at the local level. For instance, New Hampshire established statewide permitting laws to protect wetlands and mitigate shoreline erosion from development. However, most of the impacts occur at the individual housing lot level, which is too small to qualify for state oversight. The result is cumulative impacts to the coastal environment based on local ordinances that often don't meet or exceed the state standards (New Hampshire Coastal Program 2006).

Coastal hazards planning is highly decentralized and shared among coastal management agencies, local planners, and emergency management. In regard to floodplain management, coastal management and building inspections are separated and the linkages vary greatly at the state and local level. In a 2006 NOAA survey of coastal management practitioners, only 50% felt that emergency managers occasionally or never work together with land use planners and Sea Grant extension agents (Safford and others 2005). The same survey also showed that emergency managers seldom work with the insurance industry. Some interstate memorandums of understanding exist in the Northeast, such as between Rhode Island and Massachusetts (Pogue and Lewis 1999), however it is unclear whether they address unique coastal hazard issues.

Preferences for the type of infrastructure and flood protection have changed over the past few decades. In the early 1970s, Northeast states and local governments still preferred structural flood and storm surge protection (New England River Basins Commission 1975), while at the same time the federal support for such projects was diminishing. By the mid 1970s, planners recognized that "people's memory spans are also very short, and the trend has been that without regulations to prevent new development, industry, housing and commerce all return to the floodplain less than ten years after a major flood" (New England River Basins Commission 1975). The region also had not experienced a devastating storm event since 1954. Attitudes changed in the Northeast to move toward non-structural approaches, with the argument that "non-structural measures generate multiple benefits in terms of recreation, water supply, and preservation of landscape quality" (New England River Basins Commission 1975). The Long Island Sound Study was one early example of a regional plan that championed non-structural approaches (New England River Basins Commission 1975).

The fallout from Hurricane Katrina in 2005 reinforced existing regulations and spurred renewed focus on hazard plans and regulations. As identified in the vulnerability assessment section, planning and implementation tools are limited, given that floodplain maps are extremely out of date and the prevalence of accurate topography is inconsistent from place to place and expensive.

All municipalities have to produce their multihazard mitigation plans based on FEMA guidelines. A few regional planning groups exist, including those found in Connecticut and Massachusetts. An example would be the Cape Cod Commission, which has the resources and staff to produce regional innovative planning documents and analysis on hazards. Maine and New Hampshire produce mitigation plans at the county level. Rhode Island does not produce plans at the county level.

Because of a combination of increased development in vulnerable coastal areas and accelerated sea level rise scenarios, some states have developed policies and regulations for erosion setbacks. While most states have standard 30-year erosion no-build setbacks, Maine has established a 100-

year setback (Maine State Planning Office 2007). Maine has also designed a sea level rise policy that prohibits infrastructure, such as houses, on property that is tidal for more than half the year (Maine State Planning Office 2007). Rhode Island and Massachusetts have erosion maps and policies beyond 30 years. Rhode Island, Connecticut, and Massachusetts are also in the process of developing their sea level rise policies.

All the states have passed the International Building Code (IBC) with stricter building codes that go beyond the federal minimum requirements as outlined in the National Flood Insurance Program (NFIP). Some towns in Rhode Island and Massachusetts have increased the minimum building heights (freeboard) above the 100-year flood height (base flood elevation) (Cape Cod Commission 2004).

The NFIP offers towns the opportunity to reduce insurance premium rates if they participate in the Community Rating System (CRS). There are several planning and mitigation actions that a community can do to reduce the rates. Most towns either have not participated or have participated minimally in the program (Table 4).

Table 4. Participation in the FEMA NFIP Community Rating System

State	Number of Coastal Municipalities	Number that participate in the CRS	Average Rating of those that participate	Range of CRS scores
Maine	149	21	8.1	5-10
New Hampshire	14	5	8.6	8-9
Massachusetts	77	15	8.5	8-10
Rhode Island	21	4	8.3	8-10
Connecticut	25	12	8.4	7-10

There is adequate capacity across the New England region to develop basic hazard plans, though resources are requested for specialists to assist with more rigorous comprehensive planning approaches to incorporate smart growth concepts (Massachusetts Coastal Hazards Commission 2007) that increase resilience. The greatest capacity gap is in the implementation of the plans' preparedness and mitigation actions. There appears to be a gap in political commitment and funding to implement most actions.

A few priority planning and regulatory needs are shared across most of the region. Because the Northeast is a home-rule government, increased coordination between local jurisdictions could improve coastal protection and stakeholder understanding. New Hampshire's state hazard plan is a guide for local governments; however, each jurisdiction can develop distinct permitting programs and mitigation strategies (Southeast Region Planning Commission 2002). Towns in the Connecticut River estuary area used a uniform approach to prepare their hazard plans. This has resulted in consistency with federal standards and integrated mitigation strategies across jurisdictions but within the same ecosystem.

There is a clear need for updated and detailed flood and inundation maps to assist planning actions. This data improvement must also be accompanied by trained staff members at the state and local government offices to conduct policy analyses, prepare mitigation activities, calculate cost-benefit analyses, and implement building codes without variances (Pogue 2005, Massachusetts Emergency Management Agency 2004). The Massachusetts Hazard Commission called on the use of coastal smart growth rather than paying for storm damages. However, the key limiting factor to that shift is the lack of capacity in the municipalities to implement the comprehensive planning that is required (Massachusetts Coastal Hazard Commission 2007). The commission has also recommended the establishment of a storm-resilient communities program to support the planning and mitigation changes necessary.

Mitigation

Each state and local (county or town) government should have by now a hazard mitigation plan to meet federal requirements for funding and disaster assistance. This push toward pre-disaster mitigation planning and actions was a result from the impacts of Hurricane Andrew in 1992. Mitigation is now a prominent concept in the emergency and coastal management communities, as opposed to waiting for post-disaster funding and assistance (Pogue and Lewis 1999). However, obstacles remain and are common across the region. Perhaps the greatest challenge is the complacency of the public and to some extent government officials, since the region has not experienced a major disaster since the 1950s (SNENYOP 2007). Combined with this complacency is a strong preference to rely on post-storm emergency funding (Robadue 2007). This has resulted in many mitigation plans developed without much implementation to reduce risks. It is also difficult for many of these governments to commit local funding toward mitigation actions.

The mitigation plans are for the most part relatively new, although state coastal programs such as Rhode Island have had extensive policies in place—including construction standards, setbacks, and protection of coastal features such as beaches, dunes, and bluffs—and some coastal communities in other states have been enforcing similar rules for many years. Even though storm frequency is low compared to the Gulf coast and southeastern Atlantic states, the stock of buildings constructed before any regulatory standards is high, the power of past storms has been devastating, and participation in flood insurance programs in the region is surprisingly low.

While it is challenging to find status updates on mitigation actions or evidence of savings from most of the mitigation plans, there are a few case studies that highlight the long-term cost benefits. Before the current emphasis on soft engineering structures, there were many hard shore protection projects, such as hurricane barriers, sea walls, and harbor protection that have over the past couple of decades provided a return on investment. For example, in Connecticut, the Pawcatuck-Stonington Hurricane Protection Project, built in 1963 at a cost of $920,000, is considered a success in protecting a 31-acre industrial site. The Stamford Hurricane Protection Barrier, built in 1969 at a cost of $14.5 million, is reported to have prevented damages of $28 million to date. The New Bedford-Fair Haven-Acushnet hurricane protection project, built in 1966 at a cost of $18.6 million, has to date prevented an estimated $18.8 million in damages. The town of Westport, Connecticut, undertook a program beginning in 1993 to elevate 22 homes and installed evacuation signs in a project costing $1.33 million. Damage avoided in subsequent

storms was estimated to provide a total mitigation benefit by the end of the decade of $ 4.78 million for a Benefit/Cost Ratio of 3.58 (Association of State Floodplain Managers 2000). More resources and management commitment are needed for post-storm data to measure success or failure of mitigation actions. To aid in that assessment, the Massachusetts Hazard Commission (2007) has recommended that there be post-storm flood height recordings based on water marks.

Many insurance companies are not renewing policies in coastal areas so that now about 42% of policies issued under the FAIR program are for coastal structures. More incentives are needed to persuade homeowners to retrofit their buildings, as well as action to raise the level of maximum coverage above the current $300,000 limit. Land acquisition should be increased through both voluntary measures and outright purchase of storm-prone properties (Massachusetts Coastal Hazards Commission 2007). People do not think significant and damaging storms will happen because of so few events in a lifetime (Meyer, 2006). There is also a lack of models to understand how people make their decision to mitigate hazards (Paxton 2001).

Some common and widely used mitigation strategies in the region include floodplain zoning, culvert resizing, tree trimming, storm drain cleaning, Low Impact Development (LID) techniques, elevation, erosion control, beach nourishment, acquiring flood-prone and repetitive loss properties, and improving Community Rating System (CRS) score (Rhode Island, Maine, Massachusetts Multi Hazard Mitigation Plans, 2005-2007). The CRS needs to be promoted in the region because of a lack of participation in most areas (Cape Cod Commission 2004). Some towns in southeastern Connecticut have adopted stricter regulations by creating coastal high hazard zones or Coastal A-zones (Greenwich and Darien).

Erosion, sand management, and beach nourishment will continue to be challenging issues for the region as sea levels rise. The states lack a centralized program to assist homeowners with their erosion mitigation issues (Maine), and there is a demand for an environmentally sound coastal engineering program to address these issues. Sediment budgets are lacking for doing regional in-state and cross-state sand management (Massachusetts Coastal Hazards Commission 2007). States are requesting the USACE assist municipalities on this issue. Also, some cite that beach nourishment is happening only in recreational areas and not in the most vulnerable areas because of the lack of public support for cost sharing. One of the states' tasks will be to develop a method to properly evaluate the benefits and impacts of new erosion control measures, since some measures might have negative impacts to natural resources (Massachusetts Coastal Hazards Commission 2007).

Much of the region's coastal areas have already been developed. While acquisition of property in vulnerable areas or those with repetitive losses would be wise, the costs are prohibitive for most of the region. The purchase of most sites is only possible after they have been severely damaged in a storm event. Connecticut has been targeting a few repetitive loss properties while also focusing on bringing buildings up to date with standards. The region needs to greatly improve the information available on at-risk properties and repetitive loss structures (Massachusetts Coastal Hazards Commission 2007).

There is a need for developing better criteria for evaluating and selecting mitigation projects. Some communities have applied the FEMA HAZUS-MH tools to test mitigation strategies on

potential hurricane scenarios (Cape Cod Commission 2004). Guidelines or criteria would also be helpful for determining which structures should be removed or land acquired (Connecticut Department of Environmental Management 2006). Through improved guidelines and criteria, there may be improved standardization of mitigation actions that can assist other towns in their implementation actions (Connecticut Inland Water Resources Division of Bureau of Water Management 2004).

State emergency management agencies are requesting assistance in attracting and retaining qualified and experienced hazard mitigation staff members (Rhode Island CRMC 2006). Municipalities are also in need of skilled planners to develop effective mitigation strategies. This is evidenced by the lack of hazards issues included in most local planning documents, such as comprehensive, open space, capital improvement, and subdivision site plan review (Cape Cod Commission 2006).

Some states such as Rhode Island have invested their resources in educating legislative representatives from vulnerable communities in hopes of developing state legislation to aid in mitigation actions (Rhode Island CRMC 2006). Many agencies have identified the need to educate the public of the financial costs to state and municipal accounts from inappropriate development (New Hampshire Coastal Program 2006). There appears to be a lack of information available on the economics of coastal hazard mitigation.

All the states and municipalities are underfunded to fully implement their mitigation strategies. To highlight the situation, Maine has 1,500 mitigation plans with projects totaling approximately $150 million (Maine Emergency Management Agency 2004). The state receives about $1.5 million annually from the FEMA pre-hazard mitigation grants program. To overcome the financial burdens, several states are finding beneficial linkages between ecosystem protection projects and hazard mitigation. For example, sand dredged from the Cape Cod Canal will be used for habitat restoration (USACE 2006). While in Rhode Island, the USACE is working with the state to examine sites suited for restoration of degraded wetlands using dredged materials (Rhode Island CRMC 2006).

Response and Rebuilding

Coastal managers do not have a significant role to play in post-disaster response, since that is often the charge of the state emergency management agencies. There is value in having coastal professionals accessible and in communication with emergency managers and local decision-makers. Massachusetts' emergency operations center includes a space for the state coastal program to aid in site assessments and other technical matters (Massachusetts Emergency Management Agency 2004). This was beneficial during Hurricane Bob, since the rapid communications between agencies identified some key coastal problems and guided reconstruction on the barrier islands, as well as septic system removals (Massachusetts Ocean Management Task Force 2004). Coastal regulations, together with state building codes implemented by local officials, do come into consideration during the rebuilding phase after an event. Some states such as Rhode Island have a coastal policy of enacting a moratorium on coastal permits after a hazard event to allow the agency to assess the damages to the resources

and infrastructure (Rhode Island CRMC 2006). There are also harbor management plans that detail their roles in the response and rebuilding phases (Rhode Island and Massachusetts).

The Northeast is in need of a regional response plan for vital infrastructure (NROC 2007a). This plan would need to address disruptions to energy facilities, water and sanitation, and ports to name a few. Massachusetts would like the region to develop an information-sharing system that includes details on the post-disaster phase. The state has also tasked itself with identifying facilities located in medium- and high-risk zones so that the state has detailed recommendations on how best to rebuild or repair the infrastructure to reduce future impacts (Massachusetts Emergency Management Agency 2004).

There are no redevelopment plans in the Northeast states. Rhode Island Sea Grant has funding to initiate this effort as a pilot in the state's south shore in 2008.

Education

Practically every mitigation plan and hazards program in the region places education of the public and decision-makers as a high priority. They each have their strategies of workshops, brochures, classes, or public service messages on television. Most request property owners and communities at risk to prepare and mitigate their risks, although there does not appear to be any social science model being applied to understand how people make a decision to act or not (Paxton, 2001). The region would benefit from research on the best methods for getting people to act to guide future investments in education programs.

Based on experts in the region and public polling data, the public is unprepared for coastal hazards and the public underestimates the risks that hazards pose (NROC, 2007a). The reasons for this level of unpreparedness are attributable to old housing stocks, capacity of managers and the public, and complacency (SNENYOCWG 2007). Most of the coastal residents have not experienced a disaster while living on the Northeast coast, because the last major event was in 1954. For communities that have been given flood maps, there still appears to be little concern about the risks (Maine State Planning Office 2006). Some key target audiences identified in some programs are coastal homeowners to ensure that they have adequate insurance coverage (Massachusetts Coastal Hazard Commission 2007) and communities that have recently been part of a disaster declaration (Connecticut). Managers need more information about the public's perceptions of risk and vulnerability to improve their evacuation scenarios and outreach programs (Safford and others 2005).

Education, rather than incentives and regulations, seem to be the favored approach by most of the management agencies and programs. This could be due to a lack of financial resources, political challenges of regulations, or a lack of informative social science to develop approaches that are more effective (Paxton and others 2001). Most of the outreach programs are assuming that informed and educated residents will take action to prepare and mitigate their risks (New Hampshire, Massachusetts, Connecticut Multi Hazard Mitigation Plans). While education is a first step, research has shown that it rarely motivates most people to act (Paxton and others 2001).

A majority of coastal hazard professionals at a 2005 NOAA focus group event expressed displeasure with the effectiveness of their current outreach efforts (Safford and others 2005). Less than half of the programs are moderately or very effective, and 20% had either no outreach or it was ineffective. Many of them were unaware of the tools and services that NOAA has to offer in hazards information products and resources. Programs wanted new and innovative methods for displaying and disseminating information on coastal hazards (specifically storm surge) to impress upon the public their real risks and some appropriate responses. Recent sea-level rise visualizations have received high praise and have been shown on the front page of Rhode Island's leading newspaper. Suggestions for continued outreach include education programs in the schools, at home improvement stores, and at local public events (Massachusetts, New Hampshire Multi-Hazard Mitigation Plans).

Managers and the public would like to increase the availability of science-based information on the risks, economic impacts, and potential mitigation responses (Massachusetts Sea Grant). Improved mechanisms to compile and analyze coastal hazard information would be valuable to planners and regulatory officials. Several states such as Connecticut need a tool to assist in analyzing erosion and hazards impacts to create trends for improving permitting and outreach strategies (Connecticut Department of Environmental Protection 2006). A lack of funding and data has limited the performance of these site-specific erosion and flood hazard analyses to only random special cases.

Tools

This section provides a brief overview of some of the technical (non-policy) tools that the region is using to address coastal hazards.

Listing of tools being developed or used in the region for coastal hazards:

- Rhode Island Sea Grant is producing sea level rise visualizations to improve the public's and politicians' ability to understand the models and data (Rhode Island Sea Grant).
- Maine is conducting a sea level rise study to understand what the potential impacts will be to salt water wetlands (Maine Hazard Plan).
- University of Rhode Island's Geosciences Department is conducting beach profiling in Rhode Islands' south shore.
- Connecticut is monitoring migration of wetlands and marshes because of sea-level rise.
- Cape Cod is monitoring sudden wetland dieback because of sea-level rise.
- SLOSH models for New England have been standardized (USACE New England region).

The National Estuarine Research Reserves will be starting research projects on the impacts of climate change on their estuaries. Using an ecological forecasting tool, temperature data from the NOAA National Centers for Environmental Prediction will predict whether body temperatures of intertidal organisms will exceed lethal limits, and if managers can expect mass die-offs in their estuaries. This combination of natural hazards and the ecological response will be helpful in

predicting changes in geographic distributions of intertidal animals, which could change ecosystem structure (CSCOR 2007).

NERACOOS (2006) surveyed the needs of coastal professionals in the Northeast regarding shoreline hazards and emergency management. This information overlaps with the general summaries found in earlier sections of this report. Below are some of the major findings from that survey:

- Produce wave run-up models to calculate infrastructure expose
- Map and zone high-risk areas (e.g., wave run-up models, storm surge predictions for managers to understand how high water levels will be, how long the areas will be inundated, what direction flood waters will flow, what properties are at risk, etc.)
- On-scene tools to mitigate human and infrastructure risks
- Databases to assist in cost-benefit calculations (e.g., how long sand will remain in the beach) and in improving FEMA map products
- Models linking erosion and sea level during storm events (hourly predictions in embayments and river mouths, wave observations, isostatic rebound, resonance, accretion, down-cutting, steep slopes)
- Landscape response to sea level rise/salinity changes (requires detailed topography, bathymetry, and habitat baselines)
- Web-based tool on effects of sea level rise at the property level, for public education, and for government decision-making
- Trajectory and hydrodynamic models (i.e., 6-, 12-, 24-, 48- and 72-hour maps) at various depths and three-dimensional models of upwelling and down welling (e.g., identify areas at risk when oil is in the water)
- Sediment transport models to predict sediment location and movement after dredging activities; effectiveness of nourishment projects and long-shore transport in surf zone; and capping of disposal sites
- Predictive drift models of where people in rafts would drift before being rescued or where derelict ships would drift to
- Real-time sea surface temperature for survivability

Cross-Cutting Issues of Data and Information Access and Usability

There are many similarities in needs and strategies between ecosystem-based management and hazards resilience in the Northeast. This section summarizes the key issues of coordination between coastal practitioners, as well as information access and usability.

Communication and Coordination

Ecosystem-based management (EBM) and hazards resilience are broad, integrated concepts that require improved communication and coordination among multiple sectors, agencies, and states.

It appears that every program and plan recognizes this, though the effort, time, costs, and incentives are challenging. Practitioners working with EBM in the Northeast acknowledge an ongoing gap in communications between, and even within, the science, policy, and management communities. To improve the situation, it was recommended that these groups better understand each other's cultures, constraints, and opportunities for conducting EBM (GOMC 2003). In a rapid telephone survey of 36 marine industry leaders, most either didn't know much about the Gulf of Maine Council (GOMC) or didn't see much value in it (Marjorie 2004). Only about half saw value in participating and signaled that the GOMC needs to "prove its value to them" before they would invest their time and energy. The fishing community identified that its main problems with regulators is over the science, poor communication, and a lack of trust. A more detailed survey of the industry is needed to confirm the degree of discontent or lack of value seen in the GOMC actions.

For hazards resilience to be sustainable, coastal managers, local planners, and emergency management officials need to better coordinate their efforts, such as in risk assessments and between the response and the long-term redevelopment phases. This coordination needs to occur with local officials and across state lines, and this conclusion is supported by a national poll conducted by NOAA of coastal practitioners' storm surge needs. In the survey, more than 50% felt that emergency managers either only "occasionally" or "never" worked together with land use planners and Sea Grant extension agents (Safford and others 2005). Only 11% of respondents thought that emergency managers always or often work with the insurance industry. Participants in the NOAA storm surge Northeast focus group stated that NOAA needs to facilitate improved communications between the coastal management community and land use planners and emergency managers. Improved communications could assist with developing consistent protocols and standards for data collection and reporting. Without these safeguards their data will not be able to integrate with NOAA's and FEMA's data.

Several plans propose a regional approach to coordinating the data collection process to improve their application to management situations. The Gulf of Maine Council on the Environment has recommended that, to achieve this goal, "champions" within each state take the lead to strengthen or develop statewide networks that foster networking, innovation, and sharing of good practices. The champions would need to make themselves accessible to their network members and to a larger regional coordination mechanism (GOMC 2007). Meanwhile, some states are calling for advisory groups and policy-level oversight committees to coordinate and communicate EBM needs and issues (Massachusetts Bays Program 2003). These groups would be charged with evaluating baseline conditions, identifying emerging issues, and establishing management goals. NROC (2007a) wants to provide a platform for improved coordination of data related to offshore energy planning. At a regional stakeholder meeting, practitioners requested the regional partnership initiatives, such as the Gulf of Maine and NROC, take the lead in calling for improved EBM by creating action plans and calling the larger community to act (GOMC 2007).

Several education and outreach programs in each state do not appear to have coordinated their program activities as much as they could. NOAA's CZM programs have small outreach programs that are not tightly linked to Sea Grant's extension work. The National Estuarine

Research Reserves' Coastal Training Program provides similar services. It is unclear the degree to which these programs are coordinating their efforts.

Access

Despite the continued need for more data in many areas, most states acknowledge that there is an enormous amount of existing data. The challenge for state and local officials is gaining access to these data in a timely manner (Maine Planning Office 2004, GOMC 2007). There needs to be a significant improvement in the region's data and information management infrastructure. To better support EBM, the region needs to develop a system similar to the Gulf of Maine Ocean Data Partnership to improve the locating and documenting of data sources (GOMC 2007). For the Gulf of Maine region, the GOMC has significant amounts of data that practitioners would like to see disseminated better via electronic and non-electronic means (GOMC 2007). To improve access to data, the Massachusetts Oceans Report (2005) recommends that the states share the data associated with permit applications. They could charge a nominal processing fee and provide documentation to inform the user on the proper context and use of the data. Maine would like a network established to share experiences and tools for protecting working waterfronts (Maine Sea Grant College Program 2006). For floodplain information and maps, access is improving, although because of costs, the process is slow.

Usability

The key limiting factor for improved management effectiveness for EBM and hazards resilience in the Northeast is the ability of the coastal community to apply available data and information. EBM tools do exist and when they can be accessed they are often difficult to apply to management situations (GOMC 2007). To improve the use and application of data in EBM and hazards resilience, local resource managers need to be trained in simple methods for analyzing data and effectively communicating this information to the public (Maine State Planning Office 2007). This includes the full spectrum of information from ecological to socioeconomic. Inventories of ocean uses and resources in GIS format would assist in identifying trends (Massachusetts Oceans Task Force 2005).

Several ocean observing systems are operational in the Northeast. To improve their usage by managers, there needs to be improved coordination and dissemination of information (NERACOOS 2006). Managers would like to be able to quickly add their own monitoring data and traditional knowledge as well. Users will need additional training on how best to apply the data to their unique situations. To assist with hazards, the ocean observing systems need to add storm surge, forecast, and response data (NROC 2007a).

The use of hazards data and information can be improved in several specific ways. First, much of the scientific jargon should be removed where possible, such as that found with storm surge information. There is also confusion between the different measurement scales (vertical datum), unclear graphical outputs, and confusion on where to access the hazards data (Safford and others 2005). The officials and the public are also confused when presented with both the FEMA NFIP

floodplain maps and NOAA inundation maps. The NFIP maps, which are being digitized, also need to be updated to become fully useful to local planners. Local officials need improved models of storm surge for precise areas, available in a timely fashion before the storm events reach the coast. Finally, for innovative policy tools and regulations to be replicated across the region, there needs to be more information on the effectiveness of pilot projects available to communities.

Introduction to Interview Results

The results of the literature review helped identify areas in need of additional information and follow-up. This was accomplished by means of a series of one-on-one interviews with key stakeholders. Efforts were taken to minimize the number of interviews as a courtesy to reduce the level of intrusion and time burden on participants. While interviews with all stakeholder groups were not conducted, interviewees provided diverse information over the entire project geography. Participants were asked to provide input in three general areas:

- Gaps in information and capacity for ecosystem-based approaches to management of coastal resources
- Information needs to increase community resilience to coastal hazards
- Accessibility and usability of NOAA data

Needs to Implement Ecosystem-Based Management

Cross-Jurisdictional Management Needs

One of the most prominently identified needs identified from interviewees was a call for strengthened cross-jurisdictional collaboration. This call refers to both multigovernmental collaboration (local to state to federal) and collaboration within and among all the following governmental institutions and the private sector, nongovernmental organizations, academia, and others.

Increase collaboration across jurisdictions
There were specific needs identified for increased coordination across state and jurisdictional boundaries. It is often within agency mandates to manage only those resources within jurisdictional boundaries. Too often these boundaries do not account for natural boundaries such as watersheds and coastlines, which may lead to fragmented projects with only moderate success. While the realization of needing to collaborate may be evident, how to collaborate is another challenge. There are a wide variety of coastal management groups within the Northeast, such as state coastal zone mangement (CZM) programs, regional planning agencies, municipal planners, conservation commissions, and land trusts. Often the challenge is knowing who to contact within the various jurisdictions to begin collaborative efforts. Greater ecological value could be reached through cross-jurisdictional conservation, collaborative research, and cost sharing within projects. This identified need also complements one of the primary actions of marine ecosystem-based management as identified within the Communication Partnership for Science and the Sea (COMPASS) Scientific Consensus.

Lack of trust among stakeholder groups
A primary challenge to overcome is a lack of trust and willingness to collaborate among certain stakeholder groups. There are obvious benefits to sharing information and best practices across common efforts. Within the private sector and other arenas, there is often revenue competition at stake, which hampers the collaborative process. The 2006 NOAA Coastal Services Center Customer Survey inquired about stakeholder engagement and found that 69% of respondents use

formal stakeholder engagement processes to enhance collaboration. Forty-two percent of respondents said this process possessed high utility. While these numbers are encouraging, additional effort in this area may prove beneficial.

Social Science Tools and Information Needs

The use and applicability of social scientific information in decision-making has become increasingly valuable to the coastal management community. Social science is valuable in understanding the knowledge, attitudes, behaviors, and perceptions of various groups and institutions. Additionally, social scientific information encompasses the fields of economics and political science. A number of needs were identified and confirmed through interviews about social science data, tools, and application.

Economic information
Economic information was a need directly identified by those interviewed. Specific needs mentioned include valuation of coastal and ocean resources, the economic value that coasts and oceans bring to neighboring, non-coastal communities, and cost-benefit analysis information. Economic information, while valuable in decision-making, is often difficult and expensive to collect properly. Based on the results of the 2006 NOAA Coastal Services Center Customer Survey, economic data appear to be challenging as well as underutilized. Data layers that over 50% of Northeast respondents reported were not currently being used but which would be useful included marine and coastal economic data, and coastal demographics. The survey also asked about specific human dimensions tools and constraints to using them. Of the three least used social science tools, two focused on economic data. Just 28% of respondents reported that their office uses cost-benefit analysis, and only 4% reported that their office uses non-market valuation. Not surprisingly, insufficient staff members and a lack of required knowledge or skills were identified as primary constraints. While there are certainly informational needs for the physical and biological sciences, there is a general feeling that a much greater volume of information exists in these areas.

Understanding and navigating political processes and policy
Engagement within the complex institutional structures of local, state, and federal government was identified as a significant challenge. More specifically, knowledge associated with permitting, siting, and up-to-date political processes and contacts was identified as a need in the Northeast. With frequent changes of elected officials and policy, and with multiple jurisdictional levels, current, up-to-date information is perceived to be of great assistance. According to the 2006 Customer Survey, almost half (48%) of respondents have been in the coastal management field five years or less. With a dynamic political environment and a professionally young work staff, there are needed steps to bring a greater understanding to this area. Additionally, less than half of respondents (43%) reported conducting any sort of legislative/policy analysis in their offices.

Use of social science information and tools
From a general standpoint, there was an expressed need for *more social science*. While it is difficult to determine precise meaning of such a statement, the Customer Survey helps bring this

into context. A number of social science tools were frequently used within the Northeast community, such as stakeholder engagement processes, surveys, needs assessments, and evaluations. Interestingly, a number of the most frequently used tools were reported as possessing high utility by only a small proportion (<25%). For example, surveys were used by nearly 70% of respondents, but only 18% indicated that they possess high utility. Conversely, there are directly stated needs for more economic information, and no economic measure identified on the survey was used by more than 28% of respondent offices.

Ocean Observing Data and Applications

Interview respondents also mentioned ocean observing data and application needs. In a general sense, the regional associations of the Integrated Ocean Observing System (IOOS) are perceived as a complex and somewhat closed community by many within the coastal management field. Direct statements were made regarding the value of real-time data to maximize the accuracy of forecast information. Specific data measures that were mentioned include wind, waves, and water level.

There is a level of unfamiliarity among coastal managers with accessibility and application of IOOS data. The Northeast Regional Association of Coastal Ocean Observing Systems (NERACOOS) is aware of this and has taken steps to make observing data within the region more accessible to the coastal management community, completing a formal assessment of manager needs in 2006 (NERACOOS, 2006). Additionally, the 2006 NOAA Coastal Services Center Customer Survey reported that the offices of 50% of Northeast respondents used coastal and ocean observations. Only 24% indicated that this information source had high utility. Among the top constraints to using observing data was the lack of required knowledge or skills.

Mapping and Decision-Support Tools Are Needed

Topic-specific areas were identified that are in need of further mapping and tool development. Habitat maps and information was identified as a particular area of interest. Habitat data are widely useful, but the coastal management community is interested in taking the data further by visually connecting habitat areas, stressors, and potential impacts. One Center-based decision-support tool that was specifically mentioned within this context as being well received and useful was the Habitat Priority Planner (HPP).

Approximately 50% of respondents of the 2006 NOAA Coastal Services Center Customer Survey reported that their office used decision-support tools. Mapping tools and products also received mention by interviewees. There were specific requests for more up-to-date land use and buffer maps. Related to HPP, 75% of respondents indicated that on-line mapping is used in their office. Mapping tools that display a combination of human and biophysical measures are in great demand. Such tools allow greater, more thoughtful trend analysis and forecasting. Some of the most widely needed spatial data layers in the 2006 survey are directly in line with such mapping tools. These include coastal demographics, ocean and coastal economic data, currents, and fish habitat distribution. Further, land use planning was the highest priority area mentioned by 67% of respondents.

Seafloor mapping is a topic of interest to many Northeast stakeholder groups. Interview respondents indicated that this type of data is crucial and serves as a basis for a number of GIS-based and zoning projects. There is a reported need for nearshore bathymetric data to complement seafloor maps. Nearshore bathymetry coverage was described as spotty as it currently stands. Additionally, there was reported interest in the creation of a marine cadastre. With a number of obscure boundaries, coastal managers reported that there is often guesswork involved in marine spatial planning and boundary disputes.

NOAA electronic navigation charts (ENCs) are accessed by an array of user groups but were reported as challenging to use because of the sheer amount and organization of the data. The coastal management community would greatly benefit from both GIS download and a variety of viewing options for NOAA data. Additionally, more publicly available metadata is perceived as better. Some NOAA metadata resources are excellent, while some are incomplete. Often, for example, entire data sets use only a single metadata descriptor, which does not provide enough detail to determine fitness for use.

Finally, climate data and subsequent products are needed by coastal managers to effectively plan for and mitigate potential impacts of climate change. Climate change was mentioned in general terms but was an item mentioned in many instances. This area is discussed in greater detail within the coastal hazards section of this report.

Needs to Increase Community Resilience to Coastal Hazards

Building Local Planning Capacity

Because of their rural nature, most New England communities rely on a small professional staff and volunteers (i.e., local elected officials) to develop hazard mitigation and emergency response plans at the local level. Many smaller communities do not have the in-house resources and expertise to create plans that meet state and federal requirements and must hire consultants to complete this work. Grants and state financial support are utilized in the development of plans; however, these resources only fund the minimum requirements for a plan. Additional resources are needed if communities want to acquire new data or training that enables them to incorporate resilience concepts in the plans.

Communication with elected officials and public
Local officials are largely unfamiliar with the concept of community resilience. There is a need to deliver relevant and digestible information to local officials who are making decisions regarding development in vulnerable areas. In particular, planning boards need information describing the increased risk associated with various development options. This information provides the basis for making the difficult decisions to say no to risky development.

There is a need for training on how to effectively communicate hazard and planning information to adult audiences, specifically elected officials and the public. There is a concern that existing

communication and outreach efforts do not consider adult learning styles. Also, there is a need to identify appropriate terminology for each audience.

Preparing an Inexperienced Population

In addition to a lack of capacity at the local planning level, New England faces diminished capacity for the local population to react to serious coastal storm impacts. A major tropical storm has not impacted New England in recent history, which translates to a local coastal population that is out of "practice" with preparing for storm impacts. In a recent presentation, the National Weather Service described New England as having an "inexperienced population" with tropical storm impacts and underscored the need for investing in hazard mitigation and emergency response plans and communicating risks associated with coastal storms.

Understanding flood risks to coastal development
Over the last 50 years, the New England coastline has seen significant development. Managers are concerned with the impacts associated with climate change and sea level rise to the coastal transportation infrastructure, businesses, and homes. In particular, managers need updated 100-year flood maps and consensus on sea level rise ranges. Existing climate information such as the Intergovernmental Panel on Climate Change report does not provide the right scale of information for communities to use. Localized climate science is needed to support community level planning. According to the 2006 Customer Survey, half (50%) of respondents indicated the flood maps and inundation zones were not currently being used but would be useful.

Accessible Visualization Tools

There is a need for more accessible visualization tools to help managers and the public understand their risk associated with storm events. Many local communities lack the capacity to properly use existing tools. Users have cited a lack of basic knowledge of resilience concepts as a barrier to using the Coastal Risk and Vulnerability Assessment Tool. The 2006 Customer Survey confirms knowledge as a barrier, with 59% of New England respondents saying they need to learn more about "risk and vulnerability assessment." Additional constraints cited include inadequate equipment, facilities, and/or technology (48%).

Outreach and training on visualization tools available to coastal managers will improve accessibility and usability of tools. Managers cited training on existing software (52%) and technical assistance in use of software (50%) as two types of assistance that would have high utility.

Certainty in sea level rise predictions
As confidence grows in sea level rise predictions, the management community can use tools for planning and make policy decisions. Managers understand historical data from NOAA tide gauges that indicate sea level is rising in New England. Managers need more certainty in the sea level rise predictions.

In the 2006 Customer Survey, nearly half (44%) of respondents selected flooding, inundation, and storm surge as high priority issues for New England. Sea level rise increases the impacts from coastal storms and creates a need for more accurate storm surge flooding and inundation maps and forecasts. This information is critical for planning evacuations in coastal flood-prone areas. Managers need additional information to communicate risk associated with flooding to decision makers.

Sea level rise also increases the need for improved infrastructure planning for ports. Port managers need more certainty in sea level rise predictions to facilitate planning efforts for preserving or adapting port infrastructure.

In the conservation community, sea level rise and coastal storms are influencing elements of acquisition plans. Wetlands and riparian buffers provide coastal storm protection by absorbing storm surge. Additionally, these properties will absorb consistently higher tides due to sea level rise. Conservation organizations need support in educating smaller land trusts about the concept of green infrastructure so that it can be included in their strategic planning and selection of properties. Land trusts also need economic information describing the value of the ecosystem service that can be protected through conservation.

Erosion
Nearly half (43%) of Northeast coastal managers that responded to the 2006 Customer Survey described erosion as a high-priority issue. Interviews confirmed erosion as a major issue of concern. Information needs related to erosion identified in interviews include detailed shoreline change analysis for the last 50 years, erosion impacts on unconsolidated shorelines, erosion prevention techniques in sheltered shorelines, and erosion impacts from increased precipitation and storm events. There is a need to develop erosion visualization tools, both for near-term shoreline erosion and future erosion scenarios based on sea level rise predictions.

Information Sharing Across Organizations

The field of coastal resilience is growing quickly, causing multiple organizations to develop support tools and data that will assist coastal and emergency managers. A regional venue is needed for those working on coastal hazard issues to be able to share information and provide the resilience community with a better understanding of who is doing what. More importantly, information sharing will provide a better understanding of where additional investments are needed. This is also true for federal agencies. Multiple agencies (especially EPA and NOAA) are initiating programs and devoting resources to coastal hazards planning and community resilience.

Next Steps: Using the Needs Assessment Results

Following the completion of the needs assessment project, the information in this document will be shared with both internal and external NOAA partners to ensure that our findings influence

and improve the quality of our services and our ability to work with our partners to make progress in the Northeast region in these issue areas. This product is meant to inform the direction of the many regional efforts that cover these same topics.

The assessment will be shared with those involved with its development and other interested partners, including the NOAA Steering Committee, the University of Rhode Island's Coastal Resources Center, and the interviewees.

Coastal Services Center
Although the Center has been engaged in the Northeast since June 2004, this product represents the first formal needs assessment for the region, and now that the Northeast staff has gained capacity in 2007, it is timely to use the assessment for strategic planning and priority setting. We expect the assessment will help us identify technical capabilities that are needed to apply to the Northeast.

The assessment will be shared with Center staff members through posting on the website and other means for internal distribution. Responses to needs will be developed through strategic meetings with the coastal and ocean planning, hazards, and conservation theme teams, and with specific divisions whose skills and focus match needs expressed. These discussions will help guide any in-kind assistance and future project ideas tailored for New England.

NOAA
The Northeast Needs Assessment is timely in its ability to steer NOAA Regional Collaboration efforts in the region. The North Atlantic Regional Team (NART), which spans from Maine to Virginia, had decided to postpone stakeholder meetings until the team could articulate existing customer needs that had already been gathered through recent assessment efforts. This Center-led assessment will serve as the main source of customer needs for the New England subregion of the NART geography, and will be used to organize focus group meetings this fall to ground-truth and prioritize needs with major partners. NART has chosen to focus on five priority areas (e.g., hazard resilience, climate change, integrated water services, energy, and ecosystem-based management), two of which relate directly to this assessment's focus.

The NOAA Coastal Services Center's Northeast staff initiated biennial "NOAA in New England" meetings in 2005, which serve as an informal dialogue for NOAA managers based in the region to discuss both NOAA internal changes and initiatives, regional initiatives where NOAA is or should be engaged, and emerging issues of regional importance. This group has taken the initiative over the past several years to specifically discuss NOAA direction and customer needs in the areas of ecosystem-based management and hazard resilience, yet efforts were piecemeal through inviting partner speakers or reactive in responding to a NOAA tasking. There has always been group interest in a more comprehensive, systematic look at key customer needs in our geography. The NOAA in New England group has been involved in the needs assessment through a subset of its membership serving as the assessment steering committee and through receiving periodic updates. Therefore, NOAA in New England becomes an ideal audience for this product. The NOAA Coastal Services Center Northeast staff plans on rolling out assessment results through a presentation and discussion at the fall NOAA in New England

meeting, and for using this group as a petri dish for new project ideas that will better integrate our capacities to meet the priority needs of our customers.

Regional Organizations
There are several regional entities in which NOAA plays a lead role that will serve as appropriate audiences for the New England Needs Assessment findings.

Most notably, the Northeast Regional Ocean Council (NROC) fits the assessment in both geography and priority issues. As a largely coastal resource management driven body, NROC represents the core customer targeted in our literature review and interviews, and therefore can use the product as a way to educate the full council and its committees to ensure that regional priority needs are being addressed through proposed work. Timing is good as committees are just now developing an inventory of current activities around ecosystem health, coastal community resilience, and energy, and these current capacities can be cross-referenced with the needs assessment to identify gaps that require a collaborative response from the states, federal agencies, and partners engaged. The Center has also offered in-kind services to develop a Web presence for NROC, which will serve as an effective way to share the assessment with both council members and partners.

The Gulf of Maine Council on the Marine Environment (GOMC) was established in 1989 by the Governments of Nova Scotia, New Brunswick, Maine, New Hampshire, and Massachusetts to foster cooperative actions within the Gulf watershed. Its mission is to maintain and enhance environmental quality in the Gulf of Maine to allow for sustainable resource use by existing and future generations. The Center was very involved in the development of their 2006-2012 Action Plan, which focuses, in part, on ecosystem-based management and some climate change capacity building that aids resilience. The GOMC Working Group meets quarterly and would be an appropriate forum to share needs assessment results, especially where needs could be met through sharing best practices among jurisdictions and organizations, a well-recognized niche for this group.

The Northeast Regional Association of Coastal and Ocean Observing Systems (NERACOOS) shares both the geography and issue area interest with this needs assessment project. In particular, there has been a coastal hazard product needs survey among the coastal resource management community that will dovetail well with our results. The NERACOOS has been in the planning stages for the past three years, but will hold its first official board meeting in mid-August, 2008, and therefore it will be timely to share this product as this group gets underway and begins to set priorities based on regional user needs for IOOS products.

Coastal Management Partners
The NOAA Coastal Services Center's Northeast staff plans to initiate quarterly telecom meetings with specialists from OCRM's Coastal Program Division, National Estuarine Research Reserve System, and Sea Grant to create a community of NOAA specialists who are better informed of the needs of our common customers and of the current and planned activities to address these needs. This needs assessment will serve as the centerpiece for the kickoff meeting to be held in early fall 2008.

The Center will identify upcoming partner meeting opportunities (i.e., the annual CZM Partners Meeting for North Atlantic to be held in November of 2008, Sea Grant Regional Ocean Science Council) to share assessment results either through presentations, side meetings, or executive summary handouts. This will ensure that this snapshot of needs is incorporated into the many current efforts to advance regional ocean governance and management.

Appendix A

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Appendix B

Primary Audiences

State and Federal Managers

- New England Regional Ocean Council (NROC)
- Gulf of Maine Council on the Marine Environment (GOMC)
- Southern New England/New York Ocean Partnership (SE/NYOP)
- State Coastal Zone Management Programs (CZMPs)
- Other state agencies that deal with coastal issues (Departments of Natural Resources, Fish and Wildlife, Environmental Protection, Health, Environmental Quality)
- National Estuarine Research Reserves (NERRs) and National Marine Sanctuaries (NMSP)
- State Sea Grant programs
- National Estuary Programs (NEPs)
- Coastal National Wildlife Refuges and National Parks
- Atlantic States Marine Fisheries Commission
- State floodplain managers
- State and local emergency managers
- County planners
- Associations of counties
- Coastal states' point of contact for National States Geographic Information Council (NSGIC)
- Coast Guard and state-level enforcement agencies
- USACE Districts
- US Forest Service
- State Port Authorities
- State Departments of Transportation

Nongovernmental Entities and Industries

- Regional Associations: Northeast Regional Association of Coastal and Ocean Observing System (NERACOOS) and the Mid-Atlantic Coastal and Ocean Observing Regional Association (MACOORA)

- University programs involved with coastal issues (e.g., RI Coastal Resource Center)
- Nongovernmental organizations involved with coastal ecosystem and resilience issues (e.g., The Nature Conservancy, Ocean Conservancy, Conservation Law Foundation, Place-based groups such as Save the Bay and Mass Audubon)
- Coastal land trusts (e.g., Land Trust Alliance, The Nature Conservancy, Trustees of Reservations, Maine Coast Heritage Trust)
- Media
- Oil and gas industry
- Fishing industry
- Ports and navigation industry
- Recreation and Tourism
- Insurance industry

Secondary Audiences

- The Public
- NOAA Partners

Appendix C

2006 Coastal Services Center Customer Survey: Responses from the Northeast Region

The percentages reported have been rounded to the nearest whole number, so all totals may not add to 100%.

To view a report on national results from this 2006 survey, as well as results from past Coastal Services Center customer surveys, please visit the following Web address: www.csc.noaa.gov/survey.

Overview of Northeast respondents
Of a total of 433 respondents in the 2006 survey, 49 were from the Northeast regional states:

- 22 from Maine
- 4 from New Hampshire
- 9 from Massachusetts
- 7 from Rhode Island
- 7 from Connecticut

Respondents represented a variety of organizations, including:

- 5 respondents were from state Coastal Zone Management (CZM) programs
- 8 were emergency managers at either the local or state level

- 17 were from non-CZM agencies involved in coastal and marine resource management (e.g., Departments of Environmental Protection, Departments of Fish and Wildlife, Departments of Water Quality.)
- 7 were from National Estuarine Research Reserves
- 2 respondents were from state Sea Grant offices

Respondents also reported holding a variety of positions within their organizations:

- 12% were in education and outreach
- 10% were in emergency management
- 18% were in information technology (GIS, remote sensing, or a related field)
- 16% were in natural resource management
- 2% were in permitting and regulatory enforcement
- 16% were in planning
- 16% were in program or site administration and management
- 4% were in research
- 4% represented position types not listed on the survey

Nearly half of respondents have been in coastal resource management positions for five years or less, though 31% have been in the field more than 15 years:

- 48% have been in the field 5 years or less
- 17% have been in the field 6-10 years
- 4% have been in the field 11-15 years
- 20% have been in the field 16-20 years
- 2% have been in the field 21-25 years
- 9% have been in the field over 25 years

Many respondents were familiar with the Coastal Services Center (CSC), and a significant percentage have used one or more CSC products and services:

- 63% are familiar or very familiar with CSC
- 55% have visited the CSC website
- 49% receive one or more CSC publications
- 39% have attended a Coastal Zone conference
- 49% have attended a CSC workshop or training
- 29% have received technical assistance from CSC
- 45% have used data or other products from CSC
- 37% have partnered with CSC on a project

Priority Topics

Eight issues were identified as high priority by over 40% of Northeast regional respondents:

- Land use planning/growth management (67%)
- Watershed planning (45%)
- Nearshore and offshore habitat mapping (41%)
- Habitat restoration/monitoring (58%)
- Water quality monitoring (44%)
- Nonpoint source pollution (47%)
- Flooding/inundation/storm surge (44%)
- Erosion (43%)

Hazards Management Topics

Survey results revealed that many respondents feel they need to learn more about hazards management topics:

- 64% said “long term recovery” is a topic they need to know about for their job, and that they need to learn more about.
- 59% said “risk and vulnerability assessment” is a topic they need to know about for their job, and that they need to learn more about.
- 57% said “hazards mitigation” is a topic they need to know about for their job, and that they need to learn more about.
- 53% said “response immediately after a disaster” is a topic they need to know about for their job, and that they need to learn more about.
- 51% said “risk communication” is a topic they need to know about for their job, and that they need to learn more about.
- 45% said “forecasts and warnings” is a topic they need to know about for their job, and that they need to learn more about.

Asked to rank the relative priority of these hazards management topics, “risk and vulnerability” rose to the top, with 50% of Northeast respondents listing this as the number one priority. “Hazards mitigation” came in second with 28% ranking this as their top priority.

Spatial Data Use

(Note: 12% of Northeast respondents said they were not familiar with spatial data use in their office, so the following data are for the 88% of respondents that are familiar.)

- Coastal land cover was one of the two most commonly used data layers, with 74% reporting use of this layer in their office. An additional 23% said their office does not use this data layer, but it would be useful.
- Coastal land use was the other most commonly used data layer, also with 74% reporting that their offices use this layer. Similarly, an additional 23% indicated their office does not use this data layer, but it would be useful.
- Current shoreline came in third, with 72% reporting use of this layer in their office, and 21% saying it would be useful.
- Additional data layers being used by over 50% of respondents’ offices:
    - Bathymetry
    - Seagrass distribution
    - Shellfish bed distribution
    - Protected areas
    - Public access
    - Elevation/topography
- Data layers that over 50% of respondents indicated were not currently being used but which would be useful:
    - Docks and piers
    - Sediments
    - Suspended sediments
    - Coastal demographics
    - Marine and coastal economic data
    - Fish habitat distribution maps
    - Wind
    - Waves
    - Currents
    - Flood maps/inundation zones/tsunami zones

Technology Tools to Support Coastal Resource Management

Survey data provided insight on Northeast respondents' use of various technology tools, as well as the most common constraints to use. Tool use is described below, listed from most-used to least-used:

- Geographic Information Systems (GIS): 83% reported that they or their offices use GIS. 81% said this tool has high utility. for those who reported constraints to using this tool, conflicting demands on time was the greatest constraint (46%). Other top constraints were inadequate facilities/equipment/technology, lack of required knowledge/skills, and insufficient staff.
- On-line databases (data portals, data clearing houses): 79% reported that they or their offices use on-line databases. 33% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time was the greatest constraint (43%). Other top constraints were lack of relevant/necessary data and lack of required knowledge/skills.
- On-line Mapping: 75% reported that they or their offices use on-line mapping for browsing or viewing data. 31% said this tool has high utility. For those who reported constraints to using this tool, inadequate equipment/facilities/technology was the greatest constraint (52%). Other top constraints were conflicting demands on time, lack of relevant/necessary data and lack of required knowledge/skills.
- Remote sensing tools: 68% reported that they or their offices use remote sensing tools. 42% said these tools have high utility. For those who reported constraints, inadequate equipment/facilities/technology (45%) and conflicting demands on time (45%) were the greatest. The other top constraint was insufficient staff.
- Visualization (GIS-, 3D-, and photo-based): 60% reported that they or their offices use visualization. 22% said this tool has high utility. For those who reported constraints, lack of required knowledge/skills (48%), and inadequate equipment/facilities/technology (48%) were the greatest. Other top constraints were a lack of relevant/necessary data, and conflicting demands on time.
- Coastal and ocean observations: 50% reported that they or their offices use coastal and ocean observations. 24% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time was the greatest constraint (43%). Other top constraints were lack of relevant/necessary data, lack of required knowledge/skills, and insufficient staff.
- Decision-support tools (manipulating / analyzing data): 49% reported that they or their offices use decision-support tools. 23% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time was the greatest constraint (45%). Other top constraints were lack of required knowledge/skills, and inadequate facilities/equipment/technology.
- Models or model outputs (habitat modeling, SLOSH, HURREVAC): 49% reported that they or their offices use models or model outputs. 10% said these tools have high utility. For those who reported constraints, lack of required knowledge/skills was the greatest constraint (42%). Other top constraints were lack of relevant/necessary data, and conflicting demands on time.

Utility of different types of assistance with technology tools and data:
The survey asked respondents about whether several different types of assistance would have high, medium, low, or no utility. The following list shows the percentage indicating each type of assistance would have high utility, listed from highest to lowest:

- Providing data: 60%
- Providing training on existing software: 52%
- Providing on-site technical assistance in use of software: 50%

- Developing customized applications: 44%
- Developing case studies detailing the uses of existing software: 32%
- Evaluating existing software for coastal applications: 32%
- Inventorying available software: 19%

Human dimensions tools

The survey asked about human dimensions tools (e.g., social science methods, strategic planning tools) and constraints to using these tools. Tool use and constraints are described below, listed from most-used to least-used:

- Stakeholder engagement processes: 69% reported that they or their offices use stakeholder engagement processes. 42% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time and insufficient staff were the greatest constraints (34% each).
- Strategic Planning: 69% reported that they or their offices use strategic planning. 36% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time was the greatest constraint (35%).
- Surveys: 67% reported that they or their offices use surveys. 18% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time and insufficient staff were the greatest constraints (39% each).
- Performance measures or indicators: 64% reported that they or their offices use performance measures or indicators. 27% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time was the greatest constraint (46%). An additional notable constraint was insufficient staff (34%).
- Meeting facilitation: 62% reported that they or their offices use meeting facilitation. 37% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time and insufficient staff were the greatest constraints (33% each).
- Interviews: 60% reported that they or their offices use interviews. 26% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time and insufficient staff were was the greatest constraints (41% each).
- Needs Assessments: 58% reported that they or their offices use needs assessments. 18% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time was the greatest constraint (40%). Other top constraints were insufficient staff (37%) and lack of organizational policy/process supporting use (26%).
- Evaluation of individual products or projects: 55% reported that they or their offices use evaluation of individual products or projects. 26% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time was the greatest constraint (36%). Other top constraints were lack of applicability/interest and lack of organizational policy/process supporting use (25% each).
- Focus groups: 55% reported that they or their offices use focus groups. 12% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time was the greatest constraint (37%). An additional, notable constraint was insufficient staff (34%).
- Project management: 50% reported that they or their offices use project management. 16% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time was the greatest constraint (40%). Additional top constraints included insufficient staff (32%) and a lack of required knowledge/skills (26%).

- Evaluation of entire programs: 49% reported that they or their offices use evaluation of entire programs. 18% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time was the greatest constraint (39%). Other top constraints were insufficient staff (37%) and lack of organizational policy/process supporting use (28%).
- Policy/legislative analysis: 43% reported that they or their offices use policy/legislative analysis. 28% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time was the greatest constraint (26%).
- Observation: 42% reported that they or their offices use observation. 18% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time was the greatest constraint (24%).
- Stakeholder analysis: 35% reported that they or their offices use stakeholder analysis. 26% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time was the greatest constraints (29%).
- Logic models: 35% reported that they or their offices use logic models. Only 6% said this tool has high utility. For those who reported constraints to using this tool, conflicting demands on time and insufficient staff were the greatest constraints (29% each).
- Demographic analysis: 30% reported that they or their offices use demographic analysis. 11% said this tool has high utility. For those who reported constraints to using this tool, insufficient staff was the greatest constraints (28%).
- Social assessments: 29% reported that they or their offices use social assessments. 14% reported this tool as possessing high utility. For those who reported constraints to using this tool, insufficient staff was the greatest constraint (29%). An additional, notable constraint was lack of organizational policy/process supporting use (27%).
- Cost-benefit analysis: 28% reported that they or their offices use cost-benefit analysis. 11% said this tool has high utility. For those who reported constraints to using this tool, insufficient staff and a lack of relevant/necessary data were the greatest constraints (20% each).
- Content analysis: 17% reported that they or their offices use content analysis. Only 3% said this tool has high utility. For those who reported constraints to using this tool, insufficient staff, conflicting demands on time, and a lack of required knowledge/skills were the greatest constraints (20% each).
- Non-market valuation: Only 4% reported that they or their offices use non-market valuation. 15% said this tool has high utility. For those who reported constraints to using this tool, insufficient staff was the greatest constraint (21%).

Methods Used to Obtain or Exchange Information

The following list shows the percentage of Northeast respondents using different methods to exchange information about tools, technology, or other issues related to their jobs:

- Talking with colleagues (98%)
- Professional meetings and conferences (93%)
- Websites (88%)
- Workshops (86%)
- Trainings (79%)
- Technical documents, government reports, conference proceedings (71%)
- E-mail discussion groups (list serves) (71%)
- Newsletters (64%)
- Scientific journals (57%)
- Books (57%)

- Private-sector relationships (48%)
- Trade publications or corporate reports (45%)
- Magazines (45%)
- CDs (38%)
- Electronic journals (e-journals) and electronic magazines (e-zines) (33%)
- Web-based discussion groups (26%)

Training: Constraints to participating and applying, Interest in on-line learning

- 61% said conflicting demands on time always or often limits their ability to attend trainings.
- 38% said travel restrictions always or often limit their ability to attend trainings.
- 34% said awareness of trainings always or often is a constraint, while 29% said availability of training is always or often a constraint.
- 48% said lack of funding always or often limits their ability to attend trainings.
- 15% reported that a lack of management support always or often limits their ability to attend trainings.
- When asked what barriers or constraints have limited their ability to *apply* knowledge or skills acquired during trainings, the most frequent responses were highly focused on time constraints and time lag between training and actual opportunities to apply what they've learned.
- 43% have participated in on-line distance learning, and 21% said they have a high level of interest in on-line distance learning.

Appendix D
Individuals Interviewed

Lucy Ambrosino	Port Authority of NY/NJ
Cynthia Copeland	Strafford Regional Planning Commission
Steve Dickson	Maine Geological Survey
Ted Diers	New Hampshire Coastal Program
Jennifer Hunter	New Hampshire Estuaries Project
Richard Langan	CICEET, University of New Hampshire
Neil MacGaffey	MassGIS
Jeff Martin	Northeast Utilities
Pat McCullough	Northeast Utilities
Kevin Rousseau	Maine Port Authority
Dan Sampson	Massachusetts Office of Coastal Zone Management
Megan Shore	Maine Coast Heritage Trust
Susan Swanton	Maine Marine Trade Association
Jack Wiggin	Urban Harbor Institute, UMASS Boston

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