

MID-ATLANTIC REGIONAL OCEAN RESEARCH PLAN

SEPTEMBER 2012

Sea Grant Mid-Atlantic Ocean
Research Planning Project





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List of Acronyms

ASMFC	Atlantic States Marine Fisheries Commission
BOEM	Bureau of Ocean Energy Management
BMP	Best management practice
CMSP	Coastal and Marine Spatial Planning
COSEE-SE	Center for Ocean Sciences Education Excellence - South East
DOI	Department of the Interior
DRBC	Delaware River Basin Commission
EIA	Energy Information Administration
EIS	environmental impact statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FMP	Fishery management plan
GLRRIN	Great Lakes Regional Research Information Network
IOOS	Integrated Ocean Observing System
LME	Large Marine Ecosystem
LNG	Liquefied natural gas
MAFMC	Mid-Atlantic Fishery Management Council
MARACOOS	Mid-Atlantic Regional Association Coastal Ocean Observing System
MARCO	Mid-Atlantic Regional Council on the Ocean
MMS	Minerals Management Service
NOAA	National Oceanic and Atmospheric Administration
NOP	National Ocean Policy
OCS	Outer continental shelf
ORPP	Ocean Research Priorities Plan
RPB	Regional Planning Body
SARRP	South Atlantic Regional Research Project
SECOORA	Southeast Coastal Ocean Observing Regional Association
STAC	Chesapeake Bay Program's Scientific and Technical Advisory Committee

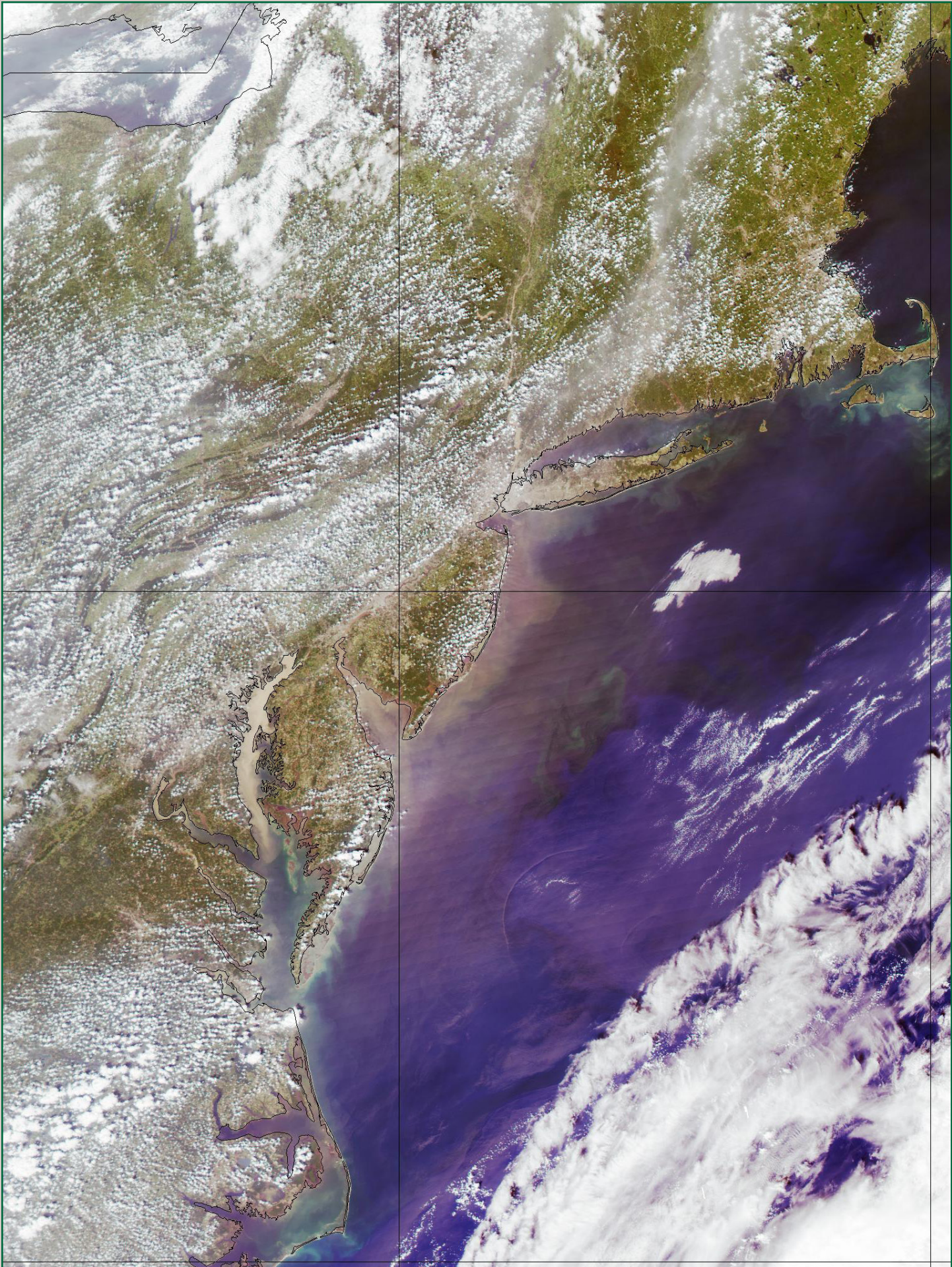


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The research work and preparation of the Mid-Atlantic Regional Ocean Research Plan was carried out by a project team based at the Gerard J. Mangone Center for Marine Policy at the University of Delaware's College of Earth, Ocean, and Environment, under the direction of the project's principal investigators, Dr. Biliانا Cicin-Sain, Director of the Mangone Center, UD, and Dr. Nancy Targett, Dean of the College of Earth, Ocean, and Environment, in consultation with the members of the project Steering Committee, the Directors of the Sea Grant state programs involved in the project: Dr. Peter Rowe (New Jersey Sea Grant), Ms. Ann Faulds (Pennsylvania Sea Grant), Dr. Nancy Targett (Delaware Sea Grant), Dr. Jonathan Kramer and Dr. Fredrika Moser (Maryland Sea Grant), Dr. Troy Hartley (Virginia Sea Grant), and Dr. Steve Rebach (North Carolina Sea Grant). Dr. James Ammerman and Dr. Katherine Bunting (New York Sea Grant) also provided review and input on the report.

This research plan has been prepared by the following members of the project team at the Gerard J. Mangone Center for Marine Policy at the University of Delaware's College of Earth, Ocean, and Environment: Dr. Biliانا Cicin-Sain, Director; Dr. Miriam Balgos, Associate Scientist; Mr. Joseph Appiott, Research Assistant; Ms. Kristin Hicks, Research Assistant; and Ms. Marisa Van Hoeven, Research Assistant, with additional input from Dr. Jennifer Merrill, Research Coordinator, Delaware Sea Grant Program.



EXECUTIVE SUMMARY

In the past 20 years, there has been increasing focus at the regional and national levels in moving toward integrated, ecosystem-based management of ocean and coastal areas. The National Ocean Policy (NOP), adopted in 2010 by Executive Order 13547: Stewardship of the Ocean, Our Coasts, and the Great Lakes, underscored the importance of mobilizing science (both natural and social) to support sound decision-making in the management of ocean and coastal resources. The National Ocean Policy also underscored the importance of a regional approach to ocean governance, involving state and federal decision-makers, scientists, industry, and the public, and a governance approach that maximizes regional flexibility and capacity.

The Development of a Regional Ocean Research Plan for the Mid-Atlantic Region is a four-year project (2008-2012) that set out to identify and analyze research needs associated with ocean and coastal issues in the Mid-Atlantic region along the Atlantic coast from New Jersey to North Carolina, involving the states of New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and North Carolina. The project received funding support from the National Sea Grant College Program through the Delaware Sea Grant Program as part of the Sea Grant Regional Initiative (NOAA Award NA08OAR4170750). The project was carried out by a research team at the University of Delaware's Gerard J. Mangone Center for Marine Policy, under the direction of the principal investigators for the project, Dr. Biliana Cicin-Sain (Director, Mangone Center, University of Delaware) and Dr. Nancy Targett (Dean, College of Earth, Ocean, and Environment, University of Delaware). The project was guided by a Steering Committee comprised of the Sea Grant leaders from the Mid-Atlantic states and other key participants.

The vision of the project was the "advancement of coordinated research that promotes economic and environmental sustainability in the Mid-Atlantic region." The project focused on five priority issue-areas that were deemed as the most pressing issues facing the ocean and coastal areas of the Mid-Atlantic region:

- Climate Change
- Offshore Energy
- Water Quality and Quantity
- Ecosystem Structure and Function
- Human Dimensions



The Mid-Atlantic Regional Ocean Research Plan was developed using a building block approach to identify priority research needs for the Mid-Atlantic region. The project team conducted a detailed literature review of 347 information sources, including reports, peer-reviewed journal articles, and strategic plans from relevant federal, state, and other entities to identify regional research needs. These research needs were coded, clustered into themes, and prioritized through a content analysis process, which included plenary and roundtable discussions by participants at a 2011 Stakeholder Workshop. Subsequent review by the project Steering Committee further refined the priorities and facilitated the preparation of an online survey.

The online survey provided an opportunity for participation by a broad community of stakeholders and practitioners in the region. Stakeholders from academia, government, industry, and non-governmental organizations, among others, were invited to participate. Two hundred-seventy (270) participants completed the survey that produced a ranked list of priorities for each issue area, and provided a basis for the final report.



Background Resources and Supporting Material

Background information on the priority issue areas and the results of the literature review are provided in the report *Development of an Ocean Research Plan for the Mid-Atlantic Region: A Technical Report*, available at <http://www.midatlanticoceanresearchplan.org/sites/www.midatlanticoceanresearchplan.org/files/u6/MidAtlanticTechnicalReport.pdf>.

The project website (<http://www.midatlanticoceanresearchplan.org>) contains a searchable database of 347 research planning documents, and details and outcomes of the stakeholder review processes.

Implementation of the research plan will be an iterative process of broad, region-wide dialogue and planning on research needs, involving all relevant stakeholders, and coordination with other regional ocean research planning projects within the Sea Grant network, as well as state and federal entities within the region. The Plan identifies priorities that foster collaboration among a full range of regional information providers and end users, and aims to provide the starting point and incentive for considering prioritized research on a regional level. The identified research needs will need to inform ongoing ocean planning activities in the Mid-Atlantic, including those of the governors of the Mid-Atlantic Regional Council on the Ocean (MARCO) and in the future implementation efforts of the NOP through the Mid-Atlantic Regional Planning Body. The next step is to engage local, state, and federal officials in discussions on an implementation strategy in order to further “the advancement of coordinated research that promotes economic and environmental sustainability in the Mid-Atlantic region.”



Research Priorities for the Mid-Atlantic Ocean Region

The project has identified the following priority research needs for the Mid-Atlantic region:

Climate Change

- 1. Sea level Rise Effects on Coastal Ecosystems:** *Determine interactive effects of human impacts on habitat conditions, hydrologic processes, and ecosystems; increase the understanding of climate change, coastal inundation, and sea level rise effects on coastal and ocean ecosystems*
- 2. Baseline Monitoring:** *Continue important existing monitoring and improve baseline monitoring for surface elevation change, including coastal subsidence and eustatic rebound rates; establish a baseline of regional marine biodiversity and ecosystem conditions*
- 3. Understand Hazard Risks:** *Carry out research to improve understanding of past, present, and future hazard risks of droughts, floods, storms, and food availability*

Offshore Energy

- 1. Establish Baseline Data:** *Establish a baseline understanding of environmental impacts; establish baseline environmental data for living resources; establish baseline data of physical environments (mapping, extreme events, climate change scenarios); map current uses to establish a baseline of sectoral needs to be used as a basis for coastal and marine spatial planning*
- 2. Technology Feasibility Assessments:** *Assess the feasibility of technology and transmission options*
- 3. Understand Socioeconomic Impacts of Offshore Energy:** *Understand the socioeconomic impacts of offshore energy development (including jobs, energy costs, infrastructure needs/impacts)*

Water Quality and Quantity

- 1. Understand Responses to Nutrient Loading and Cycling:** *Research the physiological and ecological responses and susceptibility of coastal ecosystems to nutrient loading and cycling*

- 2. Understand Response to Management Decisions:** *Build an improved understanding of coastal ecosystem response to water quality and quantity management decisions*
- 3. Coordinate Monitoring Efforts/Programs:** *Assess and identify opportunities to coordinate and improve existing water quality monitoring efforts/programs, including through the utilization of novel techniques, to improve water quality tracking parameters and the ability to forecast impairments*

Ecosystem Structure and Function

- 1. Interactions of Land-use and Ecosystems:** *Study and quantify the interactions between land-use activities and ecosystems*
- 2. Identifying Critical Habitats:** *Identify critical habitats and their management needs*
- 3. Integrate and Analyze Existing Data:** *Integrate and analyze existing data and establish the relationship between environmental data and productivity of resources*

Human Dimensions

- 1. Drivers of Behavioral Change:** *Understand how change happens at the individual, organization and decision-making process scales; understand how to translate science to management decisions; understand individual and societal tipping points; understand demographic drivers; understand incentives for change and behavior*
- 2. Vulnerability and Resilience:** *Understand community vulnerability and diversity; understand social, cultural and economic impacts of ecosystem service disruptions*
- 3. Governance and Policy Effectiveness:** *Conduct policy studies and legal analysis; Study governance designs/mechanisms, information sharing, spatial planning, and regional coordination; understand the effectiveness of community involvement; policy implementation analyses; best management practices and lessons learned*



BACKGROUND

National Ocean Policy Context

The *Development of a Regional Ocean Research Plan for the Mid-Atlantic Region* was a four-year project that began in August 2008 with funding from the National Sea Grant College Program. The project identified and analyzed research needs associated with ocean and coastal issues in the Mid-Atlantic region along the Atlantic coast, involving the states of New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and North Carolina. The effort has been guided by a Steering Committee comprised of the Sea Grant leaders from the six Mid-Atlantic states and other key participants.

In the past twenty years, there has been significant progress in the US at the regional and national levels in moving toward ecosystem-based management of ocean and coastal areas. Increasing recognition of the inherent limitations of sectoral management approaches is pushing management toward a more cross-sectoral, ecosystem-based approach. States are also beginning to articulate ocean policies for their states that balance existing, and new and emerging uses of ocean and coastal areas and their resources. To facilitate the development of a framework conducive to implementing ecosystem-based management in the US, President Obama issued Executive Order 13547 on July 19, 2010, which provides a comprehensive integrated National Ocean Policy (NOP) for the stewardship of oceans, coasts, and the Great Lakes, based on the recommendations of the White House Council on Environmental Quality Interagency Ocean Policy Task Force (Executive Order 13547, 2010).

A key component of the NOP centers on the need to ensure that decision-making related to oceans and coasts is based on the best available science, including a clear understanding of communities and ecosystems, and that objective measures are used to manage the health of oceans, coasts, and Great Lakes. It also calls for scientists who are effective communicators to translate these measures into understandable terms. In addition, the NOP outlines the development of a regional ocean planning process, involving state and federal decision-makers, scientists, industry, and the public, to achieve ecosystem-based management in all nine ocean and coastal regions of the US (Northeast, Mid-Atlantic, South Atlantic, Caribbean, Gulf of Mexico, Great Lakes, West Coast, Alaska/Arctic, and Pacific Islands).



Regional Cooperation

The National Ocean Policy clearly outlines the importance of taking a regional approach to ocean governance. The NOP specifically calls for the establishment of Regional Planning Bodies consisting of federal, state, and tribal representatives to develop regional goals, objectives, and ultimately regional Coastal and Marine Spatial (CMS) Plans. The framework establishes and describes a process by which the National Ocean Council would guide and certify the development of regional CMS plans, a method to address CMS Plans adherence and compliance, a robust information management system to allow easy access to and transparency of data and information necessary for planning, and mechanisms for frequent stakeholder and public input. Additionally, the framework describes an implementation approach that maximizes flexibility among the regions, addresses regional capacity, and aims to establish CMS Plans for all regions by 2015.



Table 1. States Included in Mid-Atlantic Ocean Planning Efforts

Mid-Atlantic Regional Council on the Ocean (MARCO)	Mid-Atlantic Regional Planning Body (RPB) of the National Ocean Policy (NOP)	Sea Grant Regional Initiative Planning States
<i>New York, New Jersey, Delaware, Maryland, Virginia</i>	<i>New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia</i>	<i>New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina</i>

Implementation of the National Ocean Policy will rely on existing legal authorities, build upon and inform current plans, projects, and decision-making, and require cooperation with state, local and tribal governments. The regional and science-based approach embodied in the National Ocean Policy provides an ideal context for expanded regional research efforts to support effective regional ocean governance and management in the US. As part of the CMS process under the NOP, the US will be subdivided into nine regional planning areas, and each region will have a corresponding Regional Planning Body (RPB) consisting of Federal, State, and tribal representatives to develop regional goals, objectives, and ultimately regional CMS Plans.

Since 2006, the National Oceanic and Atmospheric Administration (NOAA), through its National Sea Grant office, has offered opportunities for the Sea Grant programs around the nation to develop regional ocean research plans. Sea Grant engages a network of the nation’s top universities in conducting scientific research, education, training, and extension projects designed to foster science-based decisions about the conservation and management of the nation’s aquatic resources. Therefore, Sea Grant is well-placed to undertake regional research planning, given its emphasis on sound scientific research, informed and scientifically-literate stakeholders, and provision of relevant and timely information on a variety of ocean and coastal management issues.

The Sea Grant Regional Initiative was established to support the development of regional ocean research plans identifying the key ocean and coastal issues facing each region of the US, and detailing major needs for research (involving both the natural and social sciences) to support ecosystem-based management of ocean and coastal resources in each region. These plans complement the national ocean planning effort by providing a bridge between national, state and local research and information needs. The National Sea Grant College Program oversees the Sea Grant Regional Initiative and has provided funding for the development of the regional research and information plans in the following regions: Alaska, Caribbean,

Gulf of Maine, Gulf of Mexico, Insular Pacific, Mid-Atlantic, West Coast, South Atlantic, Great Lakes and the Greater New York Bight. Successful implementation of regional research plans has been closely associated with existing Governors’ regional ocean alliances, providing linkages between research and the needs of the natural resource managers.

Regional ocean management presents a number of challenges that can be addressed, in part, by the development of research plans and strategies. Funding opportunities are often limited, and research results may be applicable across a region. Cooperation, sharing of research information, and prioritization can streamline this process to ensure that research gains are maximized.

The jurisdictional boundaries defined by state lines can also pose a challenge to regional coordination and management. While regional agreements can be an effective way to ensure that information and goals are shared, there are also challenges in supporting regional goals with those of neighboring regions, states, and jurisdictions. With multiple regional research planning and management efforts along the East Coast, inter-regional cooperation and communication is important, especially in light of the fact that different regional cooperative efforts define the region differently (see Table 1). The adjacent regions to the north and south share many of the same concerns and priorities concerning ocean and coastal areas. As well, there are “border states” that participate in research and planning efforts in different regions. In the Mid-Atlantic, New Jersey, for example, participates in both the NY Bight Regional Research Plan as well as this Mid-Atlantic research planning effort. North Carolina is a part of both the Mid-Atlantic and South Atlantic Sea Grant Regional Research Planning efforts. Given the mounting evidence of species shifts between regions due to ocean warming, inter-regional communication and cooperation become increasingly important. Participation of state representatives in these boundary-spanning areas can help ensure that research and management plans are effectively integrated with the regional plans developed across the East Coast of the United States.

The Mid-Atlantic Ocean Region

This project focuses on the Mid-Atlantic region stretching from New Jersey to North Carolina. The scope of the report includes the ocean and coastal areas of the Mid-Atlantic, including estuaries and inland bays, and extends out to the limits of the continental shelf. The region is characterized by high seasonal variability, several large river and bay systems, and the coastal influence of the Gulf Stream via eddies. The ocean and coastal areas of the Mid-Atlantic region host a wide array of socially and economically important activities, and ecologically important habitats and living resources, including habitats and species associated with marine and avian migratory pathways. The Mid-Atlantic region is a critically important migratory pathway for a number of aquatic and avian species, including the endangered North Atlantic Right Whale (Knowlton, et al. 2002) and is home to the Atlantic Flyway, an important migration route for a number of species of waterfowl, pelagic birds, and songbirds of the northeastern US. (Williams, et al. 2003).

Estuarine ecosystems dominate the coastal region of the Mid-Atlantic, including the Chesapeake Bay, the Delaware Estuary, Albemarle Sound, and Pamlico Sound, which are influential in shaping the social and economic well-being of the region in many ways. The region's significant tidal wetlands are ecologically important for maintaining coastal water quality, reducing damage from coastal flooding and storms, minimizing erosion, and supporting commercially important seafood species. Watershed issues are of special concern to the coastal areas of the Mid-Atlantic, including water quality, loss of habitat, wetland restoration, sediment transport, stormwater and wastewater management, and saltwater intrusion.

The Mid-Atlantic region encompasses both rural and urban landscapes, and hosts a wide array of commercial, industrial, and agricultural activities. Many of the nation's major cities are found in the region, including Philadelphia, Baltimore, Washington, D.C., and Norfolk. Some of the coastal marine sectors of economic importance in the region include fisheries, shipbuilding, shipping, tourism, and coastal real estate. Population growth, coastal development, resource utilization, energy development, and climate change are all factors that affect the socioeconomic environment in the region.

The region is home to 45 million people and is experiencing significant population growth. The Chesapeake

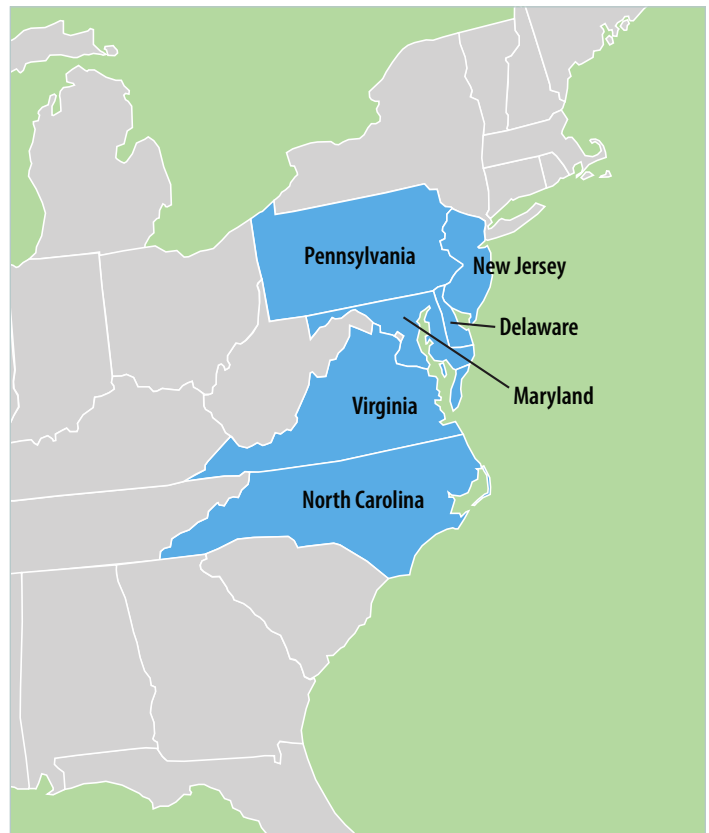


Figure 1. Mid-Atlantic States Involved in the Development of a Research Plan for the Mid-Atlantic Region

Bay area alone added 2 million people between 1980 and 2000, experiencing the highest population growth in the country during this time period (Crossett 2004). Its watershed, the second largest in the country, is home to 10 million people. The Delaware River Watershed is home to 8 million people and supplies drinking and industrial water for 15 million people (Delaware River Basin Commission 2011).

The demands of high population and the importance of both the commercial and recreational uses of the Mid-Atlantic are also key regional characteristics. The



thriving marine transportation and commercial and recreational fishing sectors are of great economic importance. However, they also pose challenges to sustainable ocean management through multiple user conflicts and continuous fishing pressure. Mid-Atlantic communities place high recreational value on their oceans and coasts, and value the conservation of open space and access to recreational opportunities in the estuaries and on the coasts. Beach nourishment and associated sand mining are a clear example of the need for science-based decision-making, and consensus among local, state, and federal jurisdictions to meet the recreational demands of residents and visitors into the future.

The Mid-Atlantic region faces a number of ongoing and emerging challenges that affect decisions on coastal management. Climate change affects the Mid-Atlantic states in a variety of ways, from impacts on large industrial and military ports to small coastal communities. Offshore wind presents a valuable opportunity for Mid-Atlantic states to reduce their greenhouse gas emissions and meet growing energy demands. The development of this industry is becoming increasingly reliant on regional cooperation to realize utility-scale grid connection. As states develop their offshore energy development plans, regional cooperation and planning in this emerging sector will be critical to realize economic gains.

States in the Mid-Atlantic are developing ocean policies that incorporate inclusive and transparent ecosystem-based ocean management. Current and new and emerging uses of the coastal zone and its resources must be balanced, while states build on their federally-approved coastal management programs.

The Mid-Atlantic states have moved rapidly toward regional cooperation in ocean management. The Mid-Atlantic Regional Council on the Ocean (MARCO), created in 2009 by declaration of the Governors of New York, New Jersey, Delaware, Maryland, and Virginia, committed to a comprehensive, regional approach to maintain and improve the health of ocean and coastal resources, and to ensure that the resources continue to contribute to the economies and quality of life of communities (MARCO 2009a). In 2009, MARCO released an action plan entitled “Actions, Timeline and Leadership to Advance the Mid-Atlantic Governors’ Agreement on Ocean Conservation,” which provides a set of actions the states will take to meet identified objectives for each of the following regional priority areas:

- Protection of important habitats and sensitive and unique offshore areas;
- Improvements in the region’s coastal water quality;
- Sustainable development of renewable energy in offshore areas; and
- Preparing for the impacts of climate change on ocean and coastal resources (MARCO 2009b).

In support of the current regional ocean planning under the National Ocean Policy, it is important to put communication channels into place for regular engagement and collaboration across critical boundary states and organizations in the implementation and subsequent iterations of the Mid-Atlantic Ocean Research Plan, in support of the National Ocean Policy and the Mid-Atlantic Regional Council on the Ocean.





Figure 2. Building Block Strategy Taken in the Sea Grant Mid-Atlantic Ocean Research Planning Project, Designed to Identify and Refine Key Research Needs in the Mid-Atlantic

METHODOLOGY

The project used a building block strategy to develop and refine research priorities over several iterations (see Figure 2), beginning with consultation with other regional research planning efforts and a review of literature.

The process of identifying the research needs of the Mid-Atlantic proceeded in a stepwise manner, in which one stage of the process informed the next, toward the production of a final set of research priorities that encompasses the needs reflected in the literature and among research experts and stakeholders. After initially interviewing those engaged in similar research planning efforts, an extensive literature review took place. Three hundred and forty seven sources of information, including reports, peer-reviewed journal articles, and strategic plans from relevant federal, state, regional, and other entities in the region were reviewed and analyzed. The literature review resulted in a synthesis of the major ocean research priorities identified in the 347 studies reflected existing issues and priorities from local, state, regional and federal levels. The research needs identified by this process were reviewed and streamlined by the Steering Committee and subsequently presented at a Stakeholder Workshop,

where they were subjected to review and comment and a prioritization process. The outcome of this workshop provided the basis of an online survey, which was sent to stakeholders across the region, for prioritization and open comment. Two hundred seventy survey responses were obtained from all of the Mid-Atlantic states. Approximately two-thirds of the survey respondents reside in coastal counties or major bays, and over 60% have resided in these counties for more than ten years. 38% of the respondents work in the academic research field, while 19% and 17% work for the federal and state governments respectively, and 16% of respondents work for non-governmental organizations. For details of the methodology, see the Appendix.

RESULTS

The results of the prioritization process are presented for each of the five major topical areas: Climate Change, Offshore Energy, Water Quality and Quantity, Ecosystem Structure and Function, and Human Dimensions. Each topical area includes the list of research priorities, a brief summary explanation of the issues in the Mid-Atlantic context, and the ranking of the research priorities for the topical area derived from the online survey.



Climate Change

Research Priorities for Climate Change

1. Sea level Rise Effects on Coastal Ecosystems:

Determine interactive effects of human impacts on habitat conditions, hydrologic processes, and ecosystems; increase the understanding of climate change, coastal inundation, and sea level rise effects on coastal and ocean ecosystems

2. Baseline monitoring: *Continue important existing monitoring and improve baseline monitoring for surface elevation change, including coastal subsidence and eustatic rebound rates; establish a baseline of regional marine biodiversity and ecosystem conditions*

3. Understand hazard risks: *Research to improve understanding of past, present, and future hazard risks of droughts, floods, storms, and food availability*

Extensive efforts to mitigate the impacts of climate change are underway at the national level, spearheaded by federal agencies and interagency groups. The US Global Change Research Program, a program that integrated the climate research efforts of NOAA, the US Environmental Protection Agency (EPA), and other federal agencies, was established to coordinate and integrate information on climactic changes in the global environment and their implications for society. The Program's landmark report, *Global Climate Change Impacts in the United States*, was released in June 2009 and outlines key findings and recommendations for how to address climate change in the US. Among the report's conclusions regarding climate change impacts on the US, it states that:

- US average temperature has risen more than 2° F over the past 50 years and is projected to continue to rise;
- Sea level rise has accelerated along most of the US coast, up to 8 inches in some areas over the past 50 years, and will continue to rise;
- Atlantic hurricanes and extreme weather events are likely to become more intense and destructive

In response to the call for better management of ocean resources, as outlined in the report of the US Commission on Ocean Policy, the National Science and Technology Council's Joint Subcommittee on Ocean Science and Technology released *Charting the Course for Ocean Science in the United States for the Next Decade* (also known as the *Ocean Research Priorities Plan*) in January 2007, which focuses on the inherent link between climate and oceans and the need for a greater understanding of this link to inform adaptation management efforts. The central climate-related findings of the report explicitly address the need to understand ocean-climate interactions and the impact of climate variability on ocean ecosystems through the use of improved and integrated observing and monitoring systems, and to apply this understanding to refine climate change projections (JSOST 2007).

Sea level rise, which is associated with increased inundation, coastal erosion, saltwater intrusion, and flooding and storm surge, poses a high risk to the low-lying coastal areas of the Mid-Atlantic. Ocean acidification and increased sea surface temperatures will impact marine and coastal ecosystems and may result in changes in marine food web structures, leading to impacts on some commercially important species. Coastal areas in the Mid-Atlantic will become more vulnerable to climate change impacts, particularly sea level rise and increased frequency and intensity of storm events, in the coming decades. These effects could also have serious impacts on the region's economic output by negatively affecting commercial fisheries and tourism. Efforts are underway at various scales in the region to address climate change and its related impacts through vulnerability assessments, data collection and research, strategic planning, policy development, and public outreach and education.

Priority Research Areas

Based upon the multi-staged research planning process involving comprehensive literature review and stakeholder engagement, the highest priority climate change

Research Priorities for Climate Change in the Mid-Atlantic Region

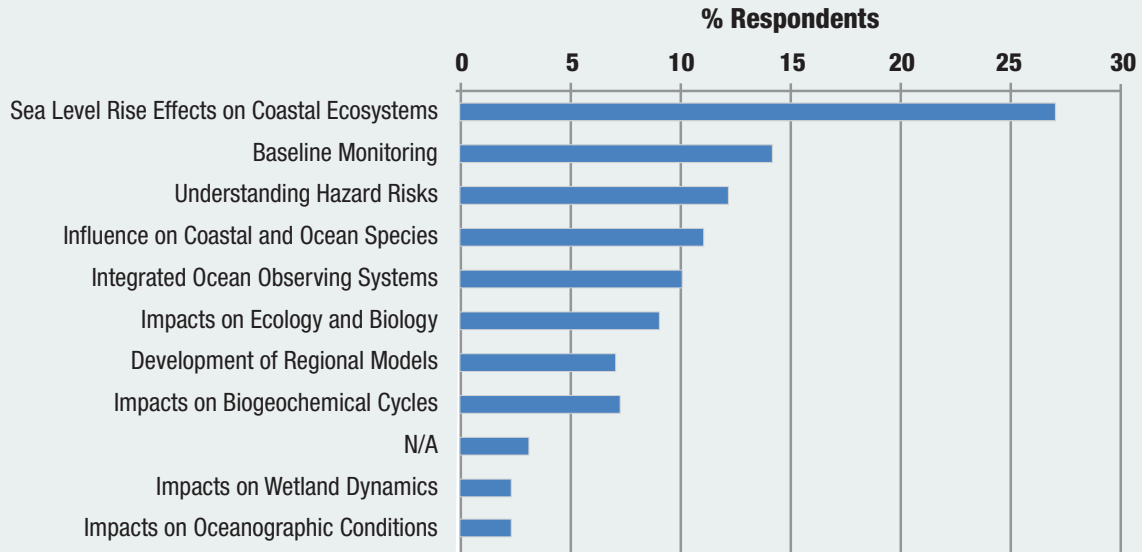


Figure 3. Prioritized List of Research Needs for Climate Change Based on the Results of the Online Survey

research needs are: **to better understand sea level rise effects on coastal ecosystems; conduct baseline monitoring; and to better understand hazard risks.**

When asked to identify their top research priority from the identified list, twenty-seven percent (27%) of the online survey respondents selected “Sea Level Rise Effects on Coastal Ecosystems”. Respondents highlighted as the second priority (14%) “Baseline Monitoring” outlining the need for monitoring of surface elevation change, including coastal subsistence and eustatic rebound rates. Incorporated into this research is the need for baseline marine biodiversity and ecosystem conditions across the region. Twelve percent (12%) of respondents selected “Understanding Hazard Risks” including for droughts, floods, storms, and food availability as their top priority. These top three priorities were also considered the top priorities in the Stakeholder Workshop ranking process, indicating a high level of agreement among the stakeholders in the region.

The following priority research areas were also gleaned from the literature and the stakeholder engagement process:

- Influence on Coastal and Ocean Species: Investigate the influences of climate change on eutrophication and ocean acidification on coastal and ocean species
- Integrated Ocean Observing Systems: Develop

integrated ocean observing systems (IOOS) to monitor and improve understanding of ocean climate interactions and impacts

- Impacts on Ecology and Biology: Understand impacts of climate variability and sea level rise on the ecology and biology of living resources in coastal and ocean ecosystems, (e.g., mortality, fecundity, recruitment, distribution, migration and predator-prey interactions)
- Development of Regional Models: Develop regional models that can generate locally valuable inundation predictions (downscaling)
- Impacts on Biogeochemical Cycles: Research to determine the impact of climate change on biogeochemical cycles
- Impacts on Wetland Dynamics: Improve the understanding of climate change on wetland accretion and sediment dynamics; track and monitor saltwater intrusion and assess impacts on estuarine ecosystems
- Impacts to Oceanographic Conditions: Research to better understand climate change impacts on wind, buoyancy, and ocean boundary conditions



Offshore Energy

Research Priorities for Offshore Energy

- 1. Establishing Baseline Data:** *Establish a baseline understanding of environmental impacts; establish baseline environmental data for living resources; establish baseline data of physical environments (mapping, extreme events, climate change scenarios); map current uses to establish a baseline of sectoral needs to be used as basis for coastal and marine spatial planning*
- 2. Technology Feasibility Assessments:** *Assess the feasibility of technology and transmission options*
- 3. Understanding Socioeconomic Impacts of Offshore Energy:** *Understand the socioeconomic impacts of offshore energy development (including jobs, energy costs, infrastructure needs/impacts)*

Offshore Energy Development

The ocean areas of the US, and of the Mid-Atlantic region in particular, are known to have suitable characteristic for energy development, including both conventional and renewable resources.

At the national level, offshore oil and gas exploitation accounts for roughly 30% of oil and 13% of natural gas production in the United States (EIA 2011). Although there are a number of refineries located in the Mid-Atlantic, there is currently no drilling on the continental shelf in this region, even though the area is not under a federal moratorium. The renewable energy industry has witnessed significant growth in the US. However, offshore renewable energy is at present a minimal component of the nation's energy repertoire. The substantial amount of renewable energy resources in the US maritime jurisdiction and the high energy demands

of large coastal populations provide a significant opportunity for development of this industry.

Offshore Oil

An area of approximately 2.9 million acres at least 50 miles off the coast of Virginia was proposed as a possible lease site in the Outer Continental Shelf (OCS) Oil and Gas Leasing Program 2007-2012 (BOEMRE 2010, Federal Register 2008). There is both strong support and opposition to conducting oil drilling in the OCS of the Mid-Atlantic region. Following the Deepwater Horizon spill in the Gulf of Mexico, there was an indefinite postponement on the comment period and cancellation of public meeting related to the EIS for the lease, (Federal Register 2010). On May 27, 2010, at the request of Secretary Salazar, President Obama announced the cancellation of the lease sale (BOEMRE 2010) and no Mid-Atlantic tracts have been included in the Proposed 2012-2017 OCS Oil and Gas Leasing Program. The exclusion is due, in part, to an undefined resource potential, out-of-date seismic surveys, and lack of infrastructure. Despite the exclusion, the Bureau of Ocean Energy Management (BOEM)¹ is facilitating resource evaluation in the Mid-Atlantic and a programmatic Environmental Impact Statement (EIS) for seismic surveys (BOEM 2010).

Offshore Wind Power

The Mid-Atlantic region has been shown to have conditions suitable for large-scale wind energy development. Researchers have estimated that the offshore wind resource of the Mid-Atlantic Bight can produce 330 GW of average electrical power per year (Kempton, et al. 2007). This resource is often close to the major cities with high energy demands in the US northeast and Great Lakes regions, which makes the region ideal for offshore wind development as a means to help meet growing energy demand. A number of Mid-Atlantic states are establishing advisory groups to provide information on the siting and monitoring of offshore wind farms. Efforts are also being made to better quantify the offshore wind resources in the region, and to build a policy framework to facilitate the development of this industry. Such efforts are considering the benefits of wind power development, as well as potential conflicts with other users and the environment. Issues being discussed include aesthetic considerations; construction of wind farms on shoals identified as beach replenishment borrow areas

¹ On October 1, 2011, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), formerly the Minerals Management Service (MMS), was replaced by the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE) as part of a major reorganization (BOEM 2011 <http://www.boemre.gov>).

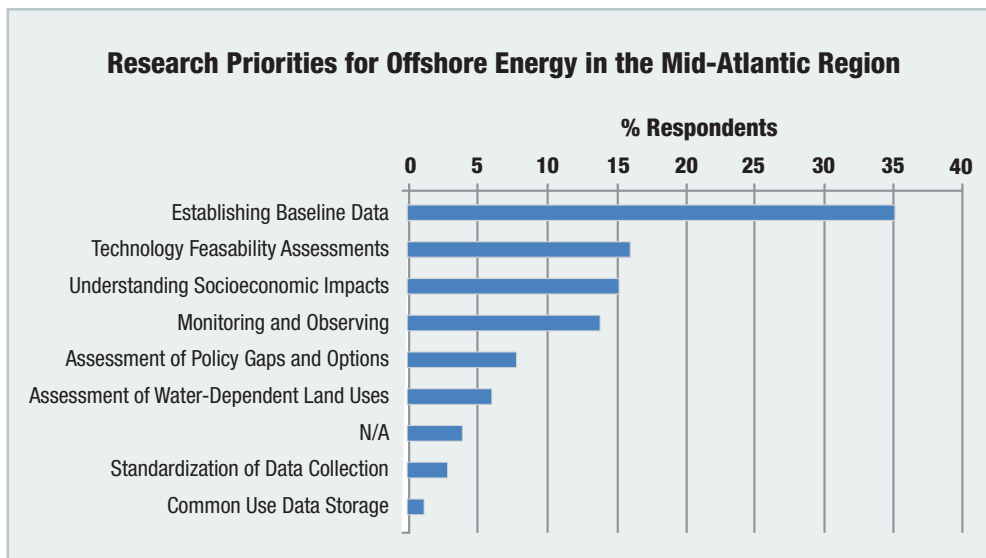


Figure 4. Prioritized List of Research Needs for Offshore Energy Based on the Results of the Online Survey

(potentially impeding access to sand resources); potential adverse effects on migratory birds and marine mammals; and potential adverse effects on tourism, commercial fishing, and navigation.

Liquefied Natural Gas (LNG)

Natural gas is gaining increasing attention as a potentially viable alternative to oil. Because domestic natural gas production is insufficient to meet demand, liquefied natural gas (LNG) is purchased overseas and shipped to the US in ocean tankers. The chemical process for conversion of LNG to gaseous form requires large volumes of cooling water, and terminals are often located along coastlines (MMS 2009). The construction and operation of coastal LNG terminals can have significant coastal impacts, including impacts from construction, pollution, and safety concerns due to the potentially explosive nature of natural gas. Currently one LNG import terminal has been approved in the Mid-Atlantic region, located south of Baltimore, Maryland, with a pipeline that will run from Baltimore to Eagle, Pennsylvania (FERC 2012a). Two additional sites have also been identified by project sponsors, all located in the Mid-Atlantic region (FERC 2012b).

Priority Research Areas

Based upon the multi-staged research planning process involving comprehensive literature review and stakeholder engagement, the following priority research needs emerged: **Establishing baseline data; technology feasibility assessments; and understanding the socioeconomic impacts of offshore energy.**

Survey respondents clearly identified the need for additional baseline offshore energy research as their first priority (35%). Environmental data for assessing environment and ecological impacts of offshore energy exploitation are needed, including living resource data, baseline physical data (mapping, extreme weather events, climate change scenarios), and additional mapping of current uses for coastal and marine spatial planning. The next priority research area was the need to assess the feasibility of new technology, including both technology and transmission feasibility (16%),

and research into the socioeconomic impacts of energy development (15%), including the impacts associated with jobs, energy costs, and the required infrastructure. Establishing baseline data and analysis of the socioeconomic impacts of offshore energy were also determined to be top priorities through the Stakeholder Workshop ranking process, along with assessment of policy gaps and options, which was identified as the top priority of 8% of the respondents in the online survey. Monitoring and observing of offshore energy potential, including the use of environmental monitoring and observing to assess and predict the potential for renewable energy, was identified as the top priority by 13% of respondents.

The following priority research areas were also gleaned from the literature and the stakeholder engagement process:

- **Assessment of Policy Gaps and Options:** Assess policy gaps and options, including the need for a consistent regulatory process and timeframe
- **Assessment of Water-dependent Land-Use:** Assess water-dependent, shore-based land-use changes associated with offshore energy; assess water-dependent offshore land-use for offshore energy (including 'green design'/clustering, multipurpose uses, pre-emptive areas)
- **Standardization of Data Collection:** Develop standardized data collection protocols
- **Common Use Data Storage:** Develop common use data storage infrastructure



Water Quality and Quantity

Research Priorities for Water Quality and Quantity

- 1. Understand Responses to Nutrient Loading and Cycling:** *Research the physiological and ecological responses and susceptibility of coastal ecosystems to nutrient loading and cycling*
- 2. Understand Response to Management Decisions:** *Build an improved understanding of coastal ecosystem response to water quality and quantity management decisions*
- 3. Coordination of Monitoring Efforts/Programs:** *Assess and identify opportunities to coordinate and improve existing water quality monitoring efforts/programs, including through the utilization of novel techniques, to improve water quality tracking parameters and the ability to forecast impairments*

In 2002, the US Commission on Ocean Policy stressed the importance of improving the nation's coastal and ocean water quality. The Commission's final report focused on the need to adequately address issues such as point and nonpoint source pollution, marine debris, and atmospheric sources of pollution, and called for improved infrastructure, and expanded and integrated water quality monitoring to achieve necessary improvements in water quality (USCOP 2004). Coastal water quality was also a central issue in the Final Recommendations of the US Interagency Ocean Policy Task Force, which were adopted by an Executive Order on July 19, 2010. The recommendations cited the need to enhance coastal and ocean water quality by promoting and implement-

ing sustainable practices on land and a commitment to coordination and cooperation among multiple sectors and management agencies (CEQ 2010).

The coastal areas of the Mid-Atlantic region are highly populated and are subject to numerous stressors from human activities. The region is home to a number of highly active ports, harbors, and coastal tourist centers, as well as vibrant agricultural and chemical industries, among others, that can contribute a significant amount of nutrients and other pollutants to the region's coasts and ocean areas. Aging wastewater management infrastructure and widespread wetlands loss (which capture pollutants from land-based sources) have exacerbated water quality challenges and have elevated coastal and ocean water quality concerns onto the entire region's agenda.

Water pollution from the concentration of ports and marinas, from upstream atmospheric deposition, from marine floatables and debris, and from wastewater and stormwater runoff, resulting largely from outdated infrastructure, all affect coastal water quality in the region. Human health may also be affected by the increase in pathogens from poorly treated wastewater and runoff. In addition, the increase in eutrophication due to nutrient over-enrichment and harmful algal blooms, or a dramatic proliferation, or "bloom," of microscopic, toxic algae, threatens ecosystem health.

Efforts to improve coastal water quality in the Mid-Atlantic have led to improvements for some indicators, including water clarity, increased dissolved oxygen in benthic areas, and decreases in heavy metals and pesticides. However, nitrogen and phosphorus loads continue to increase in the region, and impact commercial fisheries (EPA 2010). Coastal tourism is an enormous economic driver in the Mid-Atlantic, from the Outer Banks of North Carolina, up the coast through Maryland's Ocean City, Delaware's ocean beaches, and into New Jersey's "shore." Enhancing coastal and ocean water quality is a continuing challenge with increased coastal development, that is at least in part reliant on clean and healthy coasts.

Priority Research Areas

The following priority research needs for water quality and quantity emerged from the research planning process: **understand responses to nutrient loading and cycling; understand response to management decisions; and coordination of monitoring efforts and programs.**

Research Priorities for Water Quality and Quantity in the Mid-Atlantic Region

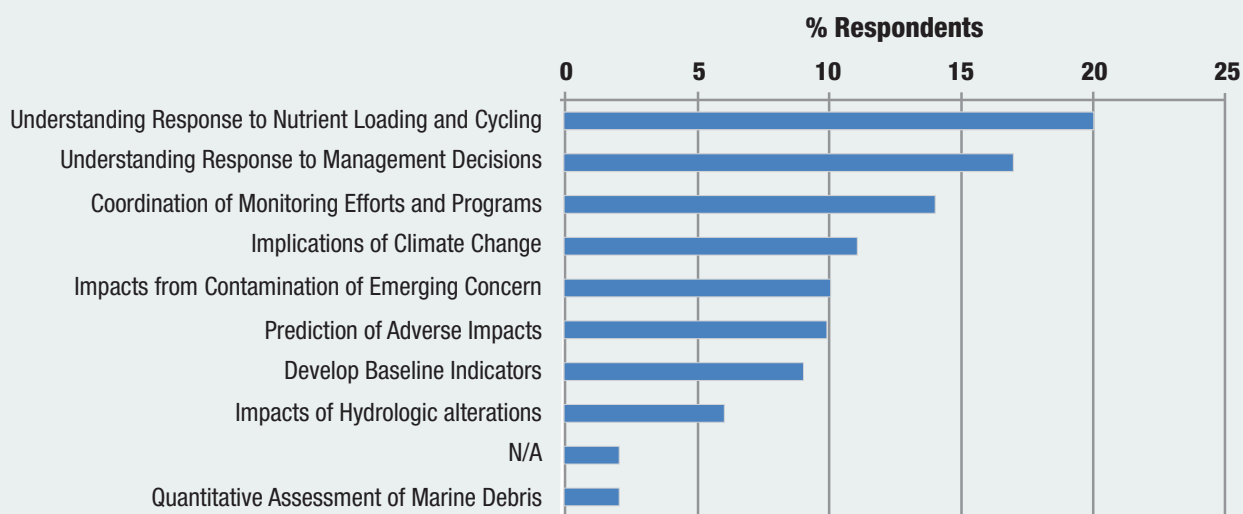


Figure 5. Prioritized List of Research Needs for Water Quality and Quantity Based on the Results of the Online Survey

Survey respondents clearly identified the need to better understand coastal ecosystem response to nutrient loading (20%), as well as the need to understand the ecosystem’s response to management decisions (17%). When these top two priorities are combined, it is clear that the survey audience recognizes the need for continued research in understanding nutrient cycling and resource management effects on water quality and quantity in the Mid-Atlantic. In addition, the respondents emphasized the need for improved coordination of monitoring programs across the region (14%). Participants in the Stakeholder Workshop ranked understanding the implications from climate change, understanding the responses to management decisions, and the coordination of monitoring efforts and programs highly. Additional research into the effects of climate change on water quality and quantity and the impacts of contaminants of emerging concern (CECs), such as pharmaceuticals, were also selected frequently as top priorities in the online survey. Ten percent of respondents identified the need for improving our ability to predict the adverse impacts of eutrophication and recovery of impacted systems.

The following priority research areas were also gleaned from the literature and the stakeholder engagement process:



- **Develop Baseline Indicators:** Develop and refine indicators to assess baseline wetland conditions relative to key wetland ecological functions and ecosystem services to support the refinement of wetland water quality standards
- **Impacts of Hydrologic Alterations:** Improve understanding of the impacts of hydrological alteration (e.g. changes in water quantity) on living resources and ecosystems
- **Quantitative Assessment of Marine Debris:** Build upon and integrate existing data to perform a quantitative assessment of the types and sources of marine debris; improve understanding of the impacts of marine debris, including derelict fishing gear, on living resources



Ecosystem Structure and Function

Research Priorities for Ecosystem Structure and Function

- 1. Interactions of Land-use and Ocean Ecosystems:** *Study and quantify the interactions between land-use activities and ocean ecosystems*
- 2. Identification of Critical Habitats:** *Identify critical habitats and their management needs*
- 3. Integration and Analysis of Existing Data:** *Integrate and analyze existing data and establish the relationship between environmental data and productivity of resources*

The coastal areas of the US are home to an abundance of natural resources, large population centers, and sensitive marine ecosystems and species. A number of key habitats in the Mid-Atlantic are of significant ecological importance and provide critical habitat, including submarine canyons, cold water corals, seagrasses, tidal marshes, and shoals. In addition, the Mid-Atlantic is home to important migratory corridors and staging areas for bird and marine mammal species. Coastal development, resource extraction, and other human uses of ocean and coastal areas can have adverse impacts on these ecosystems. Improved understanding of the complex interactions between human activities and ecosystem dynamics are needed to mitigate environmental impacts while satisfying societal needs.

Endangered and Threatened Species

The region is home to a number of species that are considered either threatened or endangered, including sea turtles, the North Atlantic right whale, and humpback whales. Five of the seven species of sea turtles found

in the world (loggerhead, Kemp's ridley, leatherback, green, and hawksbill) can be found in the Mid-Atlantic region (US FWS 2012). All five are listed as either threatened or endangered under the Endangered Species Act (ESA) (NOAA 2011). The Chesapeake Bay distinct population segment of Atlantic sturgeon is also listed as an endangered species under the ESA (NOAA 2012). Migratory corridors and pathways are critical components of essential habitat for many of the region's endangered and threatened species. Marine mammals also move through the Mid-Atlantic region during migration between southern calving grounds and northern feeding grounds. Although protected by law, these species are threatened by habitat destruction, physical harm from boats and tankers, pollution, and fishing bycatch. A better understanding of the threats to each of the species on endangered and critical species lists is necessary to improve regional management approaches.

Essential Habitat Protection and Restoration

Regional efforts are also underway in the Mid-Atlantic region to address habitat and species protection. MARCO has identified several areas of concern for habitat protection, including the protection of offshore canyons, coral reefs, and migratory pathways. There are further regional initiatives surrounding the Chesapeake and Delaware Bays. The Chesapeake Bay Program is a regional partnership aimed at the restoration of the Bay through activities designed to improve water quality, restore habitat, and improve fishery management and education. The Partnership for the Delaware Estuary is a National Estuary Program focused on increasing scientific understanding and public awareness of the health of the Delaware Estuary, which runs programs focused on oyster restoration, climate change, and regional watershed restoration.

The Magnuson-Stevens Reauthorization Act of 2007 enabled fishery management councils to become more proactive in their management of fishery species by providing them with a clear mandate to protect fish habitat from the growing threats caused by non-fishing impacts. Fishery management plans are now required to identify and describe essential fish habitat, which is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." In the Mid-Atlantic, the Lydonia, Veatch, Norfolk, and Oceanographer canyons were closed to protect essential fish habitat through the Tilefish Fishery Management Plan (FMP) (Chase 2009).

Research Priorities for Ecosystem Structure and Function in the Mid-Atlantic Region

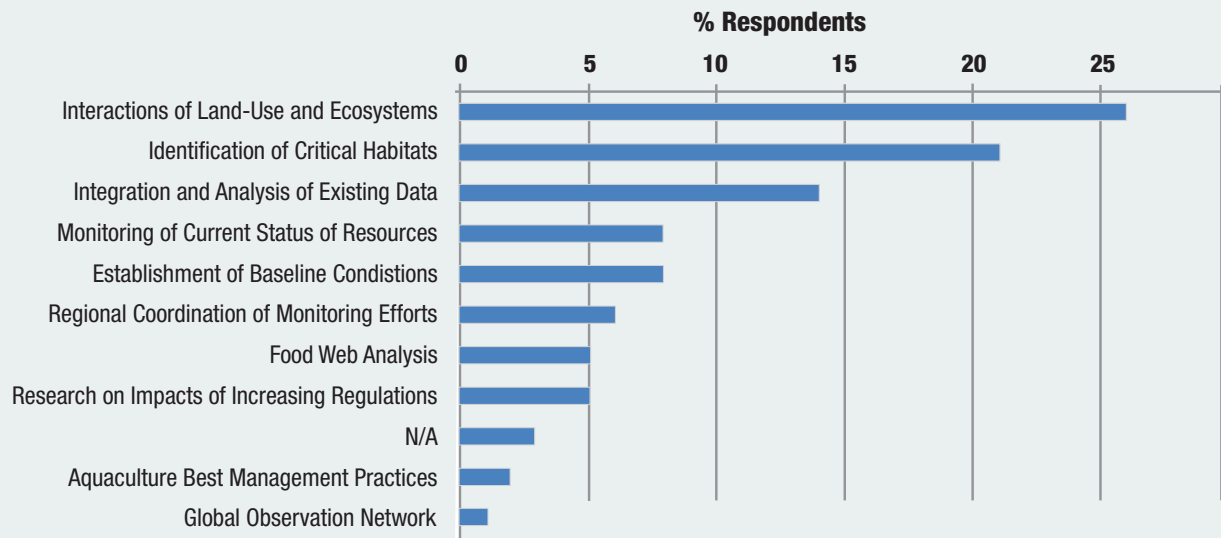


Figure 6. Prioritized List of Research Needs for Ecosystem Structure and Function Based on the Results of the Online Survey

Fisheries and Aquaculture

The Mid-Atlantic is home to many commercially and ecologically important fisheries, and many coastal towns in the region are almost wholly dependent on the fishing industry for income and livelihoods. In 2010, the Mid-Atlantic states commercial fisheries landed 386,089 metric tons of fish (an increase of more than 60 metric tons since 2008), worth \$555,153,607 (NMFS 2012). In addition to fish species, such as mackerel and flounder, crustacean and molluscan invertebrates are among the most valuable fisheries in the Mid-Atlantic. The Mid-Atlantic is also home to a rapidly growing shellfish aquaculture industry. For example, in 2010 in Virginia, the total revenue for hard clam aquaculture activities was estimated at \$25 million and \$5 million for oyster aquaculture (excluding spat on shell production) (Murray and Hudson 2011).

Priority Research Areas

Based upon the multi-staged research planning process involving comprehensive literature review and stakeholder engagement, the highest priority research needs for ecosystem structure and function are: **interactions of land-use and ocean ecosystems; identification of critical habitat; and integration and analysis of existing data.**

Of the survey choices presented, respondents most frequently selected the need to better understand interactions between land-use and ecosystems (27%). Research

to identify critical habitats was also a frequently chosen top priority (21%). In addition, integration and analysis of existing data was highlighted (14%), indicating that some of the participants felt that current efforts could be more effective with improved coordination. Participants in the Stakeholder Workshop also identified the interactions of land-use and ecosystems and the identification of critical habitats as top priorities. Current status of resources and establishment of baseline conditions were two clearly related research priorities that encompassed 16% of the responses.

The following priority research areas were also gleaned from the literature and the stakeholder engagement process:

- **Regional Coordination of Monitoring Efforts:** Coordinate monitoring efforts regionally; identify and analyze existing data; establish baselines; assess climate change impacts
- **Food Web Analyses**
- **Research on Impacts of Increasing Regulation:** Determine impacts of increasing regulation of human use on ecosystems
- **Aquaculture Best Management Practices:** Create aquaculture best management practices and programs
- **Global Observation Network:** Create and maintain a global observation network of chemical and biological sensors



Human Dimensions

Research Priorities for Human Dimensions

- 1. Drivers of Behavioral Change:** *Understand how change happens at the individual, organization, and decision-making process scales; understand how to translate science to management decisions; understand individual and societal tipping points; understand demographic drivers; understand incentives for change and behavior*
- 2. Vulnerability and Resilience:** *Understand community vulnerability and diversity; understand social, cultural, and economic impacts of ecosystem service disruptions*
- 3. Governance and Policy Effectiveness:** *Conduct policy studies and legal analysis; study governance designs/mechanisms, information sharing, spatial planning, and regional coordination; understand the effectiveness of community involvement; policy implementation analyses; best management practices and lessons learned*

What is “Human Dimensions”?

The general term, “Human Dimensions,” is comprised of the broad suite of social science disciplines that address the social, economic, cultural, political, and institutional dynamics of an issue, in this case, coastal and marine resource issues. Based upon the research questions of interest, the focus could be on the human dimensions as the dependent variables (e.g., the impact of climate change on the social, economic, cultural, political, or institutional fabric of a coastal community), or as the independent variables (e.g., the demographic

and land-use development patterns in communities that impact the quality and quantity of water). Further, human dimension research could look at social science factors as both dependent and independent variables within the context of coastal and marine issues. For example, how might certain policy and institutional changes, such as regulatory, legal, or voluntary incentives or communication and outreach strategies, influence individual, organizational or institutional behavior (e.g., pesticide applications on homeowner’s lawns, or acceptance of climate or fisheries science).

The Mid-Atlantic region encompasses both rural and urban landscapes, with large areas devoted to agriculture and forestry, as well as the major metropolitan urban and suburban areas, including Newark, Philadelphia-Camden-Wilmington, Baltimore-Washington-Northern Virginia, and Norfolk-Virginia Beach-Newport News. A number of factors drive socioeconomic conditions in the Mid-Atlantic, including population growth, expanding and contracting economic activities, coastal and land-use development, and diversity of cultural and social groups.

To date, there has been little systematic assessment of these complex, interconnected social issues and the resulting human dimensions research needs and priorities, and the need for such research is urgent (STAC 2011).

Understanding Individuals

Psychologists, economists, social market researchers, and other social scientists assess how individuals behave, why they behave that way, and what incentives, barriers, and other factors influence behavior change. The review of the literature and the extensive stakeholder engagement process highlighted, for example, the need to better understand how individuals value coastal and marine resources and ecosystem services, in economic and non-economic ways. Likewise, there is interest in examining the impacts on individuals (e.g., livelihood, health, vulnerability) from coastal, marine, and ocean policy actions.

Understanding Communities

Sociologists, anthropologists, planners, and other social scientists focus on group-scale and community-scale factors, such as communities of practice, sense of place, and cultural heritage, and how these factors guide behavior. In the same manner as individual-level variables, community factors can impact the suite of policy options best suited for a particular coastal or marine

Research Priorities for Human Dimensions in the Mid-Atlantic Region

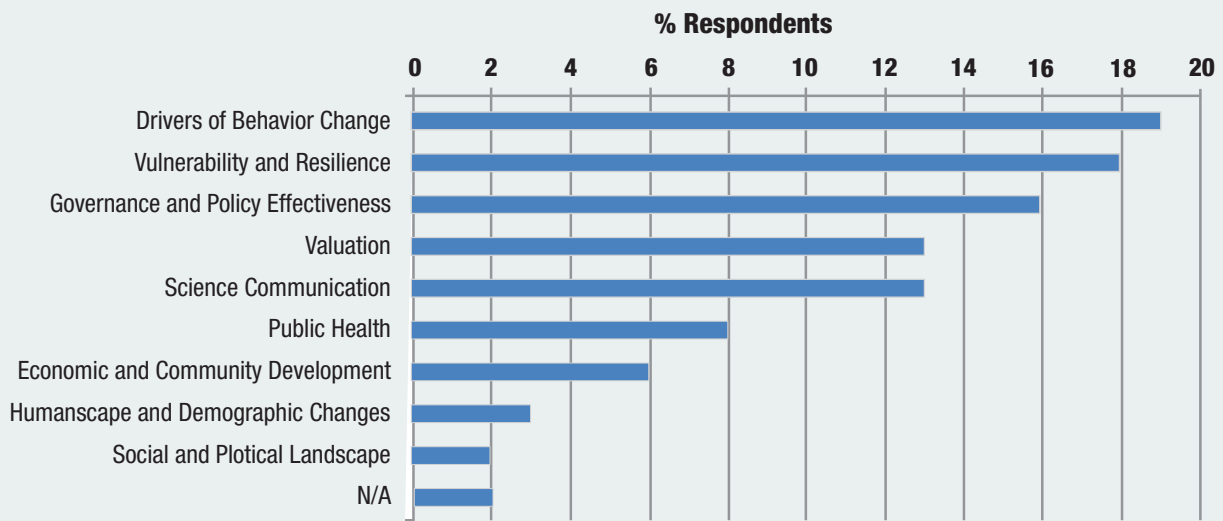


Figure 7. Prioritized List of Research Needs for Human Dimensions Based on the Results of the Online Survey

problem or place. For instance, cultural heritage could create a predisposition to certain fishing gear modifications. Alternatively, this type of research could focus on understanding whether community-scale factors are impacted by or changed as a result of coastal, marine and ocean policy and management decisions.

Understanding Institutions

Organizational psychologists, public administration and policy scholars, legal professors, and other social scientists study societal and institutional-level factors. Examples include the significance of professional and organizational norms and cultures, legal and governance frameworks, and social networks. Institutional variables (sometimes called “governance variables”) influence the suite of effective policy and management options, and are also impacted by policy implementation and management choices, including the science-to-management process.

Integrating Social and Natural Sciences

Collectively, the fundamental understanding of human, group, and organizational behavior and the individual, group, community, and institutional factors at play contribute to solving critical problems in our coastal, marine and ocean environment. In the Mid-Atlantic regional research planning process, there was clear evidence from the literature and from stakeholder input that human dimensions research could inform and improve science and policy integration, including

communicating science to the general public, elected officials, resource managers and other audiences; effectiveness of alternative policy, legal, regulatory, or other governance designs; and the research and development efforts to build innovative strategic solutions to pressing coastal and ocean problems. Further, cutting-edge human dimensions research is examining and modeling coupled human-natural systems, developing bio-economic modeling, and understanding the relationship of ecosystem services to economic and non-economic societal values, as well as to the natural systems’ structure and function. The extent to which solutions will be embraced and adopted by society depends on how they align with the human dimensions of community. Understanding the foundation for these inherent human biases and behaviors is critical to the effectiveness of coastal, marine, and ocean policy.

Priority Research Areas

The following priority research areas for human dimensions were identified through the research planning process: **understanding drivers of behavioral change; research on community vulnerability and resilience; and studies on governance and policy effectiveness.**

Survey respondents most frequently identified research to better understand the drivers of behavioral change, including consideration of how change happens at individual, organizational, and decision-making process scales, as their top priority (20%). This research cate-

gory specifically included research to better understand how science translates to resource management, understanding of “tipping points,” incentives for change and behavior, and demographic drivers. Nearly as important to survey respondents (19%) was research aimed at understanding community vulnerability and resilience, and in particular the social, cultural and economic impacts of ecosystem service disruptions. Support for policy studies and legal analysis to better understand governance and policy effectiveness was a common response among respondents (16%), and included topics such as information sharing, best management practices, and policy and implementation analyses. The top three research priorities identified through the online survey are the same top priorities that emerged from the Stakeholder Workshop ranking process.

The following priority research areas were also gleaned from the literature and the stakeholder engagement process:

- Valuation: Identify the value of ecosystem services; economic and non-economic value; understand benefits/costs, including avoided costs; understand the differences of ecosystem value among stakeholders and resulting user conflicts
- Science Communication: Understand individual perceptions, attitudes, awareness, and cultural

models; understand the role of communicators and receivers of science information; understand the effectiveness of existing and new communication methods; understand the role of human cognition societal tipping points; understand demographic drivers; understand incentives for change and behavior

- Public Health: Understand the social, cultural, and economic impact on human health and well-being from the array of Mid-Atlantic climate, energy, water, ecosystem and living resource issues
- Economic and Community Development: Conduct products and market analysis and development; research and development for green job development and sustainable resource use
- Humanscape and Demographic Changes: Understand social, cultural and economic drivers and impacts for demographic changes
- Social and Political Landscape: Study community structure and opinion leaders; understand the role and place of science and scientists



ISSUES IN IMPLEMENTATION OF THE REGIONAL OCEAN RESEARCH PLAN

Regional research planning efforts aim to help state and federal agencies with management authority in considering local, state, and national viewpoints as they formulate and implement long-term research efforts throughout the region. The Mid-Atlantic Regional Ocean Research Plan addresses the interdisciplinary needs (natural science, social science, policy) for ecosystem-based management of the ocean in the Mid-Atlantic region. It is anticipated that an iterative process of dialogue and planning on research needs and implementation will serve to support the development and implementation of a regional ocean governance plan through the Regional Planning Body (RPB) within the framework of the National Ocean Policy, and support the ocean planning efforts of MARCO. It will also need to be nested within adjacent regional research planning in the New York Bight and Southeastern Atlantic, supporting boundary-spanning states and organizations.

Lessons from Implementation of Other Regional Ocean Research Efforts

The Mid-Atlantic is among the last regions to undertake regional ocean research planning and is in a position to benefit from the lessons learned in other regional research planning efforts in the development of an implementation plan. Some salient examples are noted below.

1) Creation of a regional research network. The Great Lakes Regional Research Information Network (GLRRIN) was created as a network mechanism for government, academic, and private research programs in the Great Lakes region to foster research coordination within the region by enhancing communication and collaboration among agencies and research scientists. Through tools such as an enhanced database of researchers listed by interest and expertise, GLRRIN adds value to existing programs and brings projects and researchers together in one comprehensive network, providing a means to foster collaboration, acquire funding, and increase the impact of Great Lakes research (GLRRIN 2012). Following the approach of the Great Lakes, the South Atlantic Regional Research Planning (SARRP) Regional Advisory Group, instrumental in the production of the South Atlantic Plan, will continue as an informal network to encourage individual investigators to



address these priorities and to explore coordinated funding opportunities (Laporte, et al. 2010).

2) Identifying existing, synergistic funding opportunities. For all regional ocean research planning efforts, funding is considered critical to moving forward and will require collaborative efforts and pooling of agency and organizational resources around critical elements of the plan of mutual interest. To implement the Gulf of Mexico Regional Marine Research Plan, it was considered essential that the research community recognize opportunities in funding partnerships to optimize the use of expertise and limited resources throughout the region. For the Gulf of Maine Strategic Regional Ocean Science Plan, this took the form of a mix of peer-reviewed funded research, collaborative efforts with agencies that support regional projects, and efforts to secure long-term funding for ecosystem-based management in the Gulf of Maine. Potential funding sources and regional projects were identified, including: 1) national ocean research funders; 2) federal funding of regional studies; 3) local and sub-regional projects; and 4) Sea Grant Regional Research Projects, which are peer-reviewed research projects reflecting each





program's priorities, and are consistent with the National Sea Grant College Program's and NOAA's strategic plans (NOAA 2007a; Sempier, et al. 2009).

3) Recognizing the leadership of Sea Grant programs in ocean research in the implementation of the plan. Although regional ocean research planning efforts have been led by Sea Grant programs, the resulting plans are not *per se* regional Sea Grant plans. However, it is important to emphasize, as in the West Coast Regional Research and Information Plan, the role of each Sea Grant program in the planning process and implementation, since each program has worked with coastal communities in its state for decades to conduct scientific research, education, training, and extension projects designed to foster science-based decisions about the use and conservation of aquatic resources in their region. With strong connections to the full range of individuals who study, manage, and rely upon coastal and ocean resources, the Sea Grant programs are in a good position to initiate regional research planning efforts that integrate the concerns, priorities, and expertise of all interests and sectors as well as leading the implementation of the Mid-Atlantic Regional Ocean Research Plan (Risien 2009).

4) Communicating the plan. The South Atlantic Regional Research Project process aimed to share the research plan broadly with other organizations, institutions, agencies and researchers whose involvement will be necessary to implement the plan, including the Southeast Coastal Ocean Observing Regional Association (SECOORA), Centers for Ocean Sciences Education Excellence – South East (COSEE-SE), the National Estuarine Research Reserves, Sea Grant, and Sea Grant Extension, as these have strong outreach components, ensuring that the



plan will reach a wide variety of potential end-users (Laporte 2010).

5) Aligning priority research areas with priority actions identified by regional political alliances.

The National Sea Grant College Program closely monitors how the regional ocean research planning efforts are faring. Through periodic conference calls, lead organizations share progress in planning and implementation. Among the lessons identified in initial implementation efforts is that the plans that are closely linked to the regional political alliances move forward faster.

6) Identifying the comparative advantage of other key regional actors in implementing specific priority research areas.

The Gulf of Maine and South Atlantic Plans collected information describing ongoing or planned activities that are relevant to each priority and have identified research topics specifically aligned with the missions of particular agencies and organizations. In the Mid-Atlantic, in addition to MARCO, a number of sectoral authorities oversee the management of ocean and coastal resources at the regional level, including the Atlantic States Marine Fisheries Commission (ASMFC) and the Mid-Atlantic Fishery Management Council (MAFMC). The Mid-Atlantic Regional Association for Coastal Ocean Observing System (MARACOOS), a regional organization that focuses on coastal and ocean observations from Cape Cod, Massachusetts to Cape Hatteras, North Carolina, acts as a vital mechanism for coordinating the research efforts related to observation systems, scientists, and stakeholders.

An ecosystem-based approach is also being defined at the regional level through analytical and political efforts. The Nature Conservancy (TNC) is completing the Northwest Atlantic Marine Ecoregional Assess-



ment to identify habitats, species, and ecosystem processes for conservation in the Mid-Atlantic, including the creation of a database and detailed map layers of this information (Greene, et al. 2010). The collected information will be used to develop conservation targets and goals for the region.

Promoting a Region-Wide Dialogue on Research Plan Implementation

The most essential next step in implementing the Research Plan is to promote a broad, region-wide dialogue to enhance information sharing among research funders, scientists, local, state and federal managers, and other stakeholders, and to identify challenges and opportunities. Establishing these communication channels will enable collaboration, support boundary-spanning, and advance science-to-management impacts through a more nested set of research networks. Part of the strategy for the implementation of the Research Plan is for relevant agencies in the region to exchange information regarding their research funding priorities, and the nature and level of research support (e.g., human resources, facilities) that they could make available in carrying out specific research priorities as identified in the Research Plan, as a prelude to collaboration. This exchange of information is all the more relevant in light of the National Ocean Policy's support for research needed to advance regional ocean planning.

Inclusion of Local Governments and Communities in the Implementation Plan

Another important aspect of the implementation of the plan will be to ensure the engagement of local entities (counties, cities, and municipalities). In many cases, local groups have been addressing these research priorities in their communities, and they will have valuable lessons



learned, reflections, and insights into the most pressing and emerging ocean and coastal issues and research questions. These individuals need to be included in regional discussions, and can provide additional data that may have previously been unavailable. Coastal resource decision-making will take place, in part, at the local level, so regional research efforts must facilitate communication between researchers and local-level decision-makers.

Addressing Common Regional Research Priorities, Research Priorities Unique to the Mid-Atlantic, and Transboundary Problems and Challenges

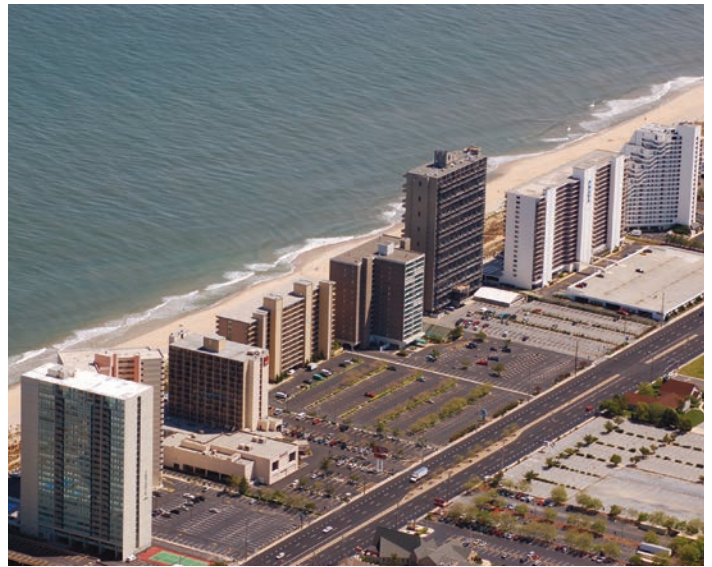
Coordination with other regional ocean research planning projects within the Sea Grant network, as well as state and federal entities within the region, will continue to be important. Implementation of the research priorities identified in this project should seek to align with other planning and monitoring efforts across the region, and possibly between regions. These could lead to the identification of intra-regional and inter-regional commonalities in research priorities, which could serve as a basis for collaborative regional/inter-regional research initiatives. Box 1 provides an overview of the common regional research priorities between the Mid-Atlantic and other Sea Grant Regional Initiatives across the East Coast.

Regional research plans also include priority research areas that transcend political and disciplinary boundaries. These include, for example, aquatic nuisance species and point source and non-point source pollution, and other transboundary issues identified through the Large Marine Ecosystem (LME) approach in the Northeast Atlantic (through transboundary diagnostic analysis and strategic action programs). Developing collaborative research implementation approaches is particularly

needed in addressing these types of priority research areas in the Mid-Atlantic.

Engagement With, and Support of, Regional Ocean Planning/Governance

More formal integration of regional research planning efforts with the regional ocean planning entities has been important in securing funding in other regions. For successful implementation, the identified research needs will need to inform ongoing ocean planning activities in the Mid-Atlantic, including those of MARCO and in the future implementation efforts of the National Ocean Policy through the Mid-Atlantic Regional Planning Body.



Box 1. Comparison of Regional Research Priorities Along the US Atlantic Coast

Regional research priorities that emerged from the Sea Grant Regional Ocean Research Planning efforts in the Gulf of Maine and the South Atlantic were analyzed for points of commonality in the following areas: climate disruption, mapping, monitoring, and modeling, policy, management, economics, and politics, and ecosystem science. At the time of analysis, information on the New York Bight was not available.

Climate Disruption

There was consensus among the plans on the need for development and improvement of coastal inundation models. All plans also noted the need to address sea level rise impacts on ecological communities and habitats, whereas the Mid-Atlantic plan also indicated a need for improved understanding of sediment and wetland dynamics, in addition to oceanographic conditions and biogeochemical cycles. Secondary effects of climate disruption were also unique to the Mid-Atlantic Plan. Risk-based management was important in both the Gulf of Maine and South Atlantic Plans.

Mapping, Monitoring, and Modeling

The need for integrated ocean monitoring was identified as a priority in all of the plans, as was the need to identify and map ocean resources, including ecological, biological, and cultural resources. The establishment of baseline data was identified as important in the Gulf of Maine, South Atlantic, and Mid-Atlantic planning efforts, whereas the Gulf of Maine and South Florida Plans identified sources and fates of pollutants as a high priority. The need to address data gaps for improved modeling was identified in the Mid-Atlantic, while the South Atlantic called for improvement and expansion of biological and physical models.

Policy, Management, Economics, and Politics

All reports highlighted the need for research on the socio-economic impacts of offshore energy development. In addition, understanding the vulnerabilities of coastal communities was identified as important in the Gulf of Maine, South Atlantic, and Mid-Atlantic planning efforts. Economic valuation is a priority in all areas, although the Gulf of Maine and South Atlantic Plans focused on ecosystem services, whereas the Mid-Atlantic Plan focused on natural hazard impact valuation. Demographic and socioeconomic research is needed in all regions to understand human uses, impacts, and drivers. Both the Mid-Atlantic and South Atlantic reports took note of the need for improved scientific communication. Sustainable development was identified as a research area in all plans, and centered around the pressures of coastal development in the Gulf of Maine and South Atlantic, and “green” development in the Mid-Atlantic. The Mid-Atlantic Plan is unique in its identification of governance and policy effectiveness as a research priority.

Ecosystem Science

The response of coastal ecosystems to restoration and management activities was a priority in all plans. While the South Atlantic Plan focused on the linkage and interdependence in this area at the ecosystem level, the Mid-Atlantic Plan focused on food web interactions. The need to understand the effects of nutrification was noted in both of these plans, as was improved understanding of water budgets and hydrological ocean inputs. Land-use and land-use change analysis were also prioritized in each of these plans. The Gulf of Maine Plan highlighted the need to collect data to inform ecosystem-based management planning.

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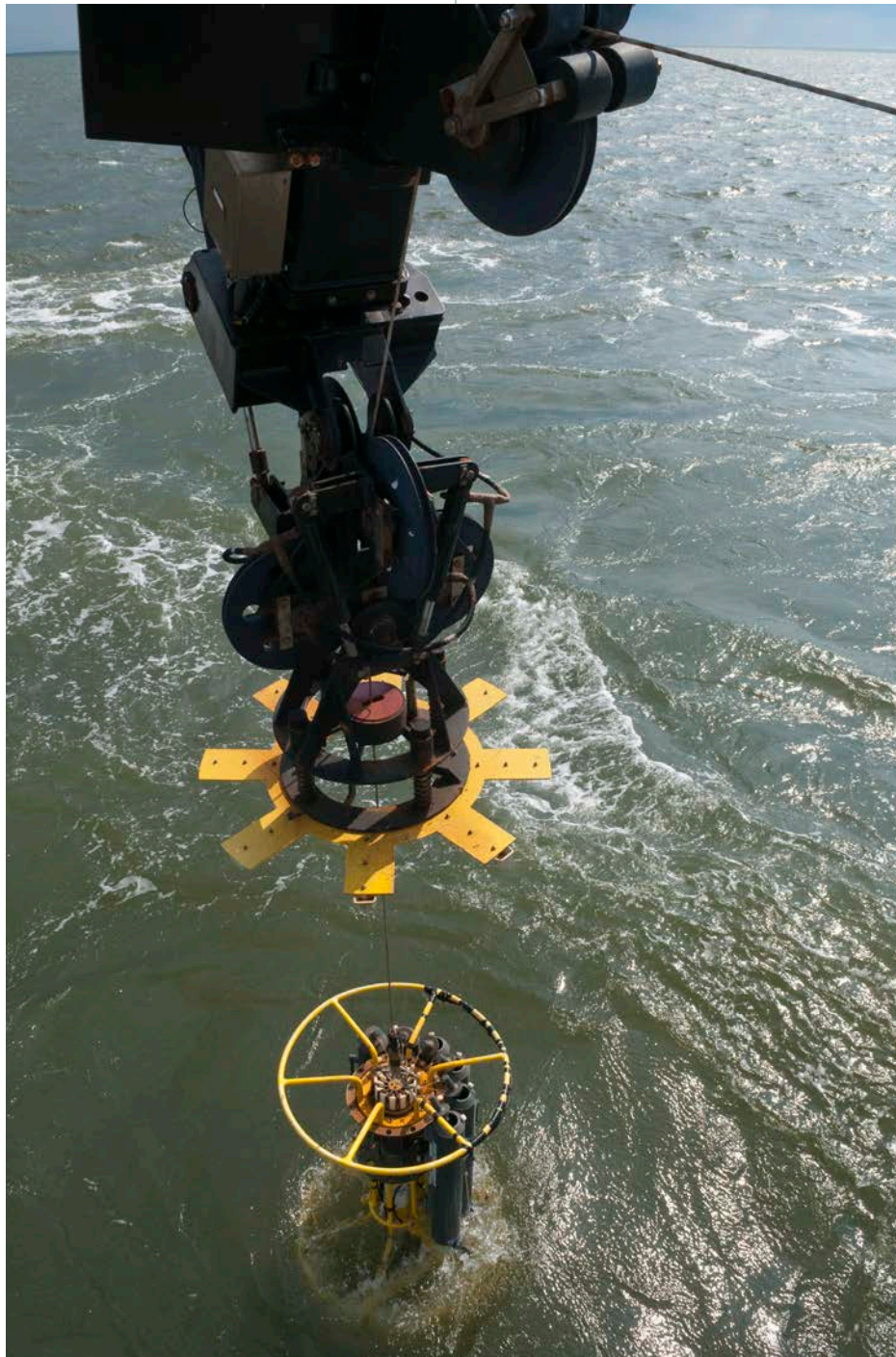
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APPENDIX. DETAILED METHODOLOGY

This Appendix reviews the major steps followed in the preparation of the Mid-Atlantic Regional Ocean Research Plan.

Initial Interviews with Key Stakeholders in Other US Coastal Regions

To inform the development of the Mid-Atlantic Regional Ocean Research Plan, the coordinators for each of the Sea Grant regional research efforts around the country were contacted at the outset of the project in Fall 2008. The coordinators were asked about the procedural steps in forming the research plan, the coordinating entity, research methods and participants, the form of the final research plan, identified issue-areas and potential overlap, stakeholder and public participation, and advice and lessons learned. Responses were received from six regions: Gulf of Mexico, South Atlantic, North East, Great Lakes, Pacific Coast, and Alaska. Details from this process are available on the project website in the information document “Regional Sea Grant Research Planning Analysis” (http://www.midatlanticoceanresearchplan.org/MAORP/sites/udel.edu.MAORP/files/u6/Regional_Sea_Grant_Research_Analysis.pdf).

Development of Priority Areas

An initial set of ocean and coastal issue-areas was developed based on research priorities identified in three “benchmark documents,” the 1994 Mid-Atlantic Regional Marine Research Plan, the 2007 Ocean Research Priorities Plan (ORPP), and the 2009 Mid-Atlantic Regional Council on the Ocean (MARCO) Agreement, as well as on other documents relevant to the study (e.g., Summary of 2008 Mid-Atlantic Regional Ocean Forum, ocean research plans from other regions). Additional and emerging topics that are not addressed in those documents were added during the course of the analysis. This initial outline of the major issues to be covered was also used in searching for pertinent publications and other literature.

Detailed Literature Review and Technical Report

This phase of the project involved the collection of 347 information sources, including reports, peer-reviewed journal articles, and agency strategic plans from relevant federal, state, and other entities in the region, each of which was assessed for validity and subjected to a content analysis procedure. These information sources were analyzed for explicit or implicit statements in-

dicating research needs for ocean and coastal areas in the Mid-Atlantic region. This literature review was the basis for the development of a detailed Technical Report, entitled “Development of an Ocean Research Plan for the Mid-Atlantic Region: A Technical Report” (available at: <http://www.midatlanticoceanresearchplan.org/sites/www.midatlanticoceanresearchplan.org/files/u6/MidAtlanticTechnicalReport.pdf>). These information resources were included in an online, searchable reference database that was modified, updated, and expanded throughout the project and is available online on the project website at www.midatlanticoceanresearchplan.org.

A Sea Grant Mid-Atlantic Ocean Research Planning Project Informal Expert Consultation Meeting convened 21 Sea Grant Directors and experts from the Mid-Atlantic at NOAA, Silver Spring, MD, on January 7, 2010. The meeting provided further advice and guidance in the development of a regional research plan for the Mid-Atlantic ocean region, which included: 1) clarifying the precise target audiences of the report; 2) carrying out a suitable process of stakeholder consultation to enhance, refine, and develop in greater operational detail the research recommendations in the various categories, as well as options for carrying out the needed research done; 3) highlighting the regional issues with a greater emphasis on “on-the-ground” issues which concern the citizens of the region, and identifying the corresponding research needs; and 4) differentiating the research needs as to whether they are natural science, social science, or policy research needs (as well as which are long-term needs and which are short-term needs).

The primary output of the literature review was the development of large tables, or matrices, that outline ocean and coastal research needs in the areas of natural science, social science, and policy for each of the four main issue-areas—climate change, offshore renewable energy, water quality and quantity, and living resources and habitat structure and function.

These tables were then streamlined into summary tables and included in the project technical report. The summary tables were reviewed and refined by the Project Steering Committee as well as an advisory group that convened on September 29, 2010. The compendium on the emerging priority research areas for the Mid-Atlantic ocean region was prepared as a document entitled “Towards a Mid-Atlantic Ocean Research Plan: Stakeholder Briefing Book” (available at: <http://www.midatlanticoceanresearchplan.org/sites/>

midatlanticoceanresearchplan.org/files/u6/Mid-Atlantic-Stakeholder-Briefing-Book.pdf), geared toward the next steps of stakeholder consultation.

Stakeholder Consultation Workshop

Next, the project sought the input and review of stakeholders in the Mid-Atlantic region. The Mid-Atlantic Regional Ocean Research Plan Stakeholder Consultation Workshop was held in July 2011, in Baltimore, MD and was attended by over 40 stakeholders from the national, regional, and state levels in the Mid-Atlantic region. The workshop aimed to give stakeholders an opportunity to provide substantive input to the draft Mid Atlantic Regional Ocean Research Plan through targeted discussions, breakout sessions, and an interactive voting process.

Research priorities identified in the draft Research Plan were provided to the workshop participants in the Stakeholder Briefing Book. Participants were divided into five breakout groups, moderated by members of the Project Steering Committee, to discuss, streamline, and revise the research needs identified from the literature review and refined by the Steering Committee.

Then, using an electronic voting system, the participants answered questions within each priority area in order to determine which of the research needs was most pressing. They were asked to consider the following questions in ranking the top three priorities.

- Which of the following research priorities do you feel best addresses an existing data gap?
- Which of the following research priorities best addresses an urgent ocean issue or concern?
- Which of the following research priorities best addresses a concern that is important to coastal communities?

The results from the voting process provided a perspective of the group of stakeholders present on the issues that were most important to them, based on several different criteria. Please refer to the workshop summary report for the workshop proceedings, breakout and voting procedures, and outcomes (available at: http://www.midatlanticoceanresearchplan.org/sites/midatlanticoceanresearchplan.org/files/u6/Mid-Atlantic_StakeholderWorkshopSummary.pdf).

Stakeholder Web-based Survey and Open Comment Period

The next step in the development of the Mid-Atlantic Regional Ocean Research Plan was the development and distribution of an online survey to gather further stakeholder input on the identified research priorities. This survey was distributed to a wide range of stakeholders, including scientists, policymakers, nongovernmental organizations, and industry, among others, and was open for a period of one month.

The survey questions were derived from the needs identified by the previous literature review and the prioritized list that emanated from the Stakeholder Consultation Workshop. The survey was designed to provide stakeholders with the opportunity to anonymously provide their input on the research needs that they felt were the most important for each of the priority areas. The survey was also designed to allow stakeholders the ability to indicate their most important, two most important, and two least important research needs, in order to provide a picture of the range of importance for each research need. Finally, the survey provided stakeholders with the opportunity to provide open-ended comments on each priority area, which allowed for the expression of research needs that may have been excluded from the survey. The list of prioritized research needs from the workshop process is provided in this report.

The survey was distributed to members of three separate email lists, with a total of 2,125 members, with approximately 30% of the emails returned due to outdated email addresses. The survey was also distributed by several partner Sea Grant programs, and links to the survey were posted on several Sea Grant websites. The survey invitation also requested that participants forward the survey to any interested parties. The final number of survey responses was 270.

The prioritized research needs from the workshop process and survey are provided in this report.

Photos courtesy of the University of Delaware Marine Public Education Office (UD MPEO) and B.Truitt/TNC:

p. vi, M. Oliver; p. 1, T. Beeson; p. 3, L. Tossey; T. Beeson; B.Truitt/TNC: p. 4, M. Oliver; p. 7, T. Beeson; p.10, UD MPEO staff; p. 12, T. Beeson; p. 14, L. Tossey; p. 16, UD MPEO staff; p. 18 L. Tossey; p. 21, L. Tossey; p. 22, L. Tossey, UD MPEO staff; p. 23 right, T. Beeson; p. 26, E. Krape

