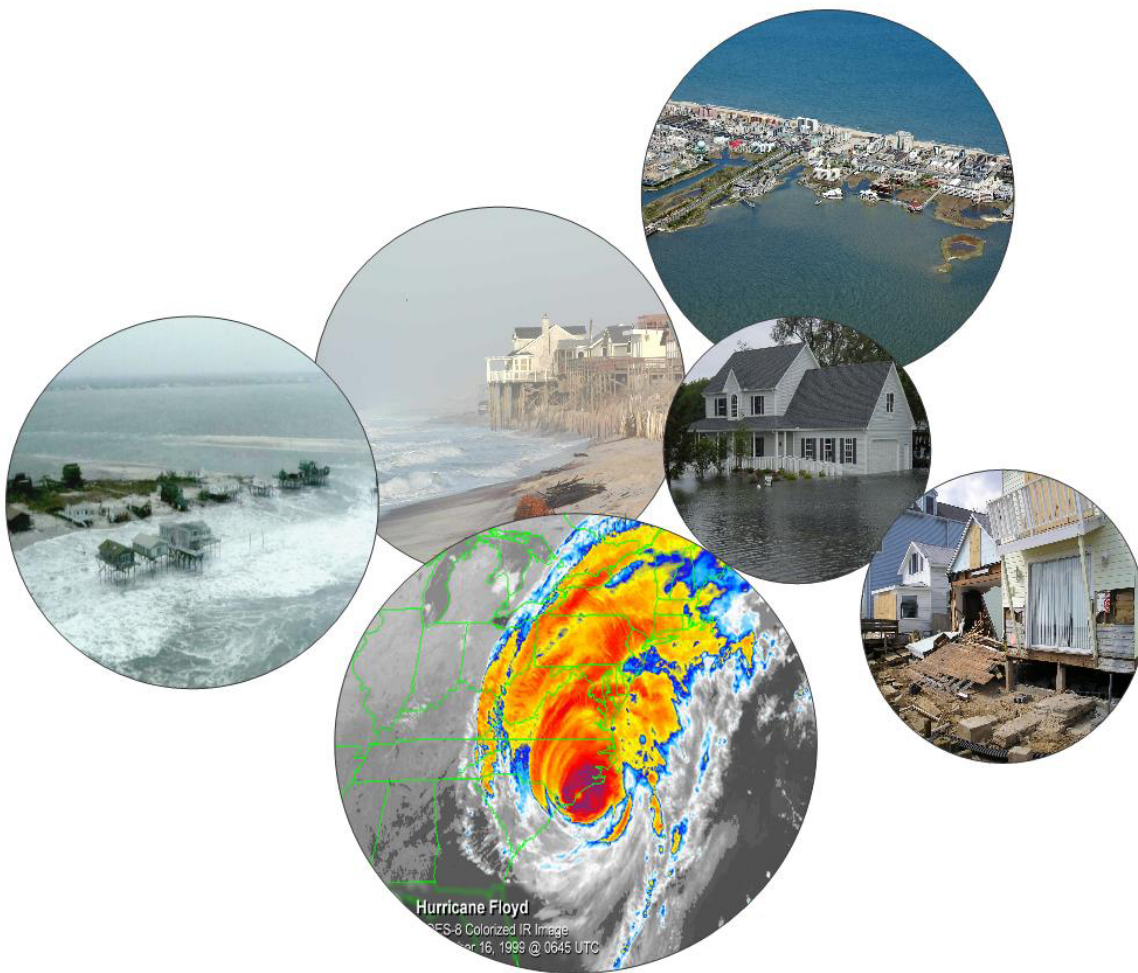


Mid-Atlantic Regional Council on the Ocean

Climate Change and Sea Level Rise Information Exchange



December 2010

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LIST OF ACRONYMS

CAFRA	Coastal Area Facility Review Act
CSC	Coastal Services Center
DNREC	Delaware Department of Natural Resources and Environmental Control
EO	Executive Order
FEMA	Federal Emergency Management Agency
GAO	Government Accountability Office
GHG	Green House Gas
GIS	Geographic Information Systems
LiDAR	Light Detection and Ranging
MARCO	Mid-Atlantic Regional Council on the Ocean
MCCC	Maryland Climate Change Commission
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
MHT	Maryland Historical Trust
MTA	Maryland Transportation Authority
MPA	Maryland Port Administration
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NPCC	New York City Panel on Climate Change
NYSDOT	New York State Department of Transportation
NYSDEC	New York State Department of Environmental Conservation
NYSDOS	New York Department of State
NYSERDA	New York State Energy Research and Development Authority
PDC	Planning District Commissions
SHA	Maryland State Highway Administration
TWG	Technical Working Group
USDOT	U.S. Department of Transportation
USGS	U.S. Geological Survey
VIMS	Virginia Institute of Marine Science
WILMAPCO	Wilmington Area Planning Council

PART I: INTRODUCTION

In June 2009 the Governors of Delaware, Maryland, New Jersey, New York, and Virginia convened a summit to mark the signing of the *Mid-Atlantic Governors' Agreement on Ocean Conservation*¹ and the establishment of the Mid-Atlantic Regional Council on the Ocean (MARCO). Under the MARCO umbrella the five states are working together to advance the protection and restoration of ocean resources, and appropriate development of offshore renewable energy resources to benefit their citizens and future generations. Adapting to climate change is one of the four priorities of the Governors' agreement (see box).

In the wake of their June 2009 summit the Governors set forth specific actions to advance the MARCO priorities. Among the initial actions for the climate change adaptation priority was the commitment to facilitate a "climate change and sea level rise information exchange" between states that would "compile state climate change planning and policy approaches and implementation plans, and identify best practices to enhance adaptation at the regional scale."²

This white paper achieves the information exchange by profiling the current status of climate change and sea level rise activities in the five MARCO states. Barriers to implementation and keys to successful implementation of climate change and sea level rise adaptation measures are noted where relevant, and links to key contacts and information sources appear throughout the text.

Part II of this document presents the states' activities organized into nearly a dozen distinct categories addressing policy development, data and tools, technical assistance, and more. Appendix A offers information on initiatives of the federal government and other entities that may inform the Mid-Atlantic states' efforts. Appendix B contains a state-by-state presentation of the activities described in Part II.

From the Mid-Atlantic Governors' Agreement on Ocean Conservation:

"Prepare the region's coastal communities for the impacts of climate change on ocean and coastal resources."

"Climate change and its associated impacts threaten to indelibly alter the Mid-Atlantic region and its resources. Increased coastal hazards, such as flooding and erosion, will threaten existing infrastructure and public health and safety. The widespread nature of this problem also will challenge our efforts to manage human activities across the region."¹

¹ A copy of the Governors' agreement can be downloaded from the MARCO website at www.midatlanticocean.org/agreement.pdf.

² The document "Actions, Timelines, and Leadership to Advance the Mid-Atlantic Governors' Agreement on Ocean Conservation" is available from the MARCO website at www.midatlanticocean.org/summary-actions.pdf.

PART II: CLIMATE CHANGE AND SEA LEVEL RISE INITIATIVES IN THE MARCO STATES

The efforts being carried out in the five states in response to sea level rise and other climate change impacts are described below, organized into the following ten categories:

- Assessing and Planning for Climate Change
- Responding to Sea Level Rise
- Improving Understanding
- Supporting Local Governments
- Managing Shorelines and Floodplains
- Protecting Natural Resources
- Using National Estuarine Research Reserves
- Engaging and Educating the Public
- Safeguarding Transportation Infrastructure
- Reforming Insurance

Within each of these categories the activities appear by state in alphabetical order (Delaware, Maryland, New Jersey, New York, and Virginia).

ASSESSING AND PLANNING FOR CLIMATE CHANGE

Within the past three years Governors or state legislatures in nearly all the Mid-Atlantic states have convened high level councils to produce plans for responding to climate change. Some have completed their work, some are still midstream, and the initiatives vary in the degree to which adaptation (as opposed to mitigation) is a focus. One municipal effort, that of New York City, is profiled among these efforts because New York City contains such a significant proportion of New York State's coastal population and infrastructure.



Maryland Governor, Martin O'Malley, signs an executive order on April 20, 2007 establishing the MCCC. (Photo: MDNR)

Maryland: The Comprehensive Strategy to Reduce Maryland's Vulnerability to Climate Change

In 2007 Governor Martin O'Malley issued an executive order establishing the Maryland Commission on Climate Change (MCCC). In 2008 the Commission produced the state's sweeping Climate Action Plan addressing science, mitigation, and adaptation to the impacts of climate change

on Maryland. The Plan's adaptation component is found in Chapter 5, the *Comprehensive Strategy to Reduce Maryland's Vulnerability to Climate Change* (Adaptation Strategy).³ The Adaptation Strategy identifies the Maryland Department of Natural Resources (MDNR) as the lead agency, with support from a wide range of other state agencies.

Phase One of the 2008 Adaptation Strategy focuses on protecting the state's economy and environment and securing public safety in the face of climate change-induced sea level rise and coastal storms. The Adaptation Strategy detailed 18 Phase One legislative, policy, and planning actions to:

- Reduce impacts both to existing built environments and future growth and development.
- Avoid financial and economic impacts.
- Protect human health, safety, and welfare.
- Protect and restore forests, wetlands, and beaches that protect against climate change impacts.

Phase One accomplishments include passage in 2008 of two laws intended to reduce vulnerability over time and protect natural resources from the impacts of sea level rise by restoring natural shoreline buffers such as grasses and wetlands, and by limiting new growth in vulnerable areas. These laws are the Living Shoreline Protection Act and the Chesapeake and Coastal Bays Critical Area Act amendments. (See below for more detailed descriptions of these and other Phase One implementation results.)

In December 2009, Maryland initiated development of Phase Two of its Adaptation Strategy. The Strategy, scheduled for release in January 2011, is the product of over 80 experts from the governmental, non-profit, and private sectors that held a series of meetings to synthesize the most recent climate change literature, evaluate adaptation options and recommend adaptation strategies to reduce the Maryland's overall vulnerability to climate change. The Strategy outlines adaptation strategies to reduce the impacts of climate change, including sea level rise, increased temperature and changes in precipitation within the following sectors: Human Health; Agriculture; Forest and Terrestrial Ecosystems; Bay and Aquatic Environments; Water Resources; and Population Growth and Infrastructure. The Phase II Strategy will provide the basis for guiding and prioritizing state-level activities with respect to both climate science and adaptation policy within short to medium-term timeframes.

New Jersey Global Warming Response Act Recommendation Report

In December 2009 the New Jersey Department of Environmental Protection released its report, *Meeting New Jersey's 2020 Greenhouse Gas Limit: New Jersey's Global Warming Response Act Recommendations Report*.⁴ The report, required by the New Jersey Global Warming Response Act of 2007, focuses primarily on greenhouse gas reduction strategies. It also recommended

³ Available at www.mde.state.md.us/assets/document/Air/ClimateChange/Chapter5.pdf.

⁴ Available at www.state.nj.us/dep/oce/gwr.htm.

that the state develop adaptation strategies to minimize climate-related risks to the environment, economy, and public health. The report recommends that the state convene experts from academia, government, non-governmental organizations, and the business community to develop a statewide climate change adaptation plan, which would guide the state in fostering consideration of the vulnerability of built and green infrastructure to future hazards as well as improving the capacity of state public health resources to respond to more arduous weather and climate conditions. The report highlights a range of examples of sector-based adaptation issues that New Jersey faces in the following categories: public health, safety, and emergency preparedness; freshwater quality and supply; energy, land use, and capital infrastructure; biodiversity, ecosystems, and agriculture; finance and economics; and outreach and education.

New York State Climate Action Council and Climate Action Plan

In August 2009 a Governor's executive order established the New York State Climate Action Council to prepare a draft Climate Action Plan by September 30, 2010.⁵ The deadline for the draft Climate Action Plan has since been extended and a draft interim report is scheduled to be released November 1, 2010. The Council is comprised of 15 state agency heads and jointly coordinated by the New York State Department of Environmental Conservation (NYSDEC) and the New York State Energy Research and Development Authority (NYSERDA). The Plan will have a dual focus: 1) how all of New York's economic sectors can achieve a goal of an 80% reduction of greenhouse gas emissions (GHG's) by 2050, and 2) how New York can adapt to climate change. The latter component is being developed by an Adaptation Technical Working Group (TWG). The Adaptation TWG will in turn have its work informed by the efforts of three other initiatives described below: the state's Sea Level Rise Task Force, the ClimAID adaptation project, and New York City's PlaNYC.

The Council's Adaptation TWG has prepared protocols for evaluating adaptation strategies. They are currently developing a catalog of adaptation strategies for New York, setting priorities for analysis, addressing adaptation needs raised by the Council's other (GHG mitigation) technical working groups, and developing recommended policy options. The Adaptation TWG's more than two dozen members are drawn from the private, nonprofit, and academic sectors as well as state and local agencies.

New York's ClimAID Project

In November 2008 NYSERDA initiated underwriting an "Integrated Assessment for Effective Climate Change Adaptation Strategies in New York State," also called "ClimAID," as part of its climate research program.⁶ Partners in the project include Columbia University, the City

⁵ Information about the Council is available at nyclimatechange.us/.

⁶ Limited ClimAID information is posted on NYSERDA's website at www.nyserda.org/programs/Environment/EMEP/project/10851/10851_pwp.asp. More information is available by contacting project manager Amanda Stevens ads@nyserda.org and from an October 2009 conference presentation providing a recent update is available at

University of New York, Cornell University, and others. ClimAID's goal is to bring together the most recent scientific information, technical expertise, and knowledge of stakeholders from key sectors around the state. ClimAID will assess the state's risks from climate change, facilitate the development of adaptive measures, and identify needs for additional research. The project convened stakeholder groups throughout 2009, focused on the following eight sectors: agriculture, ecosystems, coastal zones, energy, public health, transportation, communication, and water resources. ClimAID will also examine the crosscutting elements of science/policy linkages, economic policy linkages, and environmental justice. The release of the ClimAID report will be coordinated with the issuance of the New York State Climate Action Plan, currently scheduled for November 1, 2010. The project's work is pivotal to the Climate Action Council and the Sea Level Rise Task Force (see above).

In order to more effectively illuminate vulnerabilities, climate risks, key decisions, and adaptation strategies ClimAID is developing nearly two dozen case studies in the eight sectors it is assessing. Examples include:

- Agriculture: apple and grape production, dairy production, summer drought
- Communications infrastructure: winter storm
- Ecosystems: invasive species, brook trout habitat
- Energy: heat waves, electricity demand
- Ocean coastal zones: severe coastal storms, salt-marsh changes
- Public health: ozone and respiratory disease, West Nile virus
- Transportation infrastructure: 100-year storm in the New York City metro region
- Water resources: Susquehanna River flooding, Orange County water supply planning

New York City's PlaNYC

In 2007, New York City launched a multi-pronged adaptation effort as part of its broadly ambitious PlaNYC long term sustainability initiative.⁷ PlaNYC is being coordinated by the newly established Mayor's Office of Long Term Planning and Sustainability. This Office is overseeing the implementation of PlaNYC's climate change adaptation initiatives, including a citywide strategy that is expected to:

- Help individual neighborhoods develop site-specific strategies to address their climate change risks.
- Update the city's 100-year floodplain maps.
- Document the city's floodplain management strategies to secure discounted flood insurance for city residents.

http://www.nyserda.org/programs/Environment/EMEP/conference_2009/presentations/Solecki_DeGae_tano_Horton_Climate%20Change%20in%20New%20York%20State.pdf.

⁷ Information on PlaNYC's climate goals are available at:
www.nyc.gov/html/planyc2030/html/plan/climate.shtml.

- Amend the building code to address climate change impacts.

The Office also supports the work of an interagency task force appointed in August 2008 specifically to focus on risks to infrastructure. The public-private Climate Change Adaptation Task Force has approximately 40 members drawn from city, state, and federal government agencies and regional authorities, as well as private companies that operate, maintain or regulate critical infrastructure in the city. A private firm, The Boston Consulting Group, provided pro bono support to develop and convene the Task Force. The Task Force is slated to issue a report on the adaptation of critical infrastructure to sea level rise.

The Task Force is being advised by a New York City Panel on Climate Change (NPCC), convened at the same time as the Task Force with funding from the Rockefeller Foundation. The NPCC consists of academic and government scientists and industry experts. The NPCC was charged with quantifying potential risks from climate change, and in February 2009 the NPCC issued its first report, *Climate Risk Information*.⁸

Virginia Climate Change Action Plan

In December 2008 the Governor's Commission on Climate Change completed a year-long effort to develop a plan to guide the state's greenhouse gas reduction efforts, evaluate anticipated climate change impacts to the state's natural resources, economy, and public health, and recommend necessary actions to respond to those impacts.⁹ Regarding adaptation measures, the Commission recommended that the state:

- Make organizational changes and set priorities in state government. Focus and expand the state's capacity to implement the Climate Change Action Plan by establishing a climate change sub-cabinet, working through existing programs when possible, working collaboratively with neighboring states, formalizing the use of Planning District Commissions (PDCs) as a bridge between the state and local governments, and encouraging PDCs to address climate change in their regional strategic plans.
- Conduct outreach and education. Implement a campaign to raise awareness of the causes and impacts of climate change, build public support for implementing Plan recommendations, and inform the public about the individual, business, and governmental actions needed to mitigate and to adapt to climate change.
- Assess impacts. Seek legislative funding and support for a network of scientific and technological institutions to monitor, track, and report on the impacts of climate change on Virginia's agriculture, energy use, economy, health, and ecosystems, and to suggest optimal adaptation and mitigation strategies to the policy-makers.
- Amend laws and regulations. Ensure state and local agencies have the necessary

⁸ Download the NPCC report *Climate Risk Information* at:

www.nyc.gov/html/planyc2030/downloads/pdf/nyc_climate_change_report.pdf

⁹ The Climate Change Action Plan is available at www.deq.virginia.gov/info/climatechange.html

authorities to account for climate change in their actions.

The Commission also recommended more than two dozen specific measures directed at state agencies and local governments. These are summarized as follows:

- Develop a comprehensive sea level rise adaptation strategy by January 1, 2011.
- Acquire statewide LiDAR topography data, prioritizing coastal areas.
- Assess impacts of climate change to natural, historical, and cultural resources; to specific socioeconomic and geographic groups; to programs such as stormwater and polluted runoff management and emergency response and preparedness; to insured properties and the insurance industry; and to public health.
- Reduce vulnerability to climate change impacts by creating disincentives for development and incentives for shoreline retreat in hazard areas; considering its implications in decisions about new and existing infrastructure; engaging in land use and shoreline planning; developing adaptation plans for specific affected economic sectors; and taking steps to protect and restore natural resources.
- Coordinate with other states and the federal government, in particular the Department of Defense.

PREPARING FOR SEA LEVEL RISE

In addition to statewide climate change plans, a number of the Mid-Atlantic states have undertaken focused statewide initiatives to examine the risks and possible responses to sea level rise.

Delaware Sea Level Rise Initiative and Policy

Delaware's Sea Level Rise Initiative, inaugurated in 2009, is intended to institutionalize the consideration of sea level rise in all local and state decision making about human uses and natural resource management in Delaware. In a case study developed for a National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center workshop,¹⁰ Delaware Coastal Program staff detailed internal program changes made to align budgets and job requirements to add sea level rise responsibilities to the portfolio of every Delaware Coastal Program staff person. These changes enabled the launch of the Sea Level Rise Initiative, which is focusing on

¹⁰ Detailed information is available in the following document prepared for a December 2009 NOAA Coastal Services Center "Sea Level Rise and Inundation Community Workshop" held in December 2009: Carter, David B., Sarah W. Cooksey, Susan E. Love, Robert W. Scarborough. 2009. *Planning for Sea Level Rise in Delaware: A Case Study*. Delaware Department of Natural Resources, Delaware Coastal Programs. Dover, DE. Contact David Carter, Delaware Coastal Program, David.Carter@state.de.us to obtain a copy.

four activities to promote sea level rise understanding, preparedness, and response:

- Technical decision support
- Policy development
- Implementation actions
- Communication, training and public involvement

Delaware Coastal Program publishes a regularly-updated Sea Level Rise Initiative Project Compendium¹¹ of activities underway. The activities are detailed under the relevant categories below. By way of overview, they include:

- Early implementation projects involving two coastal communities and development of a coastal flood monitoring system.
- Policy initiatives including developing a statewide adaptation plan, retooling a grant program to spur community planning for coastal hazards and sea level rise, and participating in MARCO.
- A number of communication, training, and public involvement activities.
- Nearly a dozen scientific and technical support projects, including the release of GIS-based coastal inundation maps to determine the locations and extent of coastal vulnerability to sea level rise (described below).

In January 2010 the Secretary of the Delaware Department of Natural Resources and Environmental Control (DNREC), the Delaware Coastal Program’s umbrella agency, issued an order establishing as agency policy DNREC’s commitment to “proactively consider and plan for the potential effects of coastal inundation department-wide using projections based on the best available science.” The policy directs DNREC staff and programs to:

1. Communicate the policy internally and externally when representing the department.
2. Consider the potential effect of coastal inundation in project planning, engineering, design, and review, as well as land acquisition, management, and restoration.
3. Conduct a vulnerability assessment for all DNREC holdings and assets to identify risks from inundation and develop plans to increase resiliency and adaptability within 12 to 18 months.
4. Consider project alternatives that avoid siting buildings and infrastructure within areas that are vulnerable to inundation, or if avoidance is not practicable, design projects to address the consequences of inundation.
5. Use a prescribed range of sea level rise scenarios, appropriate to a given project’s longevity and nature, with projects of a longer expected life or more sensitive nature adopting more protective sea level rise scenarios, with values to be adjusted as the

¹¹ The Compendium is available at the Delaware Coastal Program website:
www.swc.dnrec.delaware.gov/coastal/Pages/SeaLevelRiseAdaptation.aspx

Intergovernmental Panel on Climate Change and other peer reviewed publications produce updated projections and modeling techniques.

Delaware Sea Level Rise Initiative: Keys to a Successful Launch

Delaware staff interviewed for this report noted three aspects of the Delaware Coastal Program's approach to the Sea Level Rise Initiative they believe are essential to the effort's progress:

- 1) Data. Developing a sound information basis for vulnerability analysis, especially through the acquisition of LiDAR topography data for the entire state. The LiDAR is viewed as having been a necessary prerequisite to carrying out all other components of the initiative, and the acquisition process rendered valuable lessons learned.¹²
- 2) Outreach. Conducting a substantial outreach and education effort to begin to address the public's fundamental lack of awareness about the fact and implications of sea level rise.
- 3) Implementation. Carrying out early implementation projects that are ripe for action to test ideas along the way and build support for the development of sea level rise policy.

MDNR Climate Change Policy

MDNR has the lead role among State agencies in Maryland for advancing the scientific understanding of Maryland's vulnerability to climate change, and in advocating for sound planning to avoid or minimize the anticipated impacts. The Department issued a climate change policy, "Building Resilience to Climate Change", in October 2010. The policy guides the Department's investments in and management of land, resources and assets so as to better understand, mitigate and adapt to climate change. The policy establishes practices and procedures related to new land investments, facility siting and design, habitat restoration, government operations, research and monitoring, resource planning and advocacy. Through implementation of the policy, the agency is leading by example, encouraging others to plan for and to mitigate the effects of climate change.

Maryland Historical, Archeological and Cultural Resources Vulnerability Assessment

As tasked in Maryland's Climate Action Plan, the Maryland Historical Trust (MHT) completed a vulnerability assessment of historical and cultural resources in Maryland. The types of resources evaluated were National Historic Landmarks, National Register of Historic Places, MHT Preservation Easements, Maryland Inventory of Historic Properties, archeological sites, and National Register eligible resources. The study was completed using inundation level data from the Department of Natural Resources in a geographic information system. MHT's historical and cultural GIS data layers were intersected with the inundation layers from DNR to

¹² See "Lessons Learned from Delaware LiDAR" on the NOAA Coastal Services Center website at www.csc.noaa.gov/digitalcoast/inundation/pdf/de_lessons.pdf.

generate raw numbers of potentially impacted resources at 0-2 ft and 2-5 ft inundation levels. The highest percentages of affected resources are located on the lower Eastern Shore. A total of 53% of inventoried historic properties in Somerset County would be vulnerable in a 0-5 ft. sea level rise. The analysis shows 32% of all of the archeological sites recorded in the coastal counties studied are potentially vulnerable within the 0-5 ft boundaries. Rising sea levels, erosion and major storms all pose a significant threat to historic and archeological sites, districts, and landscapes. The results from this preliminary assessment have served to raise awareness of this issue, which will be addressed through the PreserveMaryland planning process and included in the forthcoming long-range historic preservation comprehensive plan.

New York State Sea Level Rise Task Force

The Sea Level Rise Task Force was created in 2007 by the New York State Legislature to assess impacts to the state's coastlines from rising seas and recommend protective and adaptive measures for the state's coastal communities and ecosystems.¹³ The geographic scope of the Sea Level Rise Task Force report will include New York City's five boroughs and Westchester, Nassau, and Suffolk Counties, as well the main stem of the Hudson River drainage.

NYSDEC chairs and staffs the Sea Level Rise Task Force, whose members are drawn from state, county, and municipal government and public citizens appointed by the legislature. The Sea Level Rise Task Force held its first meeting in June 2008, and conducted a series of public meetings in January 2009. The Sea Level Rise Task Force is expected to issue a draft report by October 2010 to be followed by public review. The final report is due to the state legislature by January 1, 2011. Much of the Sea Level Rise Task Force's work is carried out by a steering committee of state and non-governmental agency staff who develop recommendations for Sea Level Rise Task Force approval with advice from specialized work groups (ecosystems and natural resources, infrastructure, community resilience).

The Sea Level Rise Task Force report is expected to assess anticipated sea level rise impacts and make recommendations for protective standards and enforcement related to the following: coastal development; wetlands protection, shoreline armoring, and post-storm recovery; adaptive measures such as wildlife migration corridors; habitat protection to preserve ecological services such as flood control and clean water; monitoring of climate change effects on flora and fauna; integration of adaptation strategies into state environmental plans; and state and local regulatory amendments to respond to climate change.

NYSDEC Commissioner's Climate Change Policy

NYSDEC is currently finalizing a Commissioner's Policy on "Climate Change and DEC Action," which had been issued in a draft form in April 2010. The policy directs all parts of the agency and all staff to integrate climate change considerations into the full range of departmental activities, including decision-making, planning, permitting, remediation, rulemaking, grants administration, natural resource management, enforcement, land stewardship and facilities

¹³ Information about the Task Force is available at www.dec.ny.gov/energy/45202.html.

management, internal operations, contracting, procurement, and public outreach and education. The policy lays out key climate change goals, based in part on a number of existing Executive Orders, and defines specific climate change mitigation and adaptation objectives for the agency. It also identifies specific climate change factors that all agency staff should use in their daily activities, including the use of the best available scientific projections of future environmental conditions.

IMPROVING UNDERSTANDING

All five states are engaged in myriad research, mapping, modeling, and other projects to acquire and apply data to help their institutions and citizens respond to climate change impacts. The projects highlighted below are among the most significant and recent efforts to improve understanding of the risks to Mid-Atlantic states from sea level rise and other climate change impacts.

Delaware Coastal Inundation Maps

A key technical project completed under the Sea Level Rise Initiative is the Delaware Coastal Program's development of statewide sea level rise inundation maps delineating the areas and extent of coastal inundation due to sea level rise. The maps are pivotal to the anticipated development of Delaware's Statewide Sea Level Rise Adaptation Plan. The maps depict a number of scenarios using present-day and predicted future sea levels in the year 2100. The maps are designed to account for varying mean tide levels along the Delaware Bay Coast and projected flooding from coastal storm surges, two significant advantages over existing maps. The GIS-format maps are based on bare earth LiDAR data, and will be updated as new information on sea level rise becomes available.

Maryland Data Acquisition, Mapping, and Modeling

Maryland has made significant progress acquiring new technology and data, including historic shoreline change data and statewide high resolution topographic data (LiDAR), and has utilized this data to undertake state-of-the-art sea level rise mapping and research. Data have been acquired both by MDNR and by individual Maryland counties. Some of the data products and technical tools currently available include: state-wide sea level rise vulnerability mapping, historic shoreline position and erosion rate calculations, a comprehensive coastal inventory, a sea level rise economic impact assessment, the Erosion Vulnerability Assessment Tool, the Living Shoreline Suitability Model, and the Worcester County Sea Level Rise Inundation Model.¹⁴

The Worcester County Sea Level Rise Inundation Model, developed through a partnership among MDNR, the U.S. Geological Survey (USGS) and Worcester County, was designed to

¹⁴ Maryland has made most of its data products and tools available online at Maryland Shorelines Online: shorelines.dnr.state.md.us/

support a number of the state's sea level rise and coastal hazard planning goals. USGS created a highly detailed LiDAR topographic elevation model of Worcester County to analyze the impact of rising sea level and storm flooding on Worcester County's coastline and low-lying inland areas. The resulting sea level rise inundation scenarios depict long-term and low magnitude changes in the position of Mean Sea Level and Mean High Water resulting from the ongoing rate of relative sea level rise for the area (3.0 mm/yr) and increased rates of rise suggested by climate change projections. Each of the scenarios was adapted to combine sea level rise and storm surge inundation of the area for Category 1 to Category 4 hurricanes. A Technical Report provides the methodology for the project and contains recommendations for future use of the model in state and local sea level rise planning efforts.¹⁵

New Jersey Coastal Vulnerability Assessment Protocol

The New Jersey Coastal Management Program has spearheaded the acquisition of coastal LiDAR elevation data for Cape May, Cumberland, and Salem counties adjacent to Delaware Bay. The data will result in an important base information layer upon which future coastal analysis will be based, one that is notable because the data were acquired at near mean low water conditions. The New Jersey Coastal Management Program is developing a GIS-based Coastal Vulnerability Assessment Protocol to identify the potential impacts of coastal hazards and sea level rise on the built and natural environment. The Protocol is being developed for New Jersey's Delaware Bayshore and will be piloted in communities along the bay. The results of the assessment will help the New Jersey Coastal Management Office provide community outreach in regards to coastal hazards and climate change (see discussion of the New Jersey Coastal Resilience Index in the "Supporting Local Governments" section of this paper). While the protocol can be utilized to assess community vulnerability, it also has the capacity to inform federal, state, and non-governmental entities of areas of potential habitat loss, prime restoration sites, or areas to forgo additional conservation due to inundation. By utilizing the protocol, coastal communities and natural resource managers will be able to apply the vulnerability mapping in order to begin adapting to coastal hazards and future impacts of sea level rise.¹⁶

New Jersey Coastal Evacuation Maps and Planning

All New Jersey counties have published coastal evacuation and storm surge maps identifying potential evacuation routes for coastal emergencies such as approaching tropical storms or hurricanes.¹⁷ Monmouth County recently completed a Coastal Evacuation Route Improvement

¹⁵ The Worcester County Sea Level Rise Inundation Model Technical Report is available at www.dnr.state.md.us/Bay/czm/wcslrreport.html

¹⁶ For information about the New Jersey Coastal Vulnerability Assessment Protocol contact Leigh Wood at leigh.wood@dep.state.nj.us.

¹⁷ Evacuation planning and map information can be found at www.state.nj.us/njoem/plan/evacuation-routes.html.

Study recommending changes to its evacuation routes that takes into consideration sea level rise and other climate change impacts.¹⁸

Virginia Institute of Marine Science Research

The Virginia Institute of Marine Science, a public institution with a state mandate to provide coastal and estuarine research and policy advice, has prepared analyses and recommended responses to the causes and consequences of climate change in Chesapeake Bay and the coastal zone,¹⁹ and has an ongoing program on climate change and coastal stressors.²⁰

Examples of specific projects include: a clearinghouse for datasets relevant to considerations of climate change and sea level rise impacts;²¹ a project to assess the vulnerability of tidal wetlands, shallow waters, submerged aquatic vegetation, beaches and developed lands;²² and an examination of the fate of tidal wetlands in the Lynnhaven River system in the face of sea level rise.²³

SUPPORTING LOCAL GOVERNMENTS

Each of the five states has placed a high priority on developing or expanding programs to develop the capacity of local governments to communicate effectively with their citizens and take action to prepare their communities for sea level rise and other climate change impacts.

Delaware Sea Level Rise Initiative Local Government Components

Many components of Delaware's Sea Level Rise Initiative are intended to build the capacity of local governments to address sea level rise (see above). One component, its Sustainable Coastal Communities Grant Program, is explicitly focused on helping communities to plan for coastal hazards and future impacts of sea level rise. The competitive grant program will fund communities to develop ordinances that protect natural resources and habitat, develop environmental conservation design standards for inclusion in local comprehensive land use plans, and conduct coastal habitat restoration project planning and implementation projects. The early implementation projects under the Sea Level Rise Initiative focus on two local governments. The Town of Bowers Beach and the City of Newcastle are recipients of assistance to develop action plans of prioritized projects intended to make each community more resilient and better able to recover from sea level rise, increased storm frequencies and intensities,

¹⁸ Available at www.co.monmouth.nj.us/page.aspx?Id=3260

¹⁹ See <http://www.vims.edu/research/centers/programsprojects/iccr/index.php>.

²⁰ See http://ccrm.vims.edu/coastal_zone/climate_change/index.html.

²¹ See http://ccrm.vims.edu/climate_change/index.html

²² See http://ccrm.vims.edu/research/climate_change/index.html

²³ See http://ccrm.vims.edu/gis_data_maps/static_maps/lynnhaven_project/Lynnhaven%20Final%20Report.pdf.

tidegate and dike problems or failures, wetland loss, and other climate change impacts, and to effectively pursue funding for those actions.

Maryland CoastSmart Communities Initiative

MDNR developed the *CoastSmart* Communities Initiative to support local level implementation of the Adaptation Strategy.²⁴ Under the initiative local governments can access an online resource center with a comprehensive toolbox of resources to become ready, adaptive, and resilient to the impacts of sea level rise and coastal storms. MDNR launched the program with a 2009 *CoastSmart* Communities summit whose centerpiece was a role-play exercise. Ongoing activities, detailed below, include promoting additional role play exercises, grants, technical



Participants at the Building CoastSmart Communities Interactive Summit worked through a role-play exercise to learn about sea level rise adaptation. (Photo: MDNR)

assistance, a scorecard tool, and a hazards policy review.

Role-play summit. The *CoastSmart* Communities spring 2009 high-level interactive summit and role-play exercise drew hundreds of coastal leaders from around the state. The participants engaged in a hypothetical decision-making process informed by real-world information. Professional facilitators mediated negotiations over actions that coastal communities could take to

protect their citizens, infrastructure, and investments from future risk. Participants used a scorecard that ranked actions by effectiveness and cost. They learned about key choices communities face, how to anticipate risks and opportunities, and tools that can help foster community readiness, adaptability, and resilience in the face of climate change. MDNR, the Consensus Building Institute, and the MIT-U.S. Geological Survey Science Impact Collaborative jointly created the *CoastSmart* Communities summit and role-play exercise with funding from NOAA.

Grant and technical assistance program. The *CoastSmart* Communities summit was also the occasion for the inauguration of a companion competitive grant program to provide financial and technical assistance to local governments that wish to reduce their vulnerability to the effects of coastal hazards and sea level rise through their planning and permitting activities. The grants of up to \$75,000, drawn from the state's federal Coastal Zone Management Act funds, will be awarded on an annual basis. Successful projects are eligible to receive continued support for up to three years to achieve project goals and result in the adoption of an enhancement to the Maryland coastal management program. MDNR, which manages the

²⁴ Information available at <http://www.dnr.maryland.gov/CoastSmart/>.

grants, selected its first four projects in September 2009: Ann Arundel County will develop a strategic plan targeting sea level rise and climate change; Caroline County will improve its floodplain and stormwater management programs; the City of Annapolis will develop a sea level rise adaptation and response plan that includes a vulnerability and impact assessment and policy response options; and Queenstown will develop an integrated community and watershed design project.

CoastSmart Communities Scorecard. Building on the concept of the role-play scorecard, MDNR is currently developing a more comprehensive community self assessment scorecard. The new scorecard will provide a practical method to assess how well prepared a community is to face climate change impacts, and identify specific, realistic ways communities can integrate sea level rise into existing issue-based planning, management and regulatory programs. The scorecard categories will align with the Adaptation Strategy's sectors of transportation planning, shoreline and buffer management, land use planning, building codes and infrastructure design planning, natural resource management, and emergency disaster preparedness and response. MDNR expects to complete the scorecard in the spring of 2011; some of the strategies can already be found among the "*Building CoastSmart Communities*" role-play materials at the program website.²⁵

Maryland Sea Level Rise Planning Guidance for Local Government

MDNR's Chesapeake and Coastal Program provided funding for Worcester, Somerset, and Dorchester Counties to develop sea level rise planning guidance documents in 2008. The documents are serving as "best practice" manuals for other coastal counties and informing development of the *CoastSmart Communities Scorecard*. Key components include: sea level rise vulnerability assessments; "critical action" identification; planning and regulatory development; and recommended public investment policies. All three documents highlight the importance of integrating sea level rise mapping and impact analysis information into comprehensive and emergency response planning within each jurisdiction.²⁶

New Jersey Coastal Resilience Index Project

Coupled with the New Jersey Coastal Vulnerability Assessment Protocol (see the "Increasing Understanding" section above), the New Jersey Coastal Resilience Index, a project launched in 2009, will help New Jersey coastal communities assess how well they are incorporating hazard and sea level rise mitigation efforts into their land use, hazard mitigation, and post-disaster redevelopment plans and policies, among many others. The resilience indicators will be preliminarily developed for communities along the Delaware Bay. The state successfully applied for a NOAA Coastal Management Fellow to develop, apply, and integrate the Coastal Vulnerability Protocol and the Coastal Resilience Index to assess the potential impacts of sea level rise and other hazards to the state's more developed shoreline. All of this information will

²⁵ Information available at <http://www.dnr.maryland.gov/CoastSmart/>.

²⁶ The sea level rise planning guidance documents for the three Maryland counties are available at www.dnr.state.md.us/dnrnews/infocus/climatechange.asp.

be analyzed in the context of state policies regarding resilience planning and implementation, and the regulations and ordinances of each local community to produce a unique index and community planning toolkit. The project's ultimate goal will be to develop a standard methodology that any entity – academic, governmental, or nongovernmental – can use to develop indices and toolkits tailored to communities along the rest of New Jersey's coastal waterfronts.²⁷

New York State Grants for Local Waterfront Revitalization Programs

The New York State Environmental Protection Fund is intended to provide a stable source of funding for a range of environmentally-focused grant programs. Title 11 of the Environmental Protection Fund establishes an annual grant program to help municipal and county governments prepare, refine or implement Local Waterfront Revitalization Programs on a 50/50 cost share basis. Communities can use the grants, which are administered by the Department of State's Division of Coastal Resources, for planning, design, and construction projects.²⁸

The grant program's selection process accords extra points to a handful of high priority categories; proposals that advance the development and implementation of plans or projects that prepare for and adapt to climate change and sea level rise were added to this high priority list in 2008. In the most recent grant cycle two coastal communities have won Local Waterfront Revitalization Program grants in this category. New York City received a grant for public education and outreach about climate change causes and adaptation through its Parks and Recreation Department, and to incorporate climate change considerations (along with other issues) in an update of a watershed management plan for one area of the city. The Village of Northport on Long Island Sound will use its grant to prepare a draft Local Waterfront Revitalization Program that addresses protection and preservation of its harbor waterfront and natural resources and plans for climate change and sustainable design. In addition, the capital city of Albany used a prior year grant for its ongoing process to prepare a *Climate Action and Adaption Plan* to develop regulations to minimize risks associated with climate change.

New York State Climate Smart Communities Program

At least 84 New York communities have adopted a ten-point "Climate Smart Pledge" to reduce greenhouse gas emissions and take steps to adapt to inevitable impacts of climate change through their participation in the state's Climate Smart Communities Program.²⁹ The program has had a strong emphasis on helping communities implement measures to mitigate their greenhouse gas emissions, however adaptation-focused elements of the pledge address the adoption of land use policies, plans, zoning, building codes, and public engagement strategies

²⁷ The Coastal Resilience Index Project proposal describing the effort is available at www.csc.noaa.gov/cms/fellows/pdfs/2009_NJ.pdf.

²⁸ Information for the Local Waterfront Revitalization Program is available at www.nyswaterfronts.com/grantopps_EPF.asp.

²⁹ Climate Smart Communities Program information is available at www.dec.ny.gov/energy/50845.html.

to increase community resilience to climate change risks. The program started in February 2009, at which time the program issued a preliminary guidance document with background information for interested local governments.³⁰ Step-by-step guidance is added to the website as it is developed. Communities also receive support in the form of notification of funding opportunities, letters of support for grant applications and, through NYSERDA's Focus on Local Government program, direct and indirect support in implementing climate action.

A new initiative launched in January 2010 will bolster the program's adaptation-related support to communities. The NYSDEC Office of Climate Change and the New York Department of State's (NYSDOS) Division of Coastal Resources launched a collaborative, interagency effort to provide guidance on adaptation planning to communities interested in improving their resiliency to climate change. The Department of State will draw upon expertise it has developed working with communities implementing Local Waterfront Revitalization Program climate change and sea level rise preparedness and response projects to expand the adaptation focus of the Climate Smart Communities Program. The collaboration will lead to:

- An expanded adaptation focus for the guidance document that is in development (see above).
- Initiation of work in several pilot communities, including the City of Albany.
- Stronger coordination of existing local and regional adaptation projects in the state with the Climate Smart Communities program (e.g., NYSDOS Local Waterfront Revitalization Program-funded projects and the partnership between the NYSDEC Hudson River Estuary Program and its Office of Climate Change to coordinate local efforts to develop a regional strategy to respond to climate change in the Hudson Valley).

New York State Guidelines for Local Post-Storm Redevelopment Plans

In 2008 the NYSDOS Office of Coastal, Local Government and Community Sustainability initiated a project to formulate State Guidelines for Post-Storm Redevelopment Plans.³¹ The project's goals are to provide a means for local governments to assess their resilience to coastal hazards and to provide a framework for developing local management plans to address those hazards. The Post-Storm Redevelopment Plans will assess socio-cultural and environmental resources as well as economic assets and emphasize community function rather than static protection of structures. With an assessment and plan communities can coordinate hazard mitigation activities with other planning efforts, such as capital development programs, comprehensive land use planning, local waterfront revitalization, and brownfield redevelopment in addition to storm recovery. The plans will allow communities to adapt efficiently over the course of time, taking coastal hazards including sea level rise (and other climate impacts, as appropriate) into account. Since much of New York's coastal area is already developed, adaptation of existing

³⁰ The interim guidance document for local governments is available at www.dec.ny.gov/docs/administration_pdf/cscguide.pdf.

³¹ New York's application for a NOAA Coastal Services Center Fellow to undertake the project may be downloaded at webqa.csc.noaa.gov/cms/fellows/2008_NY.pdf.

uses will be the primary means of addressing coastal storm impacts and sea level rise.

The principal tools available for adaptation to coastal hazards include elevation, relocation, and voluntary acquisition of existing structures; resilient construction; and property exchange. The Department of State's project will develop guidance on the content and process for preparing adaptation plans, including a community resilience index to characterize vulnerability. The index will help communities assess exposure to coastal hazards and the effectiveness of proposed management measures. The Department of State will issue information products prepared in support of Post-Storm Redevelopment Plans, including a guidebook, for ongoing technical assistance to other agencies and local governments. Examples include information for the state Sea Level Rise Task Force (discussed above), advice to the U.S. Army Corps of Engineers on storm damage reduction projects, and feedback to the New York State Emergency Management Office on coastal hazard management and updates to the State Multi-Hazard Mitigation Plan. The Department of State expects to complete draft guidance for Post-Storm Redevelopment Planning by September, 2010.

The Department of State is also a partner in development of a Congressionally-authorized Storm Damage Reduction Project for the Fire Island Inlet to Montauk Point region (jointly led by the U.S. Army Corps of Engineers and NYSDEC). The Department of State is advocating incorporation of the Post-Storm Redevelopment/Recovery guidelines into this project.³²

Virginia Sustainable Communities Initiative

The Virginia Coastal Zone Management Program's Sustainable Communities Initiative provides funding to local communities through Planning District Commissions to incorporate "Blue/Green Infrastructure Planning" or "Climate Change Adaptation" components in their general plans. Beginning in 2008, seven Planning District Commissions launched projects, with three of the seven focusing on climate change, and specifically on sea level rise and coastal flooding. In general, in the first two years of the projects the three climate change focused-Planning District Commissions are analyzing potential natural and manmade causes of these hazards, working with stakeholders to develop policy responses, and engaging in outreach to citizens and elected officials. In the third year they anticipate implementing the recommended local plan and ordinance changes. The three Planning District Commissions are Hampton Roads, Middle Peninsula, and the Northern Virginia Regional Commission, representing, respectively, an urbanized coastal area, a rural coastal area, and a more inland urbanized area at risk from river surges.³³

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³² The FIMP is described at www.nan.usace.army.mil/fimp/reform.htm.

³³ A description of Hampton Roads' climate change adaptation project is available at www.deq.state.va.us/coastal/description/2009projects/12-04-09.html. The Middle Peninsula's project is described at www.deq.state.va.us/coastal/description/2009projects/12-05-09.html. Northern Virginia's project is described at www.deq.state.va.us/coastal/description/2009projects/12-07-09.html.

Most of the MARCO states have adopted measures in recent years to stabilize and guide development activities away from shorelines vulnerable to sea level rise, storm surge, and other hazards accentuated by the effects of climate change.

Delaware Beach Preservation Act

Delaware's DNREC implements the state's Beach Preservation Act by promulgating maps showing "building lines" that generally prohibit seaward construction activities.³⁴ The results of the Sea Level Rise Initiative are expected to drive whether and how this framework is updated.

Delaware Floodplain Hazard Mapping

Under the Delaware Sea Level Rise Initiative's City of Newcastle early implementation project to bolster local resiliency to climate change impacts, the city will be the first in Delaware to formally take sea level rise into consideration in mapping floodplain hazards.³⁵ (See "Supporting Local Governments" and "Sea Level Rise Initiatives" above for more information.)

Maryland Living Shoreline Protection Act 2008

In 2008 the Maryland legislature enacted a law similar to a Virginia law requiring riparian property owners to rely upon "living shorelines" – nonstructural shoreline stabilization measures such as marsh creation – whenever feasible to protect shorelines from erosion while also providing critical wildlife habitat.³⁶ A variety of public agencies are involved in implementing the program and related efforts. The Maryland Department of the Environment (MDE) is charged with developing implementing regulations in cooperation with MDNR. In June 2009 the Maryland Department of the Environment issued draft regulations for a process to waive the requirement where nonstructural measures are not feasible, and to map areas designating locations where traditional structural solutions are required.³⁷ MDNR's



An example of a low sill living shoreline project in Maryland. (Photo: Bhaskaran Subramanian)

³⁴ See Delaware Code Title 7 – Conservation, Chapter 68. Beach Preservation at delcode.delaware.gov/title7/c068/index.shtml

³⁵ See the project description in the Sea Level Rise Initiative Project Compendium available at: www.swc.dnrec.delaware.gov/coastal/Pages/SeaLevelRiseAdaptation.aspx.

³⁶ The Act, Annotated Codes of Maryland, Environment Article, Section 16-201, can be downloaded at mlis.state.md.us/2008rs/chapters_noln/Ch_304_hb0973E.pdf.

³⁷ MDE maps of areas structural shoreline stabilization maps are available at www.mde.state.md.us/Programs/WaterPrograms/Wetlands_Waterways/documents_information/wetlandtidalshoremeps.asp; its draft waiver regulations are available at www.mde.state.md.us/Programs/WaterPrograms/Wetlands_Waterways/regulations/proposed_Is_regs.asp.

Maryland Chesapeake and Coastal Program conducts Living Shorelines outreach and training activities,³⁸ as does the Chesapeake Bay National Estuarine Research Reserve Coastal Training Program (see additional information about the Reserve below).³⁹ Grants and loans to private landowners, nongovernmental organizations, and local governments to construct living shorelines are available from a number of sources, including the Chesapeake Bay Trust⁴⁰ and MDNR's Shoreline Conservation and Management Services.⁴¹

Maryland Chesapeake and Coastal Bays Critical Area Act Amendments

In 2008 the Maryland Legislature amended the state's Chesapeake and Coastal Bays Critical Area Act, first enacted in 1984. The original Act established a program of state and local action to reduce the impact of development activities on habitat and aquatic resources, defining all land within 1,000 feet of the Mean High Water Line of tidal waters or the landward edge of tidal wetlands and all waters of and lands under the Chesapeake Bay and its tributaries as the state's "Critical Area." The Act established a statewide Critical Area Commission to oversee the development and implementation of local land use programs requiring landowners to implement measures to reduce polluted runoff and conserve habitat while accommodating growth and taking into consideration the cumulative impacts of development. Local governments were required to adopt comprehensive plans, zoning ordinances, and subdivision regulations that meet Commission criteria.

The 2008 amendments strengthened the Act in the following ways:⁴²

- Provide for the revocation of licenses of contractors who violate the act, require local governments to implement enforcement programs, establish new penalties and fines for anyone who violates the act, and give the Commission back up enforcement authority.
- Double the buffer requirement from 100 to 200 feet for certain projects.
- Include shore erosion control projects within the definition of "home improvement" projects covered by the Act and link to requirements of the "Living Shorelines Act" (see above).
- Replace Growth Allocation guidelines with standards, including provisions for setback requirements, minimization of impacts to identified resources, and optimization of water quality, and also provide an avenue for Commission approval of alternative measures.

³⁸ The Maryland Chesapeake and Coastal Program's Living Shorelines information is available at shorelines.dnr.state.md.us/living.asp.

³⁹ Chesapeake Bay National Estuarine Research Reserve training for implementing Living Shorelines is described at www.dnr.state.md.us/bay/cbnerr/training_history.asp.

⁴⁰ Information about the Chesapeake Bay Trust's Living Shorelines grant program is available at www.cbtrust.org/site/c.mjPKXPCJnH/b.5457537/k.B2A2/Living_Shorelines.htm.

⁴¹ Information about MDNR's Shoreline Conservation and Management Services financial and technical support resources is available at www.dnr.state.md.us/ccws/sec/index.asp.

⁴² A summary of the Critical Area Act 2008 amendments is available at www.dnr.state.md.us/criticalarea/guidancepubs/052008overviewofhousebill1253.pdf.

- Replace “impervious surface” requirements with “lot coverage” requirements.
- Establish circumstances in which local government variances can be issued, must be reported, and may be subject to appeal.
- Require the state to produce updated maps of the 1,000-foot Critical Area boundary that are digitally generated and georeferenced and regulations to address mapping methodology, the designation of new Critical Area lands, and grandfathering.

New Jersey Coastal Zone Management Rules

New Jersey’s Coastal Zone Management rules are an important tool for regulating new development in erosion hazard, flood hazard, and coastal high hazard areas (the latter delineated by the National Flood Insurance Program’s (NFIP) characterization as regions exposed to 100-year flooding with wave action), as well as environmentally sensitive areas such as dunes, wetlands, and riparian areas. The rules encourage soft shoreline protection methods in lieu of shoreline armoring and establish a range of setback requirements contingent upon site conditions. The rules do not apply to post-disaster rebuilding.

New Jersey State Flood Hazard Area Program

Severe statewide flooding in 2004 led New Jersey to update its Flood Hazard Area Control Act rules and related amendments to the state’s Coastal Permit Program rules and Coastal Zone Management rules. The rules adopted by the New Jersey Department of Environmental Protection in 2007 set more stringent standards for development in flood hazard areas and riparian zones adjacent to surface waters throughout the state. The changes include new flood hazard area and riparian zone standards applied to the review of all CAFRA (Coastal Area Facility Review Act) and Waterfront Development permits. These changes include a requirement that the lowest finished floor of a new building must be at least one foot above base flood elevation. Other new standards include a requirement for 0% net infill in all non-tidal flood hazard areas of the state to protect hydrological functions, and expanded riparian buffers to protect aquatic life.⁴³



Storm damaged house being raised above base flood elevation. (Photo: Harriet and Bud Hankins)

New Jersey Hazard Mitigation Planning

All of New Jersey’s coastal communities participate in the NFIP with the vast majority also

⁴³ Rules available at www.nj.gov/dep/landuse/se.html; a technical guidance manual in development will eventually be posted at www.nj.gov/dep/landuse/forms/index.html - se.

participating in the NFIP's Community Rating System. Actions related to public information, mapping and regulations, flood damage reduction, and flood preparedness can result in reduced flood insurance premiums for all property owners within the community.⁴⁴ All New Jersey counties have, at minimum, commenced the preparation of all-hazard mitigation plans, with several completed plans exceeding the Federal Emergency Management Agency (FEMA) content requirements by addressing supplementary processes such as chronic coastal erosion and sea level rise and their resulting impacts on future flood hazard planning and mitigation. Plans produced by several of the state's coastal counties have been approved by FEMA and thus qualify county municipalities as eligible to apply for federal hazard mitigation planning and project grants. In 2003 New Jersey Sea Grant College Program published a Manual for Coastal Hazard Mitigation compiling information on coastal hazard processes and providing technical guidance for implementing effective hazard reduction projects and planning.⁴⁵

New Jersey Green Acres and Coastal Blue Acres Program

Since 1961 New Jersey's "Green Acres" program has had the charge of acquiring available open space to provide linked protected areas as open space corridors to enhance wildlife protection, recreation, and aesthetic benefits, with many such areas in the state's coastal zone. Within this program, a "Coastal Blue Acres" element was legislated in 1995 in order to acquire and conserve coastal lands subject or prone to storm damage or that buffer or protect other lands from storm damage. In the past, Blue Acres funds were awarded as matching grants to acquire, from willing sellers, unimproved or minimally improved coastal lands at risk of storm damage or able to buffer potential storm damage, and lands that suffered severe reduction in value as a result of storm damage. In 2007, New Jersey voters approved the "Green Acres, Farmland, Blue Acres, and Historic Preservation Bond Act" that provided renewed funding for the Green Acres program, as well as specific funding for the Delaware River, Passaic River, and Raritan River floodways and associated tributaries, although funding was subsequently reallocated toward other purposes, delaying effective implementation.⁴⁶

Virginia Living Shorelines Program

The Living Shorelines program is an initiative implemented since 2006 by the Virginia Coastal Zone Management Program. Living Shorelines promotes alternatives to conventional shoreline armoring that protect property from erosion while preserving or increasing wildlife habitat, and protecting water quality by trapping excess nutrients and sediment.⁴⁷ While the Living Shorelines program predates the Climate Change Action Plan, it is consistent with Plan recommendations.

⁴⁴ Information at www.fema.gov/business/nfip/crs.shtm.

⁴⁵ The manual may be downloaded at www.state.nj.us/dep//cmp/coastal_hazard_manual.pdf.

⁴⁶ Information on the circa 1995 Blue Acres program is available at www.state.nj.us/dep/greenacres/blue.htm; information for the overarching Green Acres program can be found at www.state.nj.us/dep/greenacres/.

⁴⁷ Living Shorelines program information is available at www.deq.state.va.us/coastal/livingshore.html.

Living Shorelines use nature-based techniques such as marsh plantings, beach nourishment, and low profile oyster reefs, breakwaters, and sills to reduce erosion threats to shorelines. The program is using approximately \$800,000 of federal Coastal Zone Management Act funds to carry out the program in 2006-2011. Program components (status in parentheses) include:

- A "Living Shoreline Summit" with peer reviewed proceedings, to advance the use of this management technique (December, 2006).
- Revised wetlands guidelines to be used by the Virginia Marine Resources Commission, the Virginia Institute of Marine Science (VIMS), local wetlands boards and others to guide decisions about shoreline and tidal wetlands management (Drafted by VIMS and submitted to the Virginia Marine Resources Commission for consideration).
- Improved data on shoreline conditions to support more informed shoreline management decisions (9 local shoreline inventories and 8 local shoreline evolution reports completed or underway and \$150,000 in funding support scheduled for the 2010 fiscal year).
- Research to document the habitat value and viability of living shorelines and to improve their design (2 research projects on better sill design completed by VIMS).
- Guidance for local governments to use in shoreline management planning (brochure and Powerpoint presentation completed).
- Outreach materials for land use decision-makers, landowners, and contractors on Living Shorelines advantages and design principles (landowner brochure completed, upgraded website for three user-groups under development).
- A training program for contractors and local government staff on Living Shorelines practices (under development).
- A report on improving management of Virginia's dune and beach resources, including proposed revisions to the Coastal Primary Sand Dunes and Beaches Act (completed).
- Changes to the Coastal Primary Sand Dunes and Beaches Act by the Virginia General Assembly (adopted 2008 – expanded Act from 9 localities to the entire coastal zone).
- Revisions to the Coastal Primary Sand Dunes and Beaches Guidelines. (Drafted by VIMS and submitted to the Virginia Marine Resources Commission for consideration).
- A comparative analysis of two methodologies for developing local shoreline management plans (under development).

Other potential components include a fast track or general permit for Living Shorelines and a strategy for increasing the availability of plants for Living Shorelines projects. Grant funding to implement Living Shorelines projects is available through a partnership among the Chesapeake Bay Trust, NOAA Restoration Center, Keith Campbell Foundation, and the National Fish and Wildlife Foundation.⁴⁸

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⁴⁸ Living Shorelines grant information is available at www.cbtrust.org/site/c.mjPKXPCJnH/b.5457537/k.B2A2/Living_Shorelines.htm.

The projects described below illustrate varying scales and emphases in considering the impacts of climate change and sea level rise on the flora and fauna of the Mid-Atlantic states. They generally fall into one of two categories: reassessing comprehensive statewide wildlife plans, and developing methodologies for prioritizing the protection of natural areas for climate change adaptation.

Delaware Tidal Marsh Vulnerability Index project

In another Delaware Sea Level Rise Initiative technical project, the Delaware Coastal Program and the University of Delaware are developing a Tidal Marsh Vulnerability Index to assess the long-term viability of Delaware's marshes under differing sea level rise scenarios and to target areas for conservation, restoration, and monitoring. The Index will be used in conjunction with time-series analysis of aerial imagery to evaluate wetland vulnerability on a watershed or statewide basis, and to prioritize investments of scarce monitoring resources to evaluate the most severely threatened marsh areas. The project is being carried out at a number of test sites around the state, with the target of developing by March 2013 statewide and regional marsh vulnerability indexes for *Spartina alterniflora* and other indicator species. Once developed, the Sea Level Rise Index for Tidal Marshes tool could be transferred to other states and used for regional comparisons and regional planning.⁴⁹

Maryland Wildlife and Heritage Program Initiative

In July 2009, MDNR's Wildlife and Heritage Program began an assessment of climate change vulnerability on Rare, Threatened and Endangered species and natural communities identified as Greatest Conservation Need. The assessment will be used to provide adaptation recommendations and next steps for incorporation of climate change into the Maryland Wildlife Diversity Conservation Plan. The information will also be incorporated in the development of a performance measures monitoring system to document progress of the implementation of the Maryland Wildlife Diversity Conservation Plan.⁵⁰

Maryland Land Conservation Initiative

In August 2009 a NOAA Coastal Management Fellow began work on the project *Coastal Land Conservation in Maryland: Targeting Tools and Techniques for Sea Level Rise Adaptation and Response*.⁵¹ The project will define the characteristics of adaptive lands in Maryland, identify where the most effective habitat migration areas are located, and clarify the management actions needed to enhance their adaptation and migration potentials. For example, management activities could seek to maintain coastal ecosystem structure and function through restoration and protection activities to ensure that ecosystems can migrate and adapt, as well as sustain coastal ecosystem services (e.g., Bay water quality and coastal community

⁴⁹ See the project description in the Sea Level Rise Initiative Project Compendium available at: www.swc.dnrec.delaware.gov/coastal/Pages/SeaLevelRiseAdaptation.aspx

⁵⁰ For information on the wildlife plan efforts contact Zoë Johnson, Maryland Dept. of Natural Resources. Email: zjohnson@dnr.state.md.us Phone: (410) 260-8741.

⁵¹ Information at webqa.csc.noaa.gov/cms/fellows/pdfs/2009_MD.pdf

flood control and storm-surge protection). The Fellow is expected to develop and run a GIS-based model to assess and identify adaptive coastal lands, develop an “adaptive benefits” scorecard, and coordinate with land and habitat planning groups to use the scorecard to modify conservation policies or management strategies.

New Jersey State Wildlife Action Plan Climate Change Inclusion

New Jersey’s Wildlife Action Plan is undergoing major revisions. Among the key revisions is the inclusion of climate change predictions and concerns for New Jersey in addition to highlighting important ways these impacts may affect each regional landscape (for the entire state there are currently five regional landscapes included within the scope of the plan). The revised Plan will identify if and how each of the current conservation actions addresses the impacts of climate change on wildlife and their habitats based on five basic natural resource management strategies outlined by the U.S. Forest Service. Four of these are adaptation strategies while one is a mitigation strategy. The Plan revision will also create a sixth region, the Marine Region, thereby elevating marine habitats and wildlife to the same level as the terrestrial landscapes.⁵² A formal revision scheduled for 2015 will include more detailed information regarding climate change impacts, habitat and wildlife vulnerability, and management guidance to combat the negative impacts of climate change on New Jersey’s wildlife and their habitats (described below).

In a related development, the New Jersey Division of Fish and Wildlife hosted a workshop on October 1, 2009 to gather input from stakeholder groups on the subject of global climate change and its impact on natural resources, especially populations of wildlife. Given the potential impact of climate change on the state and its natural communities, participants in the workshop agreed that New Jersey Division of Fish and Wildlife should engage in an analysis of the relative vulnerabilities of New Jersey's habitats and species to the changes in the state's climate. This analysis will serve as basis for developing management options for climate change mitigation and adaptation. The New Jersey Division of Fish and Wildlife, working with stakeholders, is formulating a request for proposal for circulation to groups and entities qualified to carry out an analysis of the vulnerabilities of the natural resources across the multitude of habitats and species found in the state.

New York State Wildlife Climate Change Alliance

NYSDEC is part of the newly-formed Wildlife Climate Change Alliance, a coalition of state agency and non-governmental organizations formed to facilitate integration of climate change adaptation into natural resource management. The coalition has sponsored a series of workshops for NYSDEC staff and others intended to build capacity for climate change adaptation planning. An initial workshop entitled, “Safeguarding New York’s Wildlife and Natural Systems in a Changing Climate” was designed to provide a basic understanding of current climate change science and legislation, already occurring fish, wildlife and natural

⁵² Updated information about New Jersey’s Wildlife Action Plan should eventually be posted at <http://www.state.nj.us/dep/fgw/ensp/waphome.htm>.

system adaptations, and how NYSDEC can work collaboratively with its conservation partners to respond to future adaptation needs.

Virginia Wildlife Action Plan Climate Change Supplement

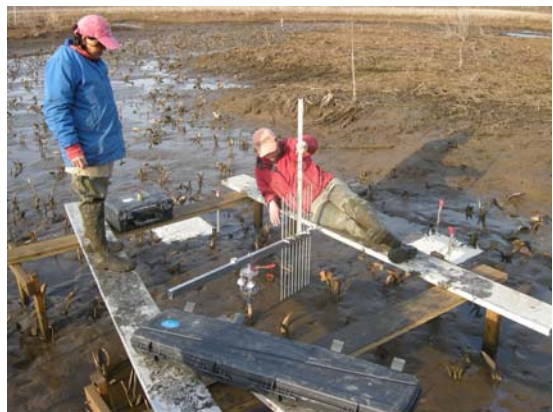
The Virginia Department of Game and Inland Fisheries, National Wildlife Federation, and Virginia Conservation Network are working together to update Virginia's Wildlife Action Plan to integrate climate change. As a part of this work the partners hosted two workshops on the same theme: *Conserving Virginia's Fish and Wildlife for the Future: Preparing for a Changing Climate*. Both workshops brought together representatives of state and federal agencies, conservation organizations, communities, and the private sector to collaboratively develop strategies to adapt Virginia's wildlife management, planning, and conservation efforts to climate change. The first workshop, held in October 2008, identified likely climate change impacts to Virginia's fish and wildlife and conservation priorities, and recommended options for adapting conservation efforts to meet changing conditions. The second workshop, held in March 2009, focused on specific ecological and wildlife issues, education and outreach, and modeling and data. Participants evaluated draft strategies to protect wildlife from climate change in Virginia, offered feedback on an outreach strategy, and discussed existing conservation management tools and additional needs. The two workshops will generate a companion document to Virginia's Wildlife Action Plan that will help the state address climate change implications for the state's wildlife as it implements the plan.⁵³

⁵³ Information on the climate change supplement to the state Wildlife Action Plan is available at www.vcnva.org/anx/index.cfm/1,342,0,0,html/ppp

UTILIZING NATIONAL ESTUARINE RESEARCH RESERVES

All five states have National Estuarine Research Reserves, estuarine areas dedicated to coordinated research, monitoring, education, stewardship and training programs operated through a partnership between state or academic agencies and NOAA. The local partner oversees day-to-day management, while NOAA connects the Reserves in a national network and provides linkages to federal agencies. In 2008 the Reserves developed a system-wide plan to engage its array of programs to help coastal managers and the public understand and prepare for climate change.⁵⁴ The plan outlines the Reserves' commitment to carry out the following activities:

- Contribute to scientific understanding of climate change and monitor ecosystem changes.
- Assess climate change impacts on human and estuarine ecosystem communities, vulnerability of these communities, and their capacity for adaptation and mitigation.
- Provide educational opportunities and training related to effects of climate change on human and estuarine systems to increase public awareness and foster behavior change.



Chesapeake Bay National Estuarine Research Reserve Research Coordinator Dr. Patricia Delgado and Research Assistant Lindsay Carroll measuring marsh accretion and subsidence using surface elevation tables. (Photo: MD CBNERR)

Below are some examples of how this commitment is being implemented at Reserves in the Mid-Atlantic region.

Delaware National Estuarine Research Reserve

The Delaware National Estuarine Research Reserve, a component of the Delaware Coastal Program implemented in partnership with NOAA, is playing a lead role in implementing many of the Delaware Sea Level Rise Initiative communications, training, and public involvement activities related to sea level rise and climate change.⁵⁵ Recent training examples include a *Coastal Inundation Mapping GIS Training* sponsored jointly with the NOAA Coastal Services Center (August 2009), *Preparing for Sea Level Rise: Development of an Adaptation Strategy for the State of Delaware Issue Characterization Workshop* (March 2009), and a *Coastal Resiliency and Vulnerability Assessment Training* the Reserve sponsored jointly with Delaware Sea Grant Marine Advisory Service and NOAA Coastal Services Center (December 2008).

⁵⁴ The NERR plan is available at www.nerrs.noaa.gov/BGDefault.aspx?ID=470.

⁵⁵ Information about the Reserve is available at www.swc.dnrec.delaware.gov/coastal/dnerr/Pages/DelawareNationalEstuarineResearchReserve.aspx.

The Reserve also conducted a public perceptions survey of Delaware residents about sea level rise and climate change asking about Delaware residents' awareness and understanding of key issues regarding climate change and sea level rise. Residents were asked questions in the following categories:

- Perceptions of the relative importance of environmental issues.
- Knowledge and awareness of climate change.
- Opinion on climate change and whether climate change is happening.
- Perceptions of climate change and sea level rise as a threat.
- Potential actions perceived to affect climate change.
- Perceptions of efficacy of taking action to mitigate climate change.
- Management strategies pertaining to sea level rise.
- Responsibility for taking action.

The Reserve will use survey results to formulate a comprehensive marketing and outreach strategy to enhance public and coastal stakeholder awareness and response to sea level rise.⁵⁶

Chesapeake Bay National Estuarine Research Reserves in Maryland and Virginia

Maryland and Virginia each have a Chesapeake Bay National Estuarine Research Reserve. Both are engaged in activities to enhance public awareness, train coastal managers, and build capacity related to climate change adaptation. Both reserves – one operated by the Maryland Department of Natural Resources, the other by the Virginia Institute for Marine Studies – have offered training sessions such as “How Prepared Are You For Rising Waters? Planning for Sea Level Rise” and implementation of each state’s Living Shorelines policies.⁵⁷



Jacques Cousteau National Estuarine Research Reserve (JCNERR). (Photo: JCNERR)

New Jersey National Estuarine Research Reserve Coastal Training Program

As in other states, New Jersey’s Jacques Cousteau National Estuarine Research Reserve is delivering climate change-focused training. The Cousteau Reserve offers training on adapting to sea level rise, coastal erosion, and severe storms including background information,

⁵⁶ “Delaware Residents’ Opinions on Climate Change and Sea Level Rise” is available at <http://www.swc.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/SLRSurveyReport.pdf>

⁵⁷ For Maryland’s activities see the upcoming and recent training activities described at www.dnr.state.md.us/bay/cbnerr/ctraining.asp. For Virginia’s activities see www.vims.edu/cbnerr/coastal_training/index.php.

case studies and tool kits with model ordinances.⁵⁸ The reserve also recently held a conference for public officials and planners on “*Preparing Your Community in the Face of a Changing Climate*,” which sought to inform local officials of hazards and potential impacts from anticipated climate change and sea level rise.

ENGAGING AND EDUCATING THE PUBLIC

Nearly all the state activities described in the preceding sections – particularly those sponsored by the National Estuarine Research Reserves in each state – incorporate elements intended to engage and educate the public about climate change impacts and adaptation needs. This section highlights two non-Reserve efforts to develop a tool or program specifically targeting education of local officials and the public about climate change impacts.

Delaware Google KML Map Development.

Recognizing that local governments have a primary role in land-use decisions but lack the GIS infrastructure to support large scale planning efforts related to coastal hazards and sea level rise, the Delaware Coastal Program and the DNREC Office of Information Technology will produce and distribute Community Resilience Planning Maps via the Delaware Coastal Program website. Local governments will be able to access and manipulate the information using free, internet-based mapping applications such as Google Maps and Virtual Earth. For a relatively low financial investment local governments can also make the information available via applications such as ArcIMS and Google Earth; these are more robust applications that allow for more complex views of information. The project’s goal is to make the state’s substantial investment in GIS usable by local governments. Making the state’s existing and future data layers available in KML format will allow local governments to create maps for planning workshops and other forms of public outreach. Distribution will initially focus on two coastal communities engaged in Delaware Coastal Program supported resiliency planning. The project, one of the Delaware Sea Level Rise Initiative’s communication, training and public involvement activities, is scheduled for completion in August 2010.⁵⁹

Virginia Community Environmental Education

Since 2001 the Virginia Office of Environmental Education⁶⁰ has overseen state efforts to educate citizens, communities, educators, and local government staff living in Virginia’s coastal zone about the causes of climate change and how they affect Virginia. In fall 2009 the Office of Environmental Education received funding from the state coastal zone management program to develop a Virginia Public Climate Change Education Training Program targeting community environmental educators; update Virginia’s master plan for environmental literacy; continue

⁵⁸ Information at <http://www.jcnerr.org/education/coastaltraining/climatechange.html>.

⁵⁹ The KML Map development project is described in the Compendium available at the Delaware Coastal Program website: www.swc.dnrec.delaware.gov/coastal/Pages/SeaLevelRiseAdaptation.aspx

⁶⁰ Information on the Office of Environmental Education available at www.deq.virginia.gov/education/.

supporting regional environmental education alliances or partnerships such as the Hampton Roads Alliance for Environmental Education; coordinate implementation of Chesapeake Agreement education commitments; strengthen communication among Virginia's 1,000 environmental, bay and marine educators through the Virginia Naturally program; administer agency and inter-agency water education programs; and support the Virginia Department of Environmental Quality's communication and education goal of an "informed and engaged citizenry."

SAFEGUARDING TRANSPORTATION INFRASTRUCTURE

At a policy level all the MARCO states have identified a need to assess and develop measures to address the risks to transportation infrastructure from sea level rise and other climate change impacts. Three of the states have projects underway to begin the evaluation process.

Delaware Transportation Planning

At present DNREC works informally with the Delaware Department of Transportation on sea level rise matters, but DNREC's recent adoption of an agency policy on sea level rise (see above) will coordinate DNREC internally and help set the stage for more formal interagency coordination on this issue. The Wilmington Area Planning Council (WILMAPCO) is the federally required metropolitan transportation planning organization for Cecil County, Maryland and New Castle County, Delaware. WILMAPCO is charged with planning and coordinating how to invest federal transportation funds to meet regional needs. In early 2010 the organization commenced work on a sea level rise transportation vulnerability assessment in coordination with those of Delaware and Maryland. WILMAPCO's assessment will profile existing and planned transportation infrastructure (highways, railways, marinas, etc.) and projects at risk for inundation at projected sea rise levels.⁶¹

Maryland Department of Transportation Initiative

The Maryland Department of Transportation is working to assess Maryland's critical transportation facilities and systems' vulnerability to projected sea level rise and extreme weather damage. The assessment will provide the information necessary to evaluate options for dealing with potential impacts to infrastructure and connectivity and the development of adaptation policies for existing and planned transportation facilities. The assessment will be used to inform development of a long-term strategic plan for system adaptation that can account for the uncertainty of future climactic conditions. Among Maryland agencies, the Maryland State Highway Administration (SHA) and the Maryland Transportation Authority (MTA) have the largest and most geographically dispersed network of facilities requiring the most complex long-term action plan. SHA has completed its assessment and the MTA

⁶¹ More information about the WILMAPCO project will be available at: www.wilmapco.org/SLR/.

assessment and inventory of mode-specific transportation system vulnerability is underway. Actions Plans for both agencies are expected to be issued in June 2011.⁶²

Maryland Port Administration Climate Change Vulnerability Assessment & Policy

As a component of the overall Maryland Transportation Initiative described above, the Maryland Port Administration (MPA) released the report, “Climate Change Vulnerability Assessment and Recommendations (2010).⁶³” The report includes recommendations for future programming of capital investments based on the findings of the vulnerability assessment. Facilities and systems under its management, as well as facilities being considered for development or redevelopment as part of MPA’s Marine Terminal Development Plan and Dredged Material Management Program are addressed.



Port of Baltimore. (Photo: MD Port Administration)

MPA has also developed a policy entitled “Incorporating Climate Change and Sea Level Rise Information into the Public Marine Terminal and Harbor Development Process.” The policy identifies the need for MPA, the owner and operator of Maryland’s public marine terminals, to make infrastructure and facility improvement decisions that consider climate change and sea level rise in order to maintain a competitive advantage for Maryland as well as to accommodate projected long-term growth in waterborne cargo.

New York State Transportation Agency Operations

In addition to its participation in ClimAID (see above) the New York State Department of Transportation (NYSDOT) awarded funding in October 2009 to Columbia University Earth Institute’s Center for Climate Systems Research for the project *Mainstreaming Climate Change Adaptation Strategies Into New York State Department of Transportation’s Operations*. The project will develop recommendations for the agency to integrate climate change risk assessment and management into its decision, policy, and planning processes using risk management and adaptation planning methods. The project has convened an Advisory Working Group on Transportation and Climate Change Adaptation. The Advisory Working Group is collaborating with a NYSDOT Technical Working Group.⁶⁴ NYSDOT has also convened an

⁶² For information on the Maryland transportation initiative contact Zoë Johnson, Maryland Department of Natural Resources. Email: zjohnson@dnr.state.md.us Phone: (410) 260-8741.

⁶³ Maryland Environmental Service and Johnson, Mirmiran, and Thompson. 2010. Maryland Port Administration Climate Change Assessment and Recommendations. Maryland Port Administration, Baltimore, Maryland.

⁶⁴ Information on the NYSDOT project is available at: www.utrc2.org/research/projects.php?viewid=193

internal Climate Change and Energy Efficiency Team to identify and advance strategies to curb the agency's greenhouse gas emissions and adapt its transportation infrastructure to the effects of climate change.

ADAPTING INSURANCE

Due to sea level rise and a likely increase in the intensity of coastal storm events, climate change poses significant risks to the insurance and reinsurance industry, the NFIP, and state-backed insurance programs. Even before considering the unforeseen weather-related events resulting from climate change, catastrophe losses have been doubling every ten years as a result of the surge in building along coastlines and other high-risk areas.⁶⁵

Maryland Climate Change Insurance Advisory Committee

In Fall 2008 the Maryland Insurance Commissioner convened a Climate Change Insurance Advisory Committee. The Committee is charged with: 1) reviewing the adequacy of the data available to insurers to assess the risk imposed by climate change; 2) examining whether adaptive options are available to help mitigate losses and rating can be structured to provide an incentive for these options; and 3) reviewing ways to promote partnerships with policyholders for loss mitigation. The Committee is scheduled to release its final report and recommendations in December 2010.⁶⁶

⁶⁵ *Climate Change and Insurance: An Agenda for Action in the United States*. A publication of Allianz Group and WWF, October 2006. Available at http://assets.panda.org/downloads/allianz_wwf_climate_change_and_insurance_embargoed_oct_2006.pdf

⁶⁶ For more information about the Maryland insurance initiative contact Joe Abe (410-260-8740 or jabe@dnr.state.md.us), the Maryland Chesapeake and Coastal Program staff person who serves on the Climate Change Insurance Advisory Committee.

APPENDIX A: OTHER IMPORTANT INITIATIVES

There are a number of climate change and sea level rise adaptation activities being carried out by other states, the federal government, and nongovernmental organizations that can affect or inform the work of the MARCO states. Particularly significant programs, policies, and activities singled out by Mid-Atlantic state agency contacts consulted in the course of preparing this white paper and information arising from supplemental internet research are described below.

STATE, LOCAL, AND NONGOVERNMENTAL APPROACHES OF INTEREST

A number of state and local government activities can inform the MARCO states in their development of a regional climate change and sea level rise adaptation strategy.

Local strategies compilation. In its publication “Local Strategies for Addressing Climate Change” the Coastal Services Center has compiled numerous case studies of state and local initiatives.⁶⁷

ICLEI Climate Resilient Communities Program. An international organization of local governments called ICLEI – Local Governments for Sustainability recently launched a *Climate Resilient Communities Program*. Operating in a vein similar to New York state’s *Climate Smart Communities Program* and Maryland’s *CoastSmart Communities Program*, ICLEI, in partnership with King County Washington and the Climate Impacts Group, has produced a first edition of a guidebook for local, regional, and state governments to assess and respond to possible climate change impacts to the built, natural, and social environments.⁶⁸

The Northeast Climate Impacts Assessment Project. In spring 2007 the Union of Concerned Scientists released the work of more than 50 independent scientists and experts participating in Union of Concerned Scientists’ Northeast Climate Impacts Assessment project.⁶⁹ Their final report, “Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions,” used global climate models to project changes this century – in temperature, precipitation, relative humidity, snow cover, and more – and effects on climate-sensitive sectors under varying greenhouse gas emission scenarios. (The report defined the Northeast to include NJ, NY, CT, ME, MA, NH, PA, RI, VT.)

⁶⁷ The local strategies compilation is available at www.csc.noaa.gov/magazine/climatechangestrategies.pdf.

⁶⁸ The ICLEI guidebook is available at www.iclei.org/programs/climate/Climate_Adaptation.

⁶⁹ NECA project documents are available at: www.northeastclimateimpacts.org/.

GAO ASSESSMENT OF THE FEDERAL ROLE

In October 2009 the U.S. Government Accountability Office (GAO) issued the report “Climate Change Adaptation: Strategic Federal Planning Could Help Government Officials Make More Informed Decisions.”⁷⁰ Among the report findings and recommendations:

- *Obstacles to adaptation.* The GAO found that competing priorities from more immediate needs, a lack of site-specific data (e.g., local projections of anticipated changes), and the absence of clearly defined roles and responsibilities among federal, state, and local agencies as key obstacles to adaptation efforts.
- *Possible priorities for federal action.* The GAO’s research discerned stakeholder desire for federal government action in three areas: 1) delivering training and education to raise awareness about adaptation needs and options among government agency officials and the general public; 2) providing and interpreting site-specific information to help officials understand climate change impacts at a relevant scale; and 3) clarifying roles and responsibilities for adaptation among federal, state, and local entities.
- *Recommendation for a national adaptation strategy.* A large majority of stakeholders interviewed by the GAO believed the development of a national adaptation strategy was needed to clarify roles and responsibilities for responding to climate change. The GAO recommended that the President direct the Council on Environmental Quality to “develop a national adaptation plan that includes setting priorities for federal, state, and local agencies” and noted that the Council on Environmental Quality generally agreed with the recommendations.

FEDERAL SEA LEVEL RISE AND CLIMATE CHANGE POLICY INITIATIVES

Several federal policy initiatives and reports, all in 2009, represent important steps by the federal government to move the nation toward climate change adaptation.

U.S. Army Corps of Engineers Sea Level Rise Policy. In July 2009 the U.S. Army Corps of Engineers issued the engineering circular “Water Resource Policies and Authorities Incorporating Sea-Level Change Considerations in Civil Works Programs” (EC 1165—2-211). The guidance applies only to civil works projects such as flood control and navigation projects (not the agency’s regulatory program).⁷¹

Executive Order 13508, Protecting and Restoring the Chesapeake Bay. In May 2009, President Obama signed an executive order (EO) for the Chesapeake Bay Protection and Restoration. The EO calls for the formation of a Federal Leadership Committee to oversee the development and coordination of programs and activities. With respect to climate change, the EO calls for the lead agencies (NOAA and USGS) to assess the impacts of a changing climate on the Chesapeake

⁷⁰ The report, GAO-10-113 October 7, 2009 is available at www.gao.gov/products/GAO-10-113.

⁷¹ A copy of the Corps policy is available at 140.194.76.129/publications/eng-circulars/ec1165-2-211/toc.html.

Bay and develop a strategy for adapting natural resource programs and public infrastructure to the impacts of a changing climate. In accordance with the EO, the Federal Oversight Committee released its Strategy for Protecting and Restoring the Chesapeake Bay Watershed in May 2010. The Strategy includes an element on “Responding to Climate Change”, which details recommendations for enhancing integrated observations systems to detect, monitor and advance our scientific understanding of climate change. The strategy also contains specific recommendations to direct federal agencies to address the impacts of climate change and provide the tools and resources needed to increase resiliency of communities and habitats in vulnerable areas.

National framework for sea level rise adaptation. NOAA and the USGS are working together to promote the formulation of a national framework for sea level rise adaptation. They convened a December 2009 workshop where representatives from all levels of government, nongovernmental organizations, industry, and academia discussed needs for data, tools, and information to support community preparedness for sea level rise and inundation. Proceedings will be available in early 2010.⁷²

Fish and Wildlife Service Strategic Plan for Climate Change. The U.S. Fish and Wildlife Service's 2009 draft Strategic Plan for Climate Change and companion Action Plan outline how the agency proposes to conserve fish and wildlife in a rapidly changing climate.⁷³

FEDERALLY-FUNDED ADAPTATION ACTIVITIES IN THE MID-ATLANTIC REGION

The following list is not exhaustive, but does highlight a number of federally-funded efforts – some targeting the Mid-Atlantic, others more general – to support climate change adaptation efforts.

NOAA Coastal Services Center. The NOAA Coastal Services Center (CSC) is a provider of a growing array of data, tools, training programs, and information designed to help communities understand the impacts of climate variability and change, and take the steps necessary to build capacity to plan for, respond to, and adapt to climate risks. These include:

- *Stakeholder engagement.* Facilitation, meeting design and planning, and partnership building to engage stakeholders.
- *Stakeholder communication.* Information in the form of websites, meetings, and publications for communicating to the public about effective (and ineffective) adaptation strategies.
- *Data and tools.* Data and tools to access, analyze, and communicate information to

⁷² For information about the development of the national framework for sea level rise adaptation contact Mary Culver, NOAA Coastal Services Center, mary.culver@noaa.gov.

⁷³ The Fish and Wildlife Service plan is available at www.fws.gov/home/climatechange/strategic_plan.html.

support decision making, including LiDAR, socioeconomic data, and data standards for mapping and visualizing hazards and climate change impacts.

- *Risk evaluation and communication.* Tools for understanding and explaining climate change risk, vulnerability, and uncertainty, including visualizations, risk assessments, and communication strategies.

For example, CSC's *Coastal Climate Adaptation Clearinghouse* is a site for state and local officials to learn about colleagues' adaptation activities and to access basic climate change information useful for outreach efforts. Resources include a collection of adaptation guides and plans, risk and vulnerability assessment methods, and outreach and education materials.⁷⁴ *Digital Coast* is a network coordinated by CSC to share data, tools, and training for coastal management.⁷⁵ As part of NOAA's North Atlantic Regional Team, CSC coordinates a number of Mid-Atlantic activities.⁷⁶ CSC Fellows working on climate change and sea level rise are detailed in the state descriptions above.⁷⁷ Offerings of particular interest include the *Digital Coast's* inundation toolkit,⁷⁸ upcoming Coastal Inundation Mapping training to be delivered in the mid-Atlantic, and GIS Tools for Strategic Conservation Planning training.⁷⁹

U.S. Department of Transportation Interstate 95 project. U.S. Department of Transportation (USDOT) awarded funding to researchers at the University of Delaware, Newark in September 2008 for a two-year study Understanding the Impacts of Climate Change on the I-95 Corridor in Maryland and Delaware. The researchers intend to develop an outline of guidelines for states and metropolitan planning organizations in the Interstate I-95 corridor linking Boston, MA and Norfolk, VA to integrate climate change adaptation strategies in the planning, design and construction of the corridor. The project will take an in-depth look at one aspect of climate change, sea level rise, on the I-95 and Northeast rail corridor in Maryland and Delaware.⁸⁰

National Estuary Program Climate Ready Estuaries. The Environmental Protection Agency's Climate Ready Estuaries program supports National Estuary Program partners and other coastal managers in assessing climate change vulnerabilities, developing and implementing adaptation strategies, public outreach, and sharing lessons learned. The Climate Ready Estuaries website offers information on climate change impacts to different estuary regions, access to tools and resources to monitor changes, and information to help managers develop adaptation plans for estuaries and coastal communities. National Estuary Programs in the Mid-Atlantic region

⁷⁴ CSC *Climate Adaptation Clearinghouse* can be accessed at community.csc.noaa.gov/climateadaptation/

⁷⁵ CSC *Digital Coast* resources can be accessed at www.csc.noaa.gov/digitalcoast/index.html

⁷⁶ CSC Mid-Atlantic initiatives are summarized at csc.noaa.gov/regions/midatlantic.html.

⁷⁷ Descriptions of all CSC Fellow placements are available at www.csc.noaa.gov/cms/fellows/stateprojects.html.

⁷⁸ The *Digital Coast* Inundation Toolkit can be accessed at www.csc.noaa.gov/digitalcoast/inundation/.

⁷⁹ CSC training programs are described at www.csc.noaa.gov/training/.

⁸⁰ Information on the USDOT-funded project is available at rip.trb.org/browse/dproject.asp?n=23136 and www.ce.udel.edu/UTC/Ames_McNeil_2009.html.

include: Peconic Bay (NY), Long Island Sound (NY), New York-New Jersey Harbor (NY, NJ), Barnegat Bay (NJ), Partnership for the Delaware Estuary (NJ, DE), Delaware Inland Bays (DE), and Maryland Coastal Bays (MD).⁸¹

Chesapeake Bay Program. According to its website, the Program's federal agency partners will be working to incorporate potential future climate patterns into its computer models to help scientists identify the most likely effects of climate change on Chesapeake Bay, its residents, and restoration efforts.⁸²

U.S. Climate Change Program Synthesis and Assessment Reports. In 2009 the U.S. Global Change Research Program issued the synthesis and assessment report "Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region." The report provides a detailed assessment for the Mid-Atlantic region of the effects of sea-level rise on coastal environments, and the steps needed to adapt to sea-level rise while protecting natural resources and sustaining economic growth. The only other region-specific U.S. Global Change Research Program synthesis and assessment report is its 2008 "Impacts of Climate Variability and Change on Transportation Systems and Infrastructure - Gulf Coast Study." Major findings include:

- Warming temperatures may require changes in materials, maintenance, and operations.
- Changes in precipitation patterns may increase short term flooding.
- Relative sea level rise may inundate existing infrastructure.
- Increased storm intensity may lead to greater service disruption and infrastructure damage.

⁸¹ Information about the Climate Ready Estuaries program is available at www.epa.gov/climate-ready-estuaries/.

⁸² See the Chesapeake Bay Program webpage on climate change at www.chesapeakebay.net/climatechange.aspx?menuitem=16860.

APPENDIX B: STATE BY STATE SUMMARIES

This appendix presents the same information that appears above in *Part II, Review of Climate Change and Sea Level Rise Initiatives in the MARCO States* in a format that allows the reader to assess the range of activities underway in an individual state.

DELAWARE

The State of Delaware's Sea Level Rise Initiative is the centerpiece of Delaware's climate change related efforts and the impetus for data development, technical assistance, public outreach, and policies to address the significant threat to the state's people and economy posed by sea level rise. The Initiative, launched in 2009, encompasses twenty projects, and is expected to bring about changes to a broad array of the state's existing enforceable policies relevant to sea level rise adaptation and other responses to climate change impacts. The Delaware Department of Natural Resources and Environmental Control (DNREC) Secretary is also considering the development of a comprehensive plan for climate change adaptation.⁸³

Delaware Sea Level Rise Initiative and Policy

Delaware's Sea Level Rise Initiative, inaugurated in 2009, is intended to institutionalize the consideration of sea level rise in all local and state decision making about human uses and natural resource management in Delaware. In a case study developed for a National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center workshop,⁸⁴ Delaware Coastal Program staff detailed internal program changes made to align budgets and job requirements to add sea level rise responsibilities to the portfolio of every Delaware Coastal Program staff person. These changes enabled the launch of the Sea Level Rise Initiative, which is focusing on four activities to promote sea level rise understanding, preparedness, and response:

- Technical decision support
- Policy development
- Implementation actions
- Communication, training and public involvement

⁸³ Personal communication, David Carter, Delaware Coastal Program, December 17, 2009. Note that in 2000 the Delaware Climate Change Consortium (DCCC), comprised of representatives from government, business, labor, environment and community-based organizations, issued a "Delaware Climate Change Action Plan" which acknowledged potential impacts of climate change, including sea level rise, but was exclusively focused on strategies to mitigate greenhouse gas emissions.

⁸⁴ Detailed information is available in the following document prepared for a December 2009 NOAA Coastal Services Center "Sea Level Rise and Inundation Community Workshop" held in December 2009: Carter, David B., Sarah W. Cooksey, Susan E. Love, Robert W. Scarborough. 2009. *Planning for Sea Level Rise in Delaware: A Case Study*. Delaware Department of Natural Resources, Delaware Coastal Programs. Dover, DE. Contact David Carter, Delaware Coastal Program, David.Carter@state.de.us to obtain a copy.

Delaware Coastal Program publishes a regularly-updated Sea Level Rise Initiative Project Compendium⁸⁵ of activities underway. The activities are detailed under the relevant categories below. By way of overview, they include:

- Early implementation projects involving two coastal communities and development of a coastal flood monitoring system.
- Policy initiatives including developing a statewide adaptation plan, retooling a grant program to spur community planning for coastal hazards and sea level rise, and participating in MARCO.
- A number of communication, training, and public involvement activities.
- Nearly a dozen scientific and technical support projects, including the release of GIS-based coastal inundation maps to determine the locations and extent of coastal vulnerability to sea level rise (described below).

In January 2010 the Secretary of the DNREC, the Delaware Coastal Program's umbrella agency, issued an order establishing as agency policy DNREC's commitment to "proactively consider and plan for the potential effects of coastal inundation department-wide using projections based on the best available science." The policy directs DNREC staff and programs to:

6. Communicate the policy internally and externally when representing the department.
7. Consider the potential effect of coastal inundation in project planning, engineering, design, and review, as well as land acquisition, management, and restoration.
8. Conduct a vulnerability assessment for all DNREC holdings and assets to identify risks from inundation and develop plans to increase resiliency and adaptability within 12 to 18 months.
9. Consider project alternatives that avoid siting buildings and infrastructure within areas that are vulnerable to inundation, or if avoidance is not practicable, design projects to address the consequences of inundation.
10. Use a prescribed range of sea level rise scenarios, appropriate to a given project's longevity and nature, with projects of a longer expected life or more sensitive nature adopting more protective sea level rise scenarios, with values to be adjusted as the Intergovernmental Panel on Climate Change and other peer reviewed publications produce updated projections and modeling techniques.

⁸⁵ The Compendium is available at the Delaware Coastal Program website:
www.swc.dnrec.delaware.gov/coastal/Pages/SeaLevelRiseAdaptation.aspx

Delaware Sea Level Rise Initiative: Keys to a Successful Launch

Delaware staff interviewed for this report noted three aspects of the Delaware Coastal Program's approach to the Sea Level Rise Initiative they believe are essential to the effort's progress:

- 1) Data. Developing a sound information basis for vulnerability analysis, especially through the acquisition of LiDAR topography data for the entire state. The LiDAR is viewed as having been a necessary prerequisite to carrying out all other components of the initiative, and the acquisition process rendered valuable lessons learned.⁸⁶
- 2) Outreach. Conducting a substantial outreach and education effort to begin to address the public's fundamental lack of awareness about the fact and implications of sea level rise.
- 3) Implementation. Carrying out early implementation projects that are ripe for action to test ideas along the way and build support for the development of sea level rise policy.

Delaware Coastal Inundation Maps

A key technical project completed under the Sea Level Rise Initiative is the Delaware Coastal Program's development of statewide sea level rise inundation maps delineating the areas and extent of coastal inundation due to sea level rise. The maps are pivotal to the anticipated development of Delaware's Statewide Sea Level Rise Adaptation Plan. The maps depict a number of scenarios using present-day and predicted future sea levels in the year 2100. The maps are designed to account for varying mean tide levels along the Delaware Bay Coast and projected flooding from coastal storm surges, two significant advantages over existing maps. The GIS-format maps are based on bare earth LiDAR data, and will be updated as new information on sea level rise becomes available.

Delaware Sea Level Rise Initiative Local Government Components

Many components of Delaware's Sea Level Rise Initiative are intended to build the capacity of local governments to address sea level rise (see above). One component, its Sustainable Coastal Communities Grant Program, is explicitly focused on helping communities to plan for coastal hazards and future impacts of sea level rise. The competitive grant program will fund communities to develop ordinances that protect natural resources and habitat, develop environmental conservation design standards for inclusion in local comprehensive land use plans, and conduct coastal habitat restoration project planning and implementation projects. The early implementation projects under the Sea Level Rise Initiative focus on two local governments. The Town of Bowers Beach and the City of Newcastle are recipients of assistance to develop action plans of prioritized projects intended to make each community more resilient

⁸⁶ See "Lessons Learned from Delaware LiDAR" on the NOAA Coastal Services Center website at www.csc.noaa.gov/digitalcoast/inundation/pdf/de_lessons.pdf.

and better able to recover from sea level rise, increased storm frequencies and intensities, tidegate and dike problems or failures, wetland loss, and other climate change impacts, and to effectively pursue funding for those actions.

Delaware Beach Preservation Act

DNREC implements the state's Beach Preservation Act by promulgating maps showing "building lines" that generally prohibit seaward construction activities.⁸⁷ The results of the Sea Level Rise Initiative are expected to drive whether and how this framework is updated.

Delaware Floodplain Hazard Mapping

Under the Delaware Sea Level Rise Initiative's City of Newcastle early implementation project to bolster local resiliency to climate change impacts, the city will be the first in Delaware to formally take sea level rise into consideration in mapping floodplain hazards.⁸⁸ (See "Supporting Local Governments" and "Sea Level Rise Initiatives" above for more information.)

Delaware Tidal Marsh Vulnerability Index Project

In another Delaware Sea Level Rise Initiative technical project, the Delaware Coastal Program and the University of Delaware are developing a Tidal Marsh Vulnerability Index to assess the long-term viability of Delaware's marshes under differing sea level rise scenarios and to target areas for conservation, restoration, and monitoring. The Index will be used in conjunction with time-series analysis of aerial imagery to evaluate wetland vulnerability on a watershed or statewide basis, and to prioritize investments of scarce monitoring resources to evaluate the most severely threatened marsh areas. The project is being carried out at a number of test sites around the state, with the target of developing by March 2013 statewide and regional marsh vulnerability indexes for *Spartina alterniflora* and other indicator species. Once developed, the Sea Level Rise Index for Tidal Marshes tool could be transferred to other states and used for regional comparisons and regional planning.⁸⁹

Delaware National Estuarine Research Reserve

The Delaware National Estuarine Research Reserve, a component of the Delaware Coastal Program implemented in partnership with NOAA, is playing a lead role in implementing many of the Delaware Sea Level Rise Initiative communications, training, and public involvement activities related to sea level rise and climate change.⁹⁰ Recent training examples include a *Coastal Inundation Mapping GIS Training* sponsored jointly with the NOAA Coastal Services

⁸⁷ See Delaware Code Title 7 – Conservation, Chapter 68. Beach Preservation at delcode.delaware.gov/title7/c068/index.shtml

⁸⁸ See the project description in the Sea Level Rise Initiative Project Compendium available at: www.swc.dnrec.delaware.gov/coastal/Pages/SeaLevelRiseAdaptation.aspx.

⁸⁹ See the project description in the Sea Level Rise Initiative Project Compendium available at: www.swc.dnrec.delaware.gov/coastal/Pages/SeaLevelRiseAdaptation.aspx

⁹⁰ Information about the Reserve is available at www.swc.dnrec.delaware.gov/coastal/dnerr/Pages/DelawareNationalEstuarineResearchReserve.aspx.

Center (August 2009), *Preparing for Sea Level Rise: Development of an Adaptation Strategy for the State of Delaware Issue Characterization Workshop* (March 2009), and a *Coastal Resiliency and Vulnerability Assessment Training* the Reserve sponsored jointly with Delaware Sea Grant Marine Advisory Service and NOAA Coastal Services Center (December 2008).

The Reserve also conducted a public perceptions survey of Delaware residents about sea level rise and climate change asking about Delaware residents' awareness and understanding of key issues regarding climate change and sea level rise. Residents were asked questions in the following categories:

- Perceptions of the relative importance of environmental issues.
- Knowledge and awareness of climate change.
- Opinion on climate change and whether climate change is happening.
- Perceptions of climate change and sea level rise as a threat.
- Potential actions perceived to affect climate change.
- Perceptions of efficacy of taking action to mitigate climate change.
- Management strategies pertaining to sea level rise.
- Responsibility for taking action.

The Reserve will use survey results to formulate a comprehensive marketing and outreach strategy to enhance public and coastal stakeholder awareness and response to sea level rise.⁹¹

Delaware Google KML Map Development.

Recognizing that local governments have a primary role in land-use decisions but lack the GIS infrastructure to support large scale planning efforts related to coastal hazards and sea level rise, the Delaware Coastal Program and the DNREC Office of Information Technology will produce and distribute Community Resilience Planning Maps via the Delaware Coastal Program website. Local governments will be able to access and manipulate the information using free, internet-based mapping applications such as Google Maps and Virtual Earth. For a relatively low financial investment local governments can also make the information available via applications such as ArcIMS and Google Earth; these are more robust applications that allow for more complex views of information. The project's goal is to make the state's substantial investment in GIS usable by local governments. Making the state's existing and future data layers available in KML format will allow local governments to create maps for planning workshops and other forms of public outreach. Distribution will initially focus on two coastal communities engaged in Delaware Coastal Program supported resiliency planning. The project, one of the Delaware Sea

⁹¹ "Delaware Residents' Opinions on Climate Change and Sea Level Rise" is available at <http://www.swc.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/SLRSurveyReport.pdf>

Level Rise Initiative's communication, training and public involvement activities, is scheduled for completion in August 2010.⁹²

Delaware Transportation Planning

At present DNREC works informally with the Delaware Department of Transportation on sea level rise matters, but DNREC's recent adoption of an agency policy on sea level rise (see above) will coordinate DNREC internally and help set the stage for more formal interagency coordination on this issue. The Wilmington Area Planning Council (WILMAPCO) is the federally required metropolitan transportation planning organization for Cecil County, Maryland and New Castle County, Delaware. WILMAPCO is charged with planning and coordinating how to invest federal transportation funds to meet regional needs. In early 2010 the organization commenced work on a sea level rise transportation vulnerability assessment in coordination with those of Delaware and Maryland. WILMAPCO's assessment will profile existing and planned transportation infrastructure (highways, railways, marinas, etc.) and projects at risk for inundation at projected sea rise levels.⁹³

⁹² The KML Map development project is described in the Compendium available at the Delaware Coastal Program website: www.swc.dnrec.delaware.gov/coastal/Pages/SeaLevelRiseAdaptation.aspx

⁹³ More information about the WILMAPCO project will be available at: www.wilmapco.org/SLR/.

MARYLAND

Maryland has vigorously developed policies and programs over the past decade to address its existing and impending threats from climate change. As awareness and understanding of those threats grew, the state moved to build on earlier efforts focused on coastal hazards to create a comprehensive state climate change strategy whose implementation is well under way.

Maryland: The Comprehensive Strategy to Reduce Maryland's Vulnerability to Climate Change

In 2007 Governor Martin O'Malley issued an executive order establishing the Maryland Commission on Climate Change (MCCC). In 2008 the Commission produced the state's sweeping Climate Action Plan addressing science, mitigation, and adaptation to the impacts of climate change on Maryland. The Plan's adaptation component is found in Chapter 5, the *Comprehensive Strategy to Reduce Maryland's Vulnerability to Climate Change* (Adaptation Strategy).⁹⁴ The Adaptation Strategy identifies the Maryland Department of Natural Resources (MDNR) as the lead agency, with support from a wide range of other state agencies.

Phase One of the 2008 Adaptation Strategy focuses on protecting the state's economy and environment and securing public safety in the face of climate change-induced sea level rise and coastal storms. The Adaptation Strategy detailed 18 Phase One legislative, policy, and planning actions to:

- Reduce impacts both to existing built environments and future growth and development.
- Avoid financial and economic impacts.
- Protect human health, safety, and welfare.
- Protect and restore forests, wetlands, and beaches that protect against climate change impacts.

Phase One accomplishments include passage in 2008 of two laws intended to reduce vulnerability over time and protect natural resources from the impacts of sea level rise by restoring natural shoreline buffers such as grasses and wetlands, and by limiting new growth in vulnerable areas. These laws are the Living Shoreline Protection Act and the Chesapeake and Coastal Bays Critical Area Act amendments. (See below for more detailed descriptions of these and other Phase One implementation results.)

In December 2009, Maryland initiated development of Phase Two of its Adaptation Strategy. The Strategy, scheduled for release in January 2011, is the product of over 80 experts from the governmental, non-profit, and private sectors that held a series of meetings to synthesize the most recent climate change literature, evaluate adaptation options and recommend adaptation strategies to reduce the Maryland's overall vulnerability to climate change. The Strategy outlines adaptation strategies to reduce the impacts of climate change, including sea level rise,

⁹⁴ Available at www.mde.state.md.us/assets/document/Air/ClimateChange/Chapter5.pdf.

increased temperature and changes in precipitation within the following sectors: Human Health; Agriculture; Forest and Terrestrial Ecosystems; Bay and Aquatic Environments; Water Resources; and Population Growth and Infrastructure. The Phase Two Strategy will provide the basis for guiding and prioritizing state-level activities with respect to both climate science and adaptation policy within short to medium-term timeframes.

Maryland Data Acquisition, Mapping, and Modeling

Maryland has made significant progress acquiring new technology and data, including historic shoreline change data and statewide high resolution topographic data (LiDAR), and has utilized this data to undertake state-of-the-art sea level rise mapping and research. Data have been acquired both by MDNR and by individual Maryland counties. Some of the data products and technical tools currently available include: state-wide sea level rise vulnerability mapping, historic shoreline position and erosion rate calculations, a comprehensive coastal inventory, a sea level rise economic impact assessment, the Erosion Vulnerability Assessment Tool, the Living Shoreline Suitability Model, and the Worcester County Sea Level Rise Inundation Model.⁹⁵

The Worcester County Sea Level Rise Inundation Model, developed through a partnership among MDNR, the U.S. Geological Survey (USGS) and Worcester County, was designed to support a number of the state's sea level rise and coastal hazard planning goals. USGS created a highly detailed LiDAR topographic elevation model of Worcester County to analyze the impact of rising sea level and storm flooding on Worcester County's coastline and low-lying inland areas. The resulting sea level rise inundation scenarios depict long-term and low magnitude changes in the position of Mean Sea Level and Mean High Water resulting from the ongoing rate of relative sea level rise for the area (3.0 mm/yr) and increased rates of rise suggested by climate change projections. Each of the scenarios was adapted to combine sea level rise and storm surge inundation of the area for Category 1 to Category 4 hurricanes. A Technical Report provides the methodology for the project and contains recommendations for future use of the model in state and local sea level rise planning efforts.⁹⁶

Maryland CoastSmart Communities Initiative

MDNR developed the *CoastSmart* Communities Initiative to support local level implementation of the Adaptation Strategy.⁹⁷ Under the initiative local governments can access an online resource center with a comprehensive toolbox of resources to become ready, adaptive, and resilient to the impacts of sea level rise and coastal storms. MDNR launched the program with a 2009 *CoastSmart* Communities summit whose centerpiece was a role-play exercise. Ongoing activities, detailed below, include promoting additional role play exercises, grants, technical

⁹⁵ Maryland has made most of its data products and tools available online at Maryland Shorelines Online: shorelines.dnr.state.md.us/

⁹⁶ The Worcester County Sea Level Rise Inundation Model Technical Report is available at www.dnr.state.md.us/Bay/czm/wcslrreport.html

⁹⁷ Information available at <http://www.dnr.maryland.gov/CoastSmart/>.

assistance, a scorecard tool, and a hazards policy review.

Role-play summit. The *CoastSmart* Communities spring 2009 high-level interactive summit and role-play exercise drew hundreds of coastal leaders from around the state. The participants engaged in a hypothetical decision-making process informed by real-world information. Professional facilitators mediated negotiations over actions that coastal communities could take to protect their citizens, infrastructure, and investments from future risk. Participants used a scorecard that ranked actions by effectiveness and cost. They learned about key choices communities face, how to anticipate risks and opportunities, and tools that can help foster community readiness, adaptability, and resilience in the face of climate change. MDNR, the Consensus Building Institute, and the MIT-U.S. Geological Survey Science Impact Collaborative jointly created the *CoastSmart* Communities summit and role-play exercise with funding from NOAA.

Grant and technical assistance program. The *CoastSmart* Communities summit was also the occasion for the inauguration of a companion competitive grant program to provide financial and technical assistance to local governments that wish to reduce their vulnerability to the effects of coastal hazards and sea level rise through their planning and permitting activities. The grants of up to \$75,000, drawn from the state's federal Coastal Zone Management Act funds, will be awarded on an annual basis. Successful projects are eligible to receive continued support for up to three years to achieve project goals and result in the adoption of an enhancement to the Maryland coastal management program. MDNR, which manages the grants, selected its first four projects in September 2009: Ann Arundel County will develop a strategic plan targeting sea level rise and climate change; Caroline County will improve its floodplain and stormwater management programs; the City of Annapolis will develop a sea level rise adaptation and response plan that includes a vulnerability and impact assessment and policy response options; and Queenstown will develop an integrated community and watershed design project.

CoastSmart Communities Scorecard. Building on the concept of the role-play scorecard, MDNR is currently developing a more comprehensive community self assessment scorecard. The new scorecard will provide a practical method to assess how well prepared a community is to face climate change impacts, and identify specific, realistic ways communities can integrate sea level rise into existing issue-based planning, management and regulatory programs. The scorecard categories will align with the Adaptation Strategy's sectors of transportation planning, shoreline and buffer management, land use planning, building codes and infrastructure design planning, natural resource management, and emergency disaster preparedness and response. MDNR expects to complete the scorecard in the spring of 2011; some of the strategies can already be found among the "*Building CoastSmart Communities*" role-play materials at the program website.⁹⁸

⁹⁸ Information available at <http://www.dnr.maryland.gov/CoastSmart/>.

Maryland Sea Level Rise Planning Guidance for Local Government

MDNR's Chesapeake and Coastal Program provided funding for Worcester, Somerset, and Dorchester Counties to develop sea level rise planning guidance documents in 2008. The documents are serving as "best practice" manuals for other coastal counties and informing development of the *CoastSmart* Communities Scorecard. Key components include: sea level rise vulnerability assessments; "critical action" identification; planning and regulatory development; and recommended public investment policies. All three documents highlight the importance of integrating sea level rise mapping and impact analysis information into comprehensive and emergency response planning within each jurisdiction.⁹⁹

Maryland Living Shoreline Protection Act 2008

In 2008 the Maryland legislature enacted a law similar to a Virginia law requiring riparian property owners to rely upon "living shorelines" – nonstructural shoreline stabilization measures such as marsh creation – whenever feasible to protect shorelines from erosion while also providing critical wildlife habitat.¹⁰⁰ A variety of public agencies are involved in implementing the program and related efforts. The Maryland Department of the Environment is charged with developing implementing regulations in cooperation with MDNR. In June 2009 the Maryland Department of the Environment issued draft regulations for a process to waive the requirement where nonstructural measures are not feasible, and to map areas designating locations where traditional structural solutions are required.¹⁰¹ MDNR's Maryland Chesapeake and Coastal Program conducts Living Shorelines outreach and training activities,¹⁰² as does the Chesapeake Bay National Estuarine Research Reserve Coastal Training Program (see additional information about the Reserve below).¹⁰³ Grants and loans to private landowners, nongovernmental organizations, and local governments to construct living shorelines are

⁹⁹ The sea level rise planning guidance documents for the three Maryland counties are available at www.dnr.state.md.us/dnrnews/infocus/climatechange.asp.

¹⁰⁰ The Act, Annotated Codes of Maryland, Environment Article, Section 16-201, can be downloaded at mlis.state.md.us/2008rs/chapters_noln/Ch_304_hb0973E.pdf.

¹⁰¹ MDE maps of areas structural shoreline stabilization maps are available at www.mde.state.md.us/Programs/WaterPrograms/Wetlands_Waterways/documents_information/wetlandtidalshoremeps.asp; its draft waiver regulations are available at www.mde.state.md.us/Programs/WaterPrograms/Wetlands_Waterways/regulations/proposed_ls_regs.asp.

¹⁰² The Maryland Chesapeake and Coastal Program's Living Shorelines information is available at shorelines.dnr.state.md.us/living.asp.

¹⁰³ Chesapeake Bay National Estuarine Research Reserve training for implementing Living Shorelines is described at www.dnr.state.md.us/bay/cbnerr/training_history.asp.

available from a number of sources, including the Chesapeake Bay Trust¹⁰⁴ and MDNR's Shoreline Conservation and Management Services.¹⁰⁵

Maryland Chesapeake and Coastal Bays Critical Area Act Amendments

In 2008 the Maryland Legislature amended the state's Chesapeake and Coastal Bays Critical Area Act, first enacted in 1984. The original Act established a program of state and local action to reduce the impact of development activities on habitat and aquatic resources, defining all land within 1,000 feet of the Mean High Water Line of tidal waters or the landward edge of tidal wetlands and all waters of and lands under the Chesapeake Bay and its tributaries as the state's "Critical Area." The Act established a statewide Critical Area Commission to oversee the development and implementation of local land use programs requiring landowners to implement measures to reduce polluted runoff and conserve habitat while accommodating growth and taking into consideration the cumulative impacts of development. Local governments were required to adopt comprehensive plans, zoning ordinances, and subdivision regulations that meet Commission criteria.

The 2008 amendments strengthened the Act in the following ways:¹⁰⁶

- Provide for the revocation of licenses of contractors who violate the act, require local governments to implement enforcement programs, establish new penalties and fines for anyone who violates the act, and give the Commission back up enforcement authority.
- Double the buffer requirement from 100 to 200 feet for certain projects.
- Include shore erosion control projects within the definition of "home improvement" projects covered by the Act and link to requirements of the "Living Shorelines Act" (see above).
- Replace Growth Allocation guidelines with standards, including provisions for setback requirements, minimization of impacts to identified resources, and optimization of water quality, and also provide an avenue for Commission approval of alternative measures.
- Replace "impervious surface" requirements with "lot coverage" requirements.
- Establish circumstances in which local government variances can be issued, must be reported, and may be subject to appeal.
- Require the state to produce updated maps of the 1,000-foot Critical Area boundary that are digitally generated and georeferenced and regulations to address mapping methodology, the designation of new Critical Area lands, and grandfathering.

¹⁰⁴ Information about the Chesapeake Bay Trust's Living Shorelines grant program is available at www.cbtrust.org/site/c.mijPKXPCJnH/b.5457537/k.B2A2/Living_Shorelines.htm.

¹⁰⁵ Information about MDNR's Shoreline Conservation and Management Services financial and technical support resources is available at www.dnr.state.md.us/ccws/sec/index.asp.

¹⁰⁶ A summary of the Critical Area Act 2008 amendments is available at www.dnr.state.md.us/criticalarea/guidancepubs/052008overviewofhousebill1253.pdf.

Maryland Wildlife and Heritage Program Initiative

In July 2009, MDNR's Wildlife and Heritage Program began an assessment of climate change vulnerability on Rare, Threatened and Endangered species and natural communities identified as Greatest Conservation Need. The assessment will be used to provide adaptation recommendations and next steps for incorporation of climate change into the Maryland Wildlife Diversity Conservation Plan. The information will also be incorporated in the development of a performance measures monitoring system to document progress of the implementation of the Maryland Wildlife Diversity Conservation Plan.¹⁰⁷

Maryland Land Conservation Initiative

In August 2009 a NOAA Coastal Management Fellow began work on the project *Coastal Land Conservation in Maryland: Targeting Tools and Techniques for Sea Level Rise Adaptation and Response*.¹⁰⁸ The project will define the characteristics of adaptive lands in Maryland, identify where the most effective habitat migration areas are located, and clarify the management actions needed to enhance their adaptation and migration potentials. For example, management activities could seek to maintain coastal ecosystem structure and function through restoration and protection activities to ensure that ecosystems can migrate and adapt, as well as sustain coastal ecosystem services (e.g., Bay water quality and coastal community flood control and storm-surge protection). The Fellow is expected to develop and run a GIS-based model to assess and identify adaptive coastal lands, develop an "adaptive benefits" scorecard, and coordinate with land and habitat planning groups to use the scorecard to modify conservation policies or management strategies.

Chesapeake Bay National Estuarine Research Reserve in Maryland

Maryland and Virginia each have a Chesapeake Bay National Estuarine Research Reserve. Both are engaged in activities to enhance public awareness, train coastal managers, and build capacity related to climate change adaptation. The reserve operated by the Maryland Department of Natural Resources has offered training sessions such as "How Prepared Are You For Rising Waters? Planning for Sea Level Rise" and implementation of the state's Living Shorelines policies.¹⁰⁹

Maryland Department of Transportation Initiative

The Maryland Department of Transportation is working to assess Maryland's critical transportation facilities and systems' vulnerability to projected sea level rise and extreme weather damage. The assessment will provide the information necessary to evaluate options

¹⁰⁷ For information on the wildlife plan efforts contact Zoë Johnson, Maryland Dept. of Natural Resources. Email: zjohnson@dnr.state.md.us Phone: (410) 260-8741.

¹⁰⁸ Information at webqa.csc.noaa.gov/cms/fellows/pdfs/2009_MD.pdf

¹⁰⁹ Maryland's National Estuarine Research Reserve activities see the upcoming and recent training activities described at www.dnr.state.md.us/bay/cbnerr/ctraining.asp.

for dealing with potential impacts to infrastructure and connectivity and the development of adaptation policies for existing and planned transportation facilities. The assessment will be used to inform development of a long-term strategic plan for system adaptation that can account for the uncertainty of future climactic conditions. Among Maryland agencies, the Maryland State Highway Administration (SHA) and the Maryland Transportation Authority (MTA) have the largest and most geographically dispersed network of facilities requiring the most complex long-term action plan. SHA has completed its assessment and the MTA assessment and inventory of mode-specific transportation system vulnerability is underway. Actions Plans for both agencies are expected to be issued in June 2011.¹¹⁰

Maryland Climate Change Insurance Advisory Committee

In Fall 2008 the Maryland Insurance Commissioner convened a Climate Change Insurance Advisory Committee. The Committee is charged with: 1) reviewing the adequacy of the data available to insurers to assess the risk imposed by climate change; 2) examining whether adaptive options are available to help mitigate losses and rating can be structured to provide an incentive for these options; and 3) reviewing ways to promote partnerships with policyholders for loss mitigation. The Committee is scheduled to release its final report and recommendations in December 2010.¹¹¹

Maryland Port Administration Climate Change Vulnerability Assessment & Policy

As a component of the overall Maryland Transportation Initiative described above, the Maryland Port Administration (MPA) released the report, "Climate Change Vulnerability Assessment and Recommendations (2010)."¹¹² The report includes recommendations for future programming of capital investments based on the findings of the vulnerability assessment. Facilities and systems under its management, as well as facilities being considered for development or redevelopment as part of MPA's Marine Terminal Development Plan and Dredged Material Management Program are addressed.

MPA has also developed a policy entitled "Incorporating Climate Change and Sea Level Rise Information into the Public Marine Terminal and Harbor Development Process." The policy identifies the need for MPA, the owner and operator of Maryland's public marine terminals, to make infrastructure and facility improvement decisions that consider climate change and sea level rise in order to maintain a competitive advantage for Maryland as well as to accommodate projected long-term growth in waterborne cargo.

¹¹⁰ For information on the Maryland transportation initiative contact Zoë Johnson, Maryland Department of Natural Resources. Email: zjohnson@dnr.state.md.us Phone: (410) 260-8741.

¹¹¹ For more information about the Maryland insurance initiative contact Joe Abe (410-260-8740 or jabe@dnr.state.md.us), the Maryland Chesapeake and Coastal Program staff person who serves on the Climate Change Insurance Advisory Committee.

¹¹² Maryland Environmental Service and Johnson, Mirmiran, and Thompson. 2010. Maryland Port Administration Climate Change Assessment and Recommendations. Maryland Port Administration, Baltimore, Maryland.

Maryland Historical, Archeological and Cultural Resources Vulnerability Assessment

As tasked in Maryland's Climate Action Plan, the Maryland Historical Trust (MHT) completed a vulnerability assessment of historical and cultural resources in Maryland. The types of resources evaluated were National Historic Landmarks, National Register of Historic Places, MHT Preservation Easements, Maryland Inventory of Historic Properties, archeological sites, and National Register eligible resources. The study was completed using inundation level data from the Department of Natural Resources in a geographic information system. MHT's historical and cultural GIS data layers were intersected with the inundation layers from DNR to generate raw numbers of potentially impacted resources at 0-2 ft and 2-5 ft inundation levels. The highest percentages of affected resources are located on the lower Eastern Shore. A total of 53% of inventoried historic properties in Somerset County would be vulnerable in a 0-5 ft. sea level rise. The analysis shows 32% of all of the archeological sites recorded in the coastal counties studied are potentially vulnerable within the 0-5 ft boundaries. Rising sea levels, erosion and major storms all pose a significant threat to historic and archeological sites, districts, and landscapes. The results from this preliminary assessment have served to raise awareness of this issue, which will be addressed through the PreserveMaryland planning process and included in the forthcoming long-range historic preservation comprehensive plan.

NEW JERSEY

New Jersey's climate change adaptation focus is on the development of new techniques to help local communities assess their vulnerability to coastal hazards and the potential effects of sea level rise. These sea level rise-specific initiatives complement existing tools that support adaptation, like New Jersey's flood hazard and coastal zone management rules.

New Jersey Global Warming Response Act Recommendation Report

In December 2009 the New Jersey Department of Environmental Protection released its report, *Meeting New Jersey's 2020 Greenhouse Gas Limit: New Jersey's Global Warming Response Act Recommendations Report*.¹¹³ The report, required by the New Jersey Global Warming Response Act of 2007, focuses primarily on greenhouse gas reduction strategies. It also recommended that the state develop adaptation strategies to minimize climate-related risks to the environment, economy, and public health. The report recommends that the state convene experts from academia, government, non-governmental organizations, and the business community to develop a statewide climate change adaptation plan, which would guide the state in fostering consideration of the vulnerability of built and green infrastructure to future hazards as well as improving the capacity of state public health resources to respond to more arduous weather and climate conditions. The report highlights a range of examples of sector-based adaptation issues that New Jersey faces in the following categories: public health, safety, and emergency preparedness; freshwater quality and supply; energy, land use, and capital infrastructure; biodiversity, ecosystems, and agriculture; finance and economics; and outreach and education.

New Jersey Coastal Vulnerability Assessment Protocol

The New Jersey Coastal Management Program has spearheaded the acquisition of coastal LiDAR elevation data for Cape May, Cumberland, and Salem counties adjacent to Delaware Bay. The data will result in an important base information layer upon which future coastal analysis will be based, one that is notable because the data were acquired at near mean low water conditions. The New Jersey Coastal Management Program is developing a GIS-based Coastal Vulnerability Assessment Protocol to identify the potential impacts of coastal hazards and sea level rise on the built and natural environment. The Protocol is being developed for New Jersey's Delaware Bayshore and will be piloted in communities along the bay. The results of the assessment will help the New Jersey Coastal Management Office provide community outreach in regards to coastal hazards and climate change (see discussion of the New Jersey Coastal Resilience Index in the "Supporting Local Governments" section of this paper). While the protocol can be utilized to assess community vulnerability, it also has the capacity to inform federal, state, and non-governmental entities of areas of potential habitat loss, prime restoration sites, or areas to forgo additional conservation due to inundation. By utilizing the protocol, coastal communities and natural resource managers will be able to apply the vulnerability mapping in order to begin adapting to coastal hazards and future

¹¹³ Available at www.state.nj.us/dep/oce/gwr.htm.

impacts of sea level rise.¹¹⁴

New Jersey Coastal Evacuation Maps and Planning

All New Jersey counties have published coastal evacuation and storm surge maps identifying potential evacuation routes for coastal emergencies such as approaching tropical storms or hurricanes.¹¹⁵ Monmouth County recently completed a Coastal Evacuation Route Improvement Study recommending changes to its evacuation routes that takes into consideration sea level rise and other climate change impacts.¹¹⁶

New Jersey Coastal Resilience Index Project

Coupled with the New Jersey Coastal Vulnerability Assessment Protocol (see the “Increasing Understanding” section above), the New Jersey Coastal Resilience Index, a project launched in 2009, will help New Jersey coastal communities assess how well they are incorporating hazard and sea level rise mitigation efforts into their land use, hazard mitigation, and post-disaster redevelopment plans and policies, among many others. The resilience indicators will be preliminarily developed for communities along the Delaware Bay. The state successfully applied for a NOAA Coastal Management Fellow to develop, apply, and integrate the Coastal Vulnerability Protocol and the Coastal Resilience Index to assess the potential impacts of sea level rise and other hazards to the state’s more developed shoreline. All of this information will be analyzed in the context of state policies regarding resilience planning and implementation, and the regulations and ordinances of each local community to produce a unique index and community planning toolkit. The project’s ultimate goal will be to develop a standard methodology that any entity – academic, governmental, or nongovernmental – can use to develop indices and toolkits tailored to communities along the rest of New Jersey’s coastal waterfronts.¹¹⁷

New Jersey Coastal Zone Management Rules

New Jersey’s Coastal Zone Management rules are an important tool for regulating new development in erosion hazard, flood hazard, and coastal high hazard areas (the latter delineated by the National Flood Insurance Program’s (NFIP) characterization as regions exposed to 100-year flooding with wave action), as well as environmentally sensitive areas such as dunes, wetlands, and riparian areas. The rules encourage soft shoreline protection methods in lieu of shoreline armoring and establish a range of setback requirements contingent upon site conditions. The rules do not apply to post-disaster rebuilding.

¹¹⁴ For information about the New Jersey Coastal Vulnerability Assessment Protocol contact Leigh Wood at leigh.wood@dep.state.nj.us.

¹¹⁵ Evacuation planning and map information can be found at www.state.nj.us/njoem/plan/evacuation-routes.html.

¹¹⁶ Available at www.co.monmouth.nj.us/page.aspx?id=3260

¹¹⁷ The Coastal Resilience Index Project proposal describing the effort is available at www.csc.noaa.gov/cms/fellows/pdfs/2009_NJ.pdf.

New Jersey State Flood Hazard Area Program

Severe statewide flooding in 2004 led New Jersey to update its Flood Hazard Area Control Act rules and related amendments to the state's Coastal Permit Program rules and Coastal Zone Management rules. The rules adopted by the New Jersey Department of Environmental Protection in 2007 set more stringent standards for development in flood hazard areas and riparian zones adjacent to surface waters throughout the state. The changes include new flood hazard area and riparian zone standards applied to the review of all CAFRA (Coastal Area Facility Review Act) and Waterfront Development permits. These include a requirement that the lowest finished floor of a new building must be at least one foot above base flood elevation. Other new standards include a requirement for 0% net infill in all non-tidal flood hazard areas of the state to protect hydrological functions, and expanded riparian buffers to protect aquatic life.¹¹⁸

New Jersey Hazard Mitigation Planning

All of New Jersey's coastal communities participate in the NFIP with the vast majority also participating in the NFIP's Community Rating System. Actions related to public information, mapping and regulations, flood damage reduction, and flood preparedness can result in reduced flood insurance premiums for all property owners within the community.¹¹⁹ All New Jersey counties have, at minimum, commenced the preparation of all-hazard mitigation plans, with several completed plans exceeding Federal Emergency Management Agency (FEMA) content requirements by addressing supplementary processes such as chronic coastal erosion and sea level rise and their resulting impacts on future flood hazard planning and mitigation. Plans produced by several of the state's coastal counties have been approved by the FEMA and thus qualify county municipalities as eligible to apply for federal hazard mitigation planning and project grants. In 2003 New Jersey Sea Grant College Program published a Manual for Coastal Hazard Mitigation compiling information on coastal hazard processes and providing technical guidance for implementing effective hazard reduction projects and planning.¹²⁰

New Jersey Green Acres and Coastal Blue Acres Program

Since 1961 New Jersey's "Green Acres" program has had the charge of acquiring available open space to provide linked protected areas as open space corridors to enhance wildlife protection, recreation, and aesthetic benefits, with many such areas in the state's coastal zone. Within this program, a "Coastal Blue Acres" element was legislated in 1995 in order to acquire and conserve coastal lands subject or prone to storm damage or that buffer or protect other lands from storm damage. In the past, Blue Acres funds were awarded as matching grants to acquire, from willing sellers, unimproved or minimally improved coastal lands at risk of storm damage or

¹¹⁸ Rules available at www.nj.gov/dep/landuse/se.html; a technical guidance manual in development will eventually be posted at www.nj.gov/dep/landuse/forms/index.html - se.

¹¹⁹ Information at www.fema.gov/business/nfip/crs.shtm.

¹²⁰ The manual may be downloaded at www.state.nj.us/dep//cmp/coastal_hazard_manual.pdf.

able to buffer potential storm damage, and lands that suffered severe reduction in value as a result of storm damage. In 2007, New Jersey voters approved the “Green Acres, Farmland, Blue Acres, and Historic Preservation Bond Act” that provided renewed funding for the Green Acres program, as well as specific funding for the Delaware River, Passaic River, and Raritan River floodways and associated tributaries, although funding was subsequently reallocated toward other purposes, delaying effective implementation.¹²¹

New Jersey State Wildlife Action Plan Climate Change Inclusion

New Jersey’s Wildlife Action Plan is undergoing major revisions. Among the key revisions is the inclusion of climate change predictions and concerns for New Jersey in addition to highlighting important ways these impacts may affect each regional landscape (for the entire state there are currently five regional landscapes included within the scope of the plan). The revised Plan will identify if and how each of the current conservation actions addresses the impacts of climate change on wildlife and their habitats based on five basic natural resource management strategies outlined by the U.S. Forest Service. Four of these are adaptation strategies while one is a mitigation strategy. The Plan revision will also create a sixth region, the Marine Region, thereby elevating the marine habitats and wildlife to the same level as the terrestrial landscapes.¹²² A formal revision scheduled for 2015 will include more detailed information regarding climate change impacts, habitat and wildlife vulnerability, and management guidance to combat the negative impacts of climate change on New Jersey’s wildlife and their habitats (described below).

In a related development, the New Jersey Division of Fish and Wildlife hosted a workshop on October 1, 2009 to gather input from stakeholder groups on the subject of global climate change and its impact on natural resources, especially populations of wildlife. Given the potential impact of climate change on the state and its natural communities, participants in the workshop agreed that New Jersey Division of Fish and Wildlife should engage in an analysis of the relative vulnerabilities of New Jersey's habitats and species to the changes in the state's climate. This analysis will serve as basis for developing management options for climate change mitigation and adaptation. The New Jersey Division of Fish and Wildlife, working with stakeholders, is formulating a request for proposal for circulation to groups and entities qualified to carry out an analysis of the vulnerabilities of the natural resources across the multitude of habitats and species found in the state.

New Jersey National Estuarine Research Reserve Coastal Training Program

As in other states, New Jersey’s Jacques Cousteau National Estuarine Research Reserve is delivering climate change-focused training. The Cousteau Reserve offers training on adapting to

¹²¹ Information on the circa 1995 Blue Acres program is available at www.state.nj.us/dep/greenacres/blue.htm; information for the overarching Green Acres program can be found at www.state.nj.us/dep/greenacres/.

¹²² Updated information about New Jersey’s Wildlife Action Plan should eventually be posted at <http://www.state.nj.us/dep/fgw/ensp/waphome.htm>.

sea level rise, coastal erosion, and severe storms including background information, case studies and tool kits with model ordinances.¹²³ The reserve also recently held a conference for public officials and planners on “*Preparing Your Community in the Face of a Changing Climate*,” which sought to inform local officials of hazards and potential impacts from anticipated climate change and sea level rise.

¹²³ Information at <http://www.jcnerr.org/education/coastaltraining/climatechange.html>.

NEW YORK

New York State and many of its local governments are actively developing an array of climate change adaptation initiatives. Adaptation is a central focus of statewide planning for climate change generally and for sea level rise in particular, with major initiatives getting underway in the past two years.

New York State Climate Action Council and Climate Action Plan

In August 2009 a Governor's executive order established the New York State Climate Action Council to prepare a draft Climate Action Plan by November 1, 2010.¹²⁴ The Council is comprised of 15 state agency heads and jointly coordinated by the New York State Department of Environmental Conservation (NYSDEC) and the New York State Energy Research and Development Authority (NYSERDA). The Plan will have a dual focus: how all of New York's economic sectors can reduce greenhouse gas emissions, and how New York can adapt to climate change. The latter component is being developed by an Adaptation Technical Working Group (TWG). The Adaptation TWG will in turn have its work informed by the efforts of three other initiatives described below: the state's Sea Level Rise Task Force, the ClimAID adaptation project, and New York City's PlaNYC.

The Council's Adaptation TWG is currently preparing and considering background information, including a catalog of adaptation actions taken or being considered in other states, and establishing protocols for evaluating adaptation strategies. Future steps will include developing a catalog of adaptation strategies for New York, setting priorities for analysis, addressing adaptation needs raised by the Council's other (greenhouse gas mitigation-focused) technical working groups, and developing recommended policy options for the Council. The Adaptation TWG's more than two dozen members are drawn from the private, nonprofit, and academic sectors as well as state and local agencies.

¹²⁴ Information about the Council is available at nyclimatechange.us/.

New York's ClimAID Project

Starting in November 2008 NYSERDA began underwriting an "Integrated Assessment for Effective Climate Change Adaptation Strategies in New York State," also called "ClimAID," as part of its climate research program.¹²⁵ Partners in the project include Columbia University, the City University of New York, Cornell University, and others. ClimAID's goal is to bring together the most recent scientific information, technical expertise, and knowledge of stakeholders from key sectors around the state. ClimAID will assess the state's risks from climate change, facilitate the development of adaptive measures, and identify needs for additional research. The project convened

stakeholder groups throughout 2009, focused on the following eight sectors: agriculture, ecosystems, coastal zones, energy, public health, transportation, communication, and water resources. ClimAID will also examine the crosscutting elements of science/policy linkages, economic policy linkages, and environmental justice. The release of the ClimAID report will be coordinated with the issuance of the New York State Climate Action Plan, currently scheduled for November 1, 2010. The project's work is pivotal to the progress of other major state climate change adaptation initiatives in the state, notably the work of the Climate Action Council and the Sea Level Rise Task Force (see above).

How NYSERDA Funds its Research

NYSERDA's Environmental Monitoring, Evaluation Protection (EMEP) Program, which coordinates the ClimAID initiative, taps a System Benefits Charge (SBC) collected by the state's investor owned utilities to support energy-related environmental research. NYSERDA administers the SBC program under an agreement with the state's Public Service Commission.

In order to more effectively illuminate vulnerabilities, climate risks, key decisions, and adaptation strategies ClimAID is developing nearly two dozen case studies in the eight sectors it is assessing. Examples of the sectors and associated case studies include:

- Agriculture: apple and grape production, dairy production, summer drought
- Communications infrastructure: winter storm
- Ecosystems: invasive species, brook trout habitat
- Energy: heat waves, electricity demand
- Ocean coastal zones: severe coastal storms, salt-marsh changes
- Public health: ozone and respiratory disease, West Nile virus
- Transportation infrastructure: 100-year storm in the New York City metro region
- Water resources: Susquehanna River flooding, Orange County water supply planning

¹²⁵ Limited ClimAID information is posted on NYSERDA's website at www.nyserderda.org/programs/Environment/EMEP/project/10851/10851_pwp.asp. More information is available by contacting project manager Amanda Stevens ads@nyserderda.org and from an October 2009 conference presentation providing a recent update is available at http://www.nyserderda.org/programs/Environment/EMEP/conference_2009/presentations/Solecki_DeGae_tano_Horton_Climate%20Change%20in%20New%20York%20State.pdf.

NYSDEC Commissioner's Climate Change Policy

NYSDEC is currently finalizing a Commissioner's Policy on "Climate Change and DEC Action," which had been issued in a draft form in April 2010. The policy directs all parts of the agency and all staff to integrate climate change considerations into the full range of departmental activities, including decision-making, planning, permitting, remediation, rulemaking, grants administration, natural resource management, enforcement, land stewardship and facilities management, internal operations, contracting, procurement, and public outreach and education. The policy lays out key climate change goals, based in part on a number of existing Executive Orders, and defines specific climate change mitigation and adaptation objectives for the agency. It also identifies specific climate change factors that all agency staff should use in their daily activities, including the use of the best available scientific projections of future environmental conditions.

New York City's PlaNYC

In 2007, the state and nation's largest city launched a multi-pronged adaptation effort as part of its broadly ambitious PlaNYC long term sustainability initiative.¹²⁶ PlaNYC is being coordinated by the newly established Mayor's Office of Long Term Planning and Sustainability. This Office is overseeing the implementation of PlaNYC's climate change adaptation initiatives, including a citywide strategy for climate change adaptation that is expected to:

- Help individual neighborhoods develop site-specific strategies to address their climate change risks.
- Update the city's 100-year floodplain maps.
- Document the city's floodplain management strategies to secure discounted flood insurance for city residents.
- Amend the building code to address climate change impacts.

The Office also supports the work of an interagency task force appointed in August 2008 specifically to focus on risks to infrastructure. The public-private Climate Change Adaptation Task Force has approximately 40 members drawn from city, state, and federal government agencies and regional authorities, as well as private companies that operate, maintain or regulate critical infrastructure in the city. A private firm, The Boston Consulting Group, provided pro bono support to develop and convene the Task Force. The Task Force is slated to issue a report on the adaptation of critical infrastructure to sea level rise.

¹²⁶ Information on PlaNYC's climate goals are available at:
www.nyc.gov/html/planyc2030/html/plan/climate.shtml.

The Task Force is being advised by a New York City Panel on Climate Change (NPCC), convened at the same time as the Task Force with funding from the Rockefeller Foundation. The NPCC consists of academic and government scientists and industry experts. As its first task the NPCC was charged with quantifying potential risks from climate change, and in February 2009 the NPCC issued its first report, *Climate Risk Information*.¹²⁷

Sea Level Rise Implications of Incorporating Ice Melt Rates

Currently-accepted global climate models project sea levels to rise around New York City by up to 23 inches by 2080. However, the NPCC report *Climate Risk Information* notes that the models do not incorporate “observed and longer-term historical ice-melt rates...[that suggest] sea level could rise by approximately 41 to 55 inches by the 2080s.”

New York State Sea Level Rise Task Force

The Sea Level Rise Task Force was created in 2007 by the New York State Legislature to assess impacts to the state's coastlines from rising seas and recommend protective and adaptive measures for the state's coastal communities and ecosystems.¹²⁸ The geographic scope of the Sea Level Rise Task Force report will include New York City's five boroughs and Westchester, Nassau, and Suffolk Counties, as well the main stem of the Hudson River drainage.

NYSDEC chairs and staffs the Sea Level Rise Task Force, whose members are drawn from state, county, and municipal government and public citizens appointed by the legislature. The Sea Level Rise Task Force held its first meeting in June 2008, and conducted a series of public meetings in January 2009. The Sea Level Rise Task Force is expected to issue a draft report by October 2010 to be followed by public review. The final report is due to the State Legislature by January 1, 2011. Much of the Sea Level Rise Task Force's work is carried out by a steering committee of state and non-governmental agency staff who develop recommendations for Sea Level Rise Task Force approval with advice from specialized work groups (ecosystems and natural resources, infrastructure, community resilience).

The Sea Level Rise Task Force report is expected to assess anticipated sea level rise impacts and make recommendations for protective standards and enforcement related to the following: coastal development; wetlands protection, shoreline armoring, and post-storm recovery; adaptive measures such as wildlife migration corridors; habitat protection to preserve ecological services such as flood control and clean water; monitoring of climate change effects on flora and fauna; integration of adaptation strategies into state environmental plans; and state and local regulatory amendments to respond to climate change.

¹²⁷ Download the NPCC report *Climate Risk Information* at:

www.nyc.gov/html/planyc2030/downloads/pdf/nyc_climate_change_report.pdf

¹²⁸ Information about the Task Force is available at www.dec.ny.gov/energy/45202.html.

New York State Grants for Local Waterfront Revitalization Programs

The New York State Environmental Protection Fund is intended to provide a stable source of funding for a range of environmentally-focused grant programs. Title 11 of the Environmental Protection Fund establishes an annual grant program to help municipal and county governments prepare, refine or implement Local Waterfront Revitalization Programs on a 50/50 cost share basis. Communities can use the grants, which are administered by the Department of State's Division of Coastal Resources, for planning, design, and construction projects.¹²⁹

The grant program's selection process accords extra points to a handful of high priority categories; proposals that advance the development and implementation of plans or projects that prepare for and adapt to climate change and sea level rise were added to this high priority list in 2008. In the most recent grant cycle two coastal communities have won Local Waterfront Revitalization Program grants in this category. New York City received a grant for public education and outreach about climate change causes and adaptation through its Parks and Recreation Department, and to incorporate climate change considerations (along with other issues) in an update of a watershed management plan for one area of the city. The Village of Northport on Long Island Sound will use its grant to prepare a draft Local Waterfront Revitalization Program that addresses protection and preservation of its harbor waterfront and natural resources and plans for climate change and sustainable design. In addition, the capital city of Albany used a prior year grant for its ongoing process to prepare a *Climate Action and Adaption Plan* to develop regulations to minimize risks associated with climate change.

New York State Climate Smart Communities Program

At least 84 New York communities have adopted a ten-point "Climate Smart Community Pledge" to reduce greenhouse gas emissions and take steps to adapt to inevitable impacts of climate change through their participation in the state's Climate Smart Communities Program, an interagency effort of NYSERDA, the Public Service Commission and the departments of State and Environmental Conservation.¹³⁰ The program has had a strong emphasis on helping communities implement measures to mitigate their greenhouse gas emissions; however, adaptation-focused elements of the pledge address the adoption of land use policies, plans, zoning, building codes, and public engagement strategies to increase community resilience to climate change risks. The program started in February 2009, at which time the program issued a preliminary guidance document with background information for interested local governments.¹³¹ Step-by-step guidance is added to the website as it is developed. Communities also receive support in the form of notification of funding opportunities, letters of

¹²⁹ Information for the Local Waterfront Revitalization Program is available at www.nyswaterfronts.com/grantopps_EPF.asp.

¹³⁰ Climate Smart Communities Program information is available at www.dec.ny.gov/energy/50845.html.

¹³¹ The interim guidance document for local governments is available at www.dec.ny.gov/docs/administration_pdf/cscguide.pdf.

support for grant applications and, through the NYSERDA Focus on Local Government program, direct and indirect support in implementing climate action.

A new initiative launched in January 2010 will bolster the program's adaptation-related support to communities. The NYSDEC Office of Climate Change and the NYSDOS Division of Coastal Resources launched a collaborative, interagency effort to provide guidance on adaptation planning to communities interested in improving their resiliency to climate change. NYSDOS will draw upon expertise it has developed working with communities implementing Local Waterfront Revitalization Program climate change and sea level rise preparedness and response projects to expand the adaptation focus of the Climate Smart Communities Program. The collaboration will lead to the following:

- An expanded adaptation focus for online guidance (see above).
- Initiation of work in several pilot communities.
- Stronger coordination of existing local and regional adaptation projects in the state with the Climate Smart Communities program (e.g., NYSDOS Local Waterfront Revitalization Program-funded projects and the partnership between the NYSDEC Hudson River Estuary Program and its Office of Climate Change to coordinate local efforts to develop a regional strategy to respond to climate change in the Hudson Valley).

New York State Guidelines for Local Post-Storm Redevelopment Plans

In 2008 the NYSDOS Office of Coastal, Local Government and Community Sustainability initiated a project to formulate State Guidelines for Post-Storm Redevelopment Plans.¹³² The project's goals are to provide a means for local governments to assess their resilience to coastal hazards and to provide a framework for developing local management plans to address those hazards. The Post-Storm Redevelopment Plans will assess socio-cultural and environmental resources as well as economic assets and emphasize community function rather than static protection of structures. With an assessment and plan communities can coordinate hazard mitigation activities with other planning efforts, such as capital development programs, comprehensive land use planning, local waterfront revitalization, and brownfield redevelopment in addition to storm recovery. The plans will allow communities to adapt efficiently over the course of time, taking coastal hazards including sea level rise (and other climate impacts, as appropriate) into account. Since much of New York's coastal area is already developed, adaptation of existing uses will be the primary means of addressing coastal storm impacts and sea level rise.

The principal tools available for adaptation to coastal hazards include elevation, relocation, and voluntary acquisition of existing structures; resilient construction; and property exchange. The Department of State's project will develop guidance on the content and process for preparing adaptation plans, including a community resilience index to characterize vulnerability. The index will help communities assess exposure to coastal hazards and the effectiveness of

¹³² New York's application for a NOAA Coastal Services Center Fellow to undertake the project may be downloaded at webqa.csc.noaa.gov/cms/fellows/2008_NY.pdf.

proposed management measures. The Department of State will issue information products prepared in support of Post-Storm Redevelopment Plans, including a guidebook, for ongoing technical assistance to other agencies and local governments. Examples include information for the state Sea Level Rise Task Force (discussed above), advice to the U.S. Army Corps of Engineers on storm damage reduction projects, and feedback to the New York State Emergency Management Office on coastal hazard management and updates to the State Multi-Hazard Mitigation Plan. The Department of State expects to complete draft guidance for Post-Storm Redevelopment Planning by September, 2010.

NYSDOS is also a partner in development of a Congressionally-authorized Storm Damage Reduction Project for the Fire Island Inlet to Montauk Point region (jointly led by the U.S. Army Corps of Engineers and NYSDEC). The Department of State is advocating incorporation of the Post-Storm Redevelopment/Recovery guidelines into this project.¹³³

New York State Transportation Agency Operations

In addition to its participation in ClimAID (see above) The New York State Department of Transportation (NYSDOT) awarded funding in October 2009 to Columbia University Earth Institute's Center for Climate Systems Research for the project *Mainstreaming Climate Change Adaptation Strategies Into New York State Department of Transportation's Operations*. The project will develop recommendations for the agency to integrate climate change risk assessment and management into its decision, policy, and planning processes using risk management and adaptation planning methods. The project has convened an Advisory Working Group on Transportation and Climate Change Adaptation. The Advisory Working Group is collaborating with a NYSDOT Technical Working Group.¹³⁴ NYSDOT has also convened an internal Climate Change and Energy Efficiency Team to identify and advance strategies to curb the agency's greenhouse gas emissions and adapt its transportation infrastructure to the effects of climate change.

Wildlife Climate Change Alliance

NYSDEC is part of the newly-formed Wildlife Climate Change Alliance, a coalition of state agency and non-governmental organizations formed to facilitate integration of climate change adaptation into natural resource management. The coalition has sponsored a series of workshops for NYSDEC staff and others intended to build capacity for climate change adaptation planning. An initial workshop entitled, "Safeguarding New York's Wildlife and Natural Systems in a Changing Climate" was designed to provide a basic understanding of current climate change science and legislation, already occurring fish, wildlife and natural system adaptations, and how NYSDEC can work collaboratively with its conservation partners to respond to future adaptation needs.

¹³³ The FIMP is described at www.nan.usace.army.mil/fimp/reform.htm.

¹³⁴ Information on the NYSDOT project is available at: www.utrc2.org/research/projects.php?viewid=193

VIRGINIA

In 2008 a Governor's commission issued a wide-ranging plan to guide the state's efforts to assess, mitigate, and respond to climate change impacts. Those recommendations were compatible with state programs already in place to increase protections for the state's shorelines and to encourage the state's subregional Planning District Commissions to prepare for climate change and sea level rise.

Virginia Climate Change Action Plan

In December 2008 the Governor's Commission on Climate Change completed a year-long effort to develop a plan to guide the state's greenhouse gas reduction efforts, evaluate anticipated climate change impacts to the state's natural resources, economy, and public health, and recommend necessary actions to respond to those impacts.¹³⁵ Regarding adaptation measures, the Commission recommended that the state:

- Make organizational changes and set priorities in state government. Focus and expand the state's capacity to implement the Climate Change Action Plan by establishing a climate change sub-cabinet, working through existing programs when possible, working collaboratively with neighboring states, formalizing the use of Planning District Commissions (PDCs) as a bridge between the state and local governments, and encouraging PDCs to address climate change in their regional strategic plans.
- Conduct outreach and education. Implement a campaign to raise awareness of the causes and impacts of climate change, build public support for implementing Plan recommendations, and inform the public about the individual, business, and governmental actions needed to mitigate and to adapt to climate change.
- Assess impacts. Seek legislative funding and support for a network of scientific and technological institutions to monitor, track, and report on the impacts of climate change on Virginia's agriculture, energy use, economy, health, and ecosystems, and to suggest optimal adaptation and mitigation strategies to the policy-makers.
- Amend laws and regulations. Ensure state and local agencies have the necessary authorities to account for climate change in their actions.

The Commission also recommended more than two dozen specific measures directed at state agencies and local governments. These are summarized as follows:

- Develop a comprehensive sea level rise adaptation strategy by January 1, 2011.
- Acquire statewide LiDAR topography data, prioritizing coastal areas.

¹³⁵ The Climate Change Action Plan is available at www.deq.virginia.gov/info/climatechange.html

- Assess impacts of climate change to natural, historical, and cultural resources; to specific socioeconomic and geographic groups; to programs such as stormwater and polluted runoff management and emergency response and preparedness; to insured properties and the insurance industry; and to public health.
- Reduce vulnerability to climate change impacts by creating disincentives for development and incentives for shoreline retreat in hazard areas; considering its implications in decisions about new and existing infrastructure; engaging in land use and shoreline planning; developing adaptation plans for specific affected economic sectors; and taking steps to protect and restore natural resources.
- Coordinate with other states and the federal government, in particular the Department of Defense.

Virginia Sustainable Communities Initiative

The Virginia Coastal Zone Management Program's Sustainable Communities Initiative provides funding to local communities through Planning District Commissions to incorporate "Blue/Green Infrastructure Planning" or "Climate Change Adaptation" components in their general plans. Beginning in 2008, seven Planning District Commissions launched projects, with three of the seven focusing on climate change, and specifically on sea level rise and coastal flooding. In general, in the first two years of the projects the three climate change focused-Planning District Commissions are analyzing potential natural and manmade causes of these hazards, working with stakeholders to develop policy responses, and engaging in outreach to citizens and elected officials. In the third year they anticipate implementing the recommended local plan and ordinance changes. The three Planning District Commissions are Hampton Roads, Middle Peninsula, and the Northern Virginia Regional Commission, representing, respectively, an urbanized coastal area, a rural coastal area, and a more inland urbanized area at risk from river surges.¹³⁶

Virginia Living Shorelines Program

The Living Shorelines program is an initiative implemented since 2006 by the Virginia Coastal Zone Management Program. Living Shorelines promotes alternatives to conventional shoreline armoring that protect property from erosion while preserving or increasing wildlife habitat, and protecting water quality by trapping excess nutrients and sediment.¹³⁷ While the Living Shorelines program predates the Climate Change Action Plan, it is consistent with Plan recommendations.

¹³⁶ A description of Hampton Roads' climate change adaptation project is available at www.deq.state.va.us/coastal/description/2009projects/12-04-09.html. The Middle Peninsula's project is described at www.deq.state.va.us/coastal/description/2009projects/12-05-09.html. Northern Virginia's project is described at www.deq.state.va.us/coastal/description/2009projects/12-07-09.html.

¹³⁷ Living Shorelines program information is available at www.deq.state.va.us/coastal/livingshore.html.

Living Shorelines use nature-based techniques such as marsh plantings, beach nourishment, and low profile oyster reefs, breakwaters, and sills to reduce erosion threats to shorelines. The program is using approximately \$800,000 of federal Coastal Zone Management Act funds to carry out the program in 2006-2011. Program components (status in parentheses) include:

- A "Living Shoreline Summit" with peer reviewed proceedings, to advance the use of this management technique (December, 2006).
- Revised wetlands guidelines to be used by the Virginia Marine Resources Commission, the Virginia Institute of Marine Science (VIMS), local wetlands boards and others to guide decisions about shoreline and tidal wetlands management (Drafted by VIMS and submitted to the Virginia Marine Resources Commission for consideration).
- Improved data on shoreline conditions to support more informed shoreline management decisions (9 local shoreline inventories and 8 local shoreline evolution reports completed or underway and \$150,000 in funding support scheduled for the 2010 fiscal year).
- Research to document the habitat value and viability of living shorelines and to improve their design (2 research projects on better sill design completed by VIMS).
- Guidance for local governments to use in shoreline management planning (brochure and Powerpoint presentation completed).
- Outreach materials for land use decision-makers, landowners, and contractors on Living Shorelines advantages and design principles (landowner brochure completed, upgraded website for three user-groups under development).
- A training program for contractors and local government staff on Living Shorelines practices (under development).
- A report on improving management of Virginia's dune and beach resources, including proposed revisions to the Coastal Primary Sand Dunes and Beaches Act (completed).
- Changes to the Coastal Primary Sand Dunes and Beaches Act by the Virginia General Assembly (adopted 2008 – expanded Act from 9 localities to the entire coastal zone).
- Revisions to the Coastal Primary Sand Dunes and Beaches Guidelines. (Drafted by VIMS and submitted to the Virginia Marine Resources Commission for consideration).
- A comparative analysis of two methodologies for developing local shoreline management plans (under development).

Other potential components include a fast track or general permit for Living Shorelines and a strategy for increasing the availability of plants for Living Shorelines projects. Grant funding to implement Living Shorelines projects is available through a partnership among the Chesapeake Bay Trust, NOAA Restoration Center, Keith Campbell Foundation, and the National Fish and Wildlife Foundation.¹³⁸

¹³⁸ Living Shorelines grant information is available at www.cbtrust.org/site/c.mjPKXPCJnH/b.5457537/k.B2A2/Living_Shorelines.htm.

Chesapeake Bay National Estuarine Research Reserve in Virginia

Maryland and Virginia each have a Chesapeake Bay National Estuarine Research Reserve. Both are engaged in activities to enhance public awareness, train coastal managers, and build capacity related to climate change adaptation. The reserve operated by the Virginia Institute for Marine Studies has offered training sessions such as “How Prepared Are You For Rising Waters? Planning for Sea Level Rise” and implementation of the state’s Living Shorelines policies.¹³⁹

Virginia Community Environmental Education

Since 2001 the Virginia Office of Environmental Education¹⁴⁰ has overseen state efforts to educate citizens, communities, educators, and local government staff living in Virginia’s coastal zone about the causes of climate change and how they affect Virginia. In fall 2009 the Office of Environmental Education received funding from the state coastal zone management program to develop a Virginia Public Climate Change Education Training Program targeting community environmental educators; update Virginia’s master plan for environmental literacy; continue supporting regional environmental education alliances or partnerships such as the Hampton Roads Alliance for Environmental Education; coordinate implementation of Chesapeake Agreement education commitments; strengthen communication among Virginia’s 1,000 environmental, bay and marine educators through the Virginia Naturally program; administer agency and inter-agency water education programs; and support the Virginia Department of Environmental Quality’s communication and education goal of an “informed and engaged citizenry.”

Virginia Institute of Marine Science Research

The Virginia Institute of Marine Science, a public institution with a state mandate to provide coastal and estuarine research and policy advice, has prepared analyses and recommended responses to the causes and consequences of climate change in Chesapeake Bay and the coastal zone,¹⁴¹ and has an ongoing program on climate change and coastal stressors.¹⁴² Examples of specific projects include: a clearinghouse for datasets relevant to considerations of climate change and sea level rise impacts;¹⁴³ a project to assess the vulnerability of tidal wetlands, shallow waters, submerged aquatic vegetation, beaches and developed lands,¹⁴⁴ and an examination of the fate of tidal wetlands in the Lynnhaven River system in the face of sea level rise.¹⁴⁵

¹³⁹ For Virginia’s National Estuarine Research Reserve activities see www.vims.edu/cbnerr/coastal_training/index.php.

¹⁴⁰ Information on the Office of Environmental Education available at www.deq.virginia.gov/education/.

¹⁴¹ See <http://www.vims.edu/research/centers/programsprojects/iccr/index.php>.

¹⁴² See http://ccrm.vims.edu/coastal_zone/climate_change/index.html.

¹⁴³ See http://ccrm.vims.edu/climate_change/index.html

¹⁴⁴ See http://ccrm.vims.edu/research/climate_change/index.html

¹⁴⁵ See http://ccrm.vims.edu/gis_data_maps/static_maps/lynnhaven_project/Lynnhaven%20Final%20Report.pdf.

Virginia Wildlife Action Plan Climate Change Supplement

The Virginia Department of Game and Inland Fisheries, National Wildlife Federation, and Virginia Conservation Network are working together to update Virginia's Wildlife Action Plan to integrate climate change. As a part of this work the partners hosted two workshops on the same theme: *Conserving Virginia's Fish and Wildlife for the Future: Preparing for a Changing Climate*. Both workshops brought together representatives of state and federal agencies, conservation organizations, communities, and the private sector to collaboratively develop strategies to adapt Virginia's wildlife management, planning, and conservation efforts to climate change. The first workshop, held in October 2008, identified likely climate change impacts to Virginia's fish and wildlife and conservation priorities, and recommended options for adapting conservation efforts to meet changing conditions. The second workshop, held in March 2009, focused on specific ecological and wildlife issues, education and outreach, and modeling and data. Participants evaluated draft strategies to protect wildlife from climate change in Virginia, offered feedback on an outreach strategy, and discussed existing conservation management tools and additional needs. The two workshops will generate a companion document to Virginia's Wildlife Action Plan that will help the state address climate change implications for the state's wildlife as it implements the plan.¹⁴⁶

¹⁴⁶ Information on the climate change supplement to the state Wildlife Action Plan is available at www.vcnva.org/anx/index.cfm/1,342,0,0,html/ppp