NICHOLAS INSTITUTE REPORT

Climate Ready Estuaries
A Blueprint for Change

Prepared by
The Nicholas Institute for Environmental Policy Solutions
Duke University

Prepared for
Albemarle-Pamlico National Estuary Program

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Executive Summary

Protecting coastal communities and the ecosystems that support them from climate change and sea-level rise is a tremendous challenge for North Carolina. It provides new urgency and a great opportunity for the Albemarle-Pamlico National Estuary Program (APNEP) and its federal, state, local, and private partners to come together to protect and restore a place that they and the nation value and love.

The citizens and local officials of the Albemarle-Pamlico region are determined, resourceful, and adaptable. They have weathered and rebuilt after countless storms and floods. They have moved from Portsmouth Island, Core Banks, and floodplains – but not away from the coast. They have elevated their homes in Belhaven and Swan Quarter. They advocated for buyouts of floodplain swine farms and junkyards and the creation of new parks and greenways. They have lobbied their legislators and their upstream neighbors to clean up the Chowan, Tar-Pamlico, and Neuse rivers. They even moved the iconic Cape Hatteras Lighthouse back from the ocean and out of harm's way in 1999. This Blueprint reflects the local values of the Albemarle-Pamlico region and outlines initial actions that should be taken to support those values.

Blueprint Purpose

Initially conceived as an outreach pilot to increase public and local government awareness in five counties of the Albemarle-Pamlico region, our Blueprint summarizes the initial outreach efforts, develops a blueprint with findings and recommendations for increasing the region's climate resilience, compiles a resource of up-to-date science on sea-level rise impacts, and serves as a first step in educating the public and decision makers about the opportunities and challenges inherent in becoming a climate ready estuary.

Findings from the Surveys and Interviews

Over the past two years agencies and universities have invested considerable resources in conducting surveys, education, and outreach in the Albemarle-Pamlico region. Our targeted meetings built on that work and our findings reflect both the previous work of others and the outcome of our targeted meetings.

Citizens and communities value the Albemarle-Pamlico ecosystem. Sea-level rise and climate change, however, compete with other urgent priorities at the local level. In order for local decision makers to make good decisions to address the impacts of sea-level rise and climate change, accurate and accessible maps and information are essential. We note that some local decision makers dispute climate change and sea-level rise. Municipal officials may be more receptive than county officials to information and assistance from state and federal agencies. Local leaders' concerns will be affected by the impacts that they and their constituents experience: infrastructure deterioration; salt in drinking water; wastewater, drainage, and water management challenges; loss of estuarine shorelines; and economic development.

Recommendations

Our recommendations address three areas of need: (1) improving access to and quality of information, (2) improving government efficiency and coordination, and (3) implementation steps that APNEP should take as soon as possible.

The public and decision makers need the **best available information** in order to make sustainable decisions for their communities. All of the targeted meeting participants identified lack of reliable information as their most important concern. We identified several information gaps that APNEP or the state must address to build a climate ready estuary. Climate monitoring and modeling of the region should be improved to provide communities with site- or region-specific information on which to base community decisions. Maps are effective tools that help communities understand how climate change and sea-level rise will impact them. We recommend updating current floodplain maps and developing several distinct maps, including maps to identify risks to drinking water sources and systems, threats to septic systems, and risks to drainage and water management systems. Decision makers also need to understand the value of the coastal and estuarine ecosystem to their communities and economies. We recommend periodic measurement of the ecosystem services provided by the resources of the Albemarle-Pamlico region.

Many local, state, federal, and private agencies have important roles and responsibilities to plan for and adapt to climate change and sea-level rise. The diversity of agencies active in the Albemarle-Pamlico region make it essential to coordinate regulatory and nonregulatory efforts, incentives, and education programs in the most efficient manner. We recommend identifying agency roles and responsibilities to ensure full coordination of a comprehensive climate ready estuary effort. We also recommend that existing state programs designed to protect and restore living ecosystems and shorelines be integrated to the maximum extent practical.

Building a climate ready estuary depends on reliable information, integrated government structure, and strong implementation steps. Our final set of recommendations identifies actions that APNEP could take now to establish a firm foundation from which to develop a comprehensive program. We recommend that APNEP develop, implement, and sustain a communication plan. As part of this project we provide a basic communication plan outline that is included in this Blueprint as Supplement C. Our interviews also revealed that some communities have already identified impacts of climate change on their community resources. We recommend providing technical and financial assistance to these pilot communities. Communities in the Albemarle-Pamlico region have extensive experience with natural hazards. Private insurers, markets, and the federal flood insurance program have a strong role in influencing community growth patterns in response to risk. We recommend that APNEP take a strong role in coordinating efforts related to hazard management. Finally, we recommend that APNEP be an advocate for the Albemarle-Pamlico region. APNEP is uniquely positioned to educate decision makers at all government levels about the value and importance of the ecosystems and the regional economy.

Blueprint for Building a Climate Ready Estuary In North Carolina

The health of the estuarine ecosystem is inextricably entwined with key economic drivers such as recreational fishing, commercial fishing, shellfish production, recreation, homeownership, agriculture, forestry, and tourism, making protection of the estuarine ecosystems of critical importance. Coastal North Carolina is home to one of the nation's most productive estuarine systems, which gives heightened importance to the need for advance planning to ensure economic and ecological sustainability. The Albemarle-Pamlico region is one of three areas of the country most threatened by sea-level rise. The region faces some of the most serious and potentially imminent impacts of climate change, yet little planning has occurred to address these threats.

In June 2008, the U.S. Environmental Protection Agency (EPA) launched the Climate Ready Estuaries (CRE) program to build local capacity to adapt to climate change. In response, the Albemarle-Pamlico National Estuary Program (APNEP) initiated a collaborative effort, tapping into the scientific expertise of North Carolina universities to facilitate public awareness and understanding and to engage local government officials. This effort builds on APNEP's ongoing work with a number of its partners to bolster the region's resilience and mitigate the effects of climate change on the landscape. Although storm events often capture headlines and the public's attention, the most pressing long-run issue for the region is sea-level rise and its associated impacts on human communities and both aquatic and terrestrial habitats. In particular the counties of Dare, Hyde, Tyrrell, and Washington are at the greatest risk from flooding (Figure 1).

In order to be a climate ready estuary, people and the institutions that affect and are affected by the estuarine system must have three critical attributes. They must:

- understand and be aware of potential changes and impacts to the system;
- have the motivation to adapt to those changes; and
- have the capacity and resources to adapt to those changes.

While the APNEP has worked with many partners to educate the public and local officials about climate change and its potential impacts, our research and the research of others suggests that our region is behind in all three of these attributes.

Even where there is knowledge and awareness about climate change and its effects, there is a sense among local officials and the public that real problems from climate change are far off on the horizon. Lacking a sense of urgency, there is little motivation to make necessary changes to personal choices and behaviors, or to governmental investments, regulations, and practices. Furthermore, when these issues are communicated to the public, they are rarely framed in a way that taps into the concerns of local residents. Finally, without the awareness and motivation of local citizens and policymakers there will be no capacity to prepare, plan, or adapt.

Local officials will not be able to persuade their citizens to plan for and adapt to climate change and sea-level rise without science-based information provided by state and federal agencies and by universities. Gauging public understanding and educating the public are parallel strategies that need to build upon one another. That is, opportunities for learning about public opinion can be co-convened with opportunities for providing public education.

Accordingly, the main focus of the pilot program was to increase public and local government awareness in Beaufort, Dare, Hyde, Tyrrell, and Washington counties in the APNEP region, to compile a resource of up-to-date science on sea-level rise impacts, and to begin to reach out to the public and local lawmakers and resource managers about the opportunities and challenges inherent in becoming a climate ready estuary.

The Blueprint is a synthesis of the Nicholas Institute's outreach to the five counties in the APNEP system and our recommendations for further outreach and next steps.

The Blueprint:

- Develops findings based on surveys and targeted interviews with key individuals to assess awareness and concern about climate change, sea-level rise, and actions to address impacts.
- Provides recommendations intended to improve the area's resilience and adaptation capacity, including specific recommendations to the APNEP policy board. The recommendations:
  - address information gaps and encourage access to the best available information for decision makers and the public;
  - address the need for improved government efficiency and coordinated government action at all levels; and
  - identify implementation steps that APNEP could take as soon as possible.

The supplemental materials and appendices provide more detailed information about the methods and research foundation for the Blueprint.

The Blueprint begins with the findings based on surveys and targeted interviews. Then, it provides our recommendations for making this region a climate ready estuary.

Findings from Surveys and Interviews

Over the past two years, multiple agencies and universities, including APNEP, the University of North Carolina at Chapel Hill (UNC-CH), and the Nicholas Institute have conducted public opinion surveys in the Albemarle-Pamlico region. The surveys looked at both local government staff and the general public. The survey work and public outreach forums indicate a lack of urgency in public perceptions about climate change and its effects on the natural and built environment around our estuaries. For example, 2008 survey work by students at the Albemarle Ecological Field Site (Manteo, North Carolina) of the UNC-CH Institute for the Environment revealed very low public appreciation of the threat of sea-level rise on estuarine resources. Additionally, survey work in estuarine counties by graduate students at Duke University's Nicholas School of the Environment in 2008 and 2009 for the Nicholas Institute showed a low understanding of the effects of shoreline armoring on estuarine erosion and a low appreciation of the threat of sea-level rise by locally elected officials.

In addition to the student survey work, APNEP—in partnership with the Albemarle-Pamlico Conservation and Communities Collaborative (AP3C), The Nature Conservancy (TNC), Environmental Defense Fund (EDF), the Conservation Fund, and others—conducted a series of public scoping sessions to record and understand North Carolina residents' concerns about the combined impact of sea-level rise and population growth. Initial results indicate that residents perceive equity issues, threats to traditional livelihoods like fishing and farming, and impacts to water quality among the greatest concerns. The North Carolina Division of Coastal Management conducted an online survey about public perceptions on sea-level rise in 2009 and hosted a science forum on sea-level rise with the Coastal Resources Commission in January 2010 in Raleigh.

The Nicholas Institute built on the survey and public outreach work and conducted targeted interviews with key individuals, including local elected officials, water utility managers, emergency managers, and leaders in Beaufort, Dare, Hyde, Tyrrell, and Washington counties to establish awareness, concern, and ability to effect responses to climate change impacts within their jurisdictions. The Nicholas Institute created county-specific presentations that were given at scheduled county commissioners' meetings. This forum was chosen as the most efficient way to access the local elected and appointed officials and resource managers in each community. Four of the meetings were held at night; one, in Tyrrell County, was held in the afternoon. Attendance ranged from 20 to 100 people. No attempt was made to determine how the CRE presentation influenced attendance at the meeting. The presentation consisted of a 20-minute information session, supported by PowerPoint, followed by questions and answers. In addition to the commission meetings, the Nicholas Institute met with selected mayors, town managers, water utility directors, and other resource administrators in four of the five counties to discuss specific concerns and issues related to sea-level rise and storm activity that each area already faces. Attendance at these meetings ranged from one to four people.

Map of the key region, showing sites of presentations and interviews.

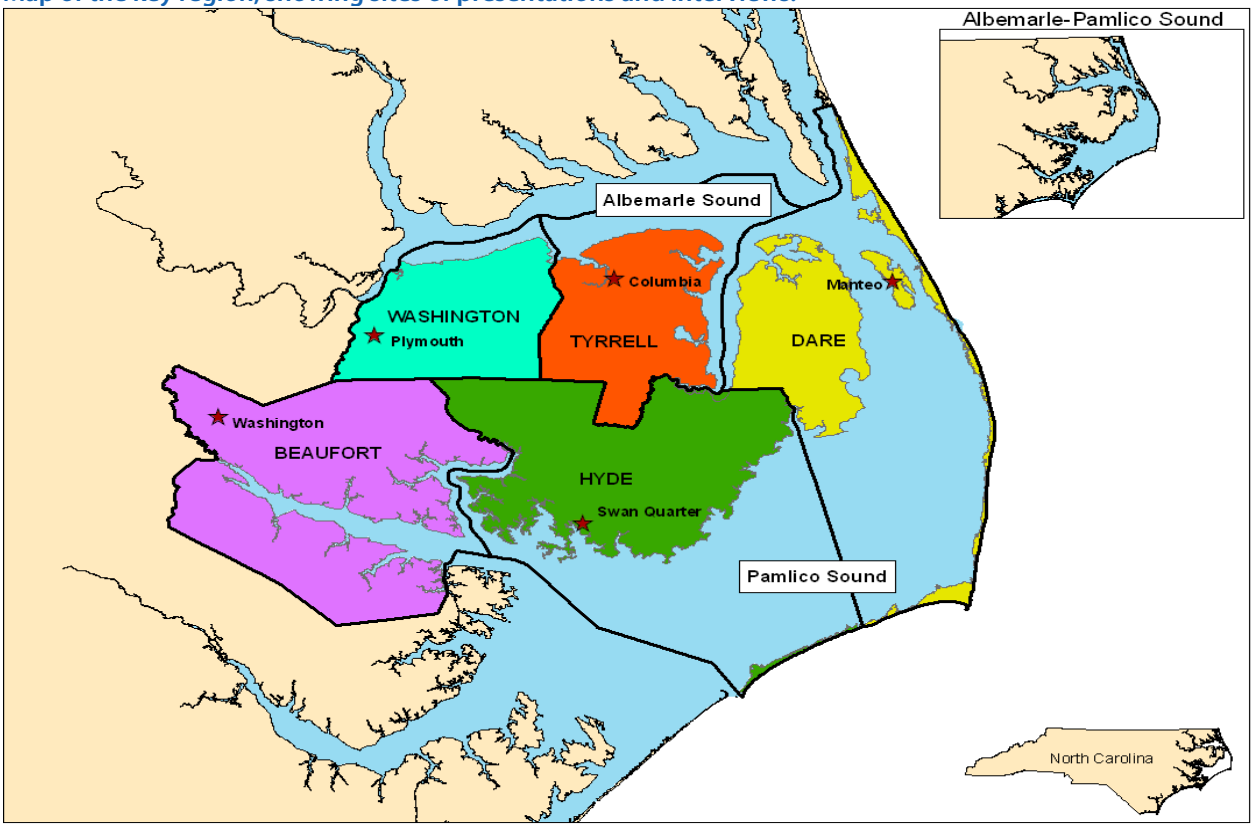

Table 1. Locations and dates of targeted meetings.

County	County Seat	Date of County Commissioners Meeting	Date of Town Managers Meeting
Dare	Manteo	8/17/2009	8/17/2009
Tyrrell	Columbia	8/18/2009	8/18/2009
Hyde	Swan Quarter	10/5/2009	No town meeting
Washington	Plymouth	7/20/2009	7/21/2009
Beaufort	Washington	9/16/2009	9/9/2009

The targeted meetings had overall success in achieving program goals. The presentations at the county commission meetings were effective in bringing the issues of sea-level rise and climate change to the attention of community leaders. The uncertainties associated with the potential impacts of climate change and sea-level rise can be disconcerting. Having a constructive and practical discussion of potential effects served to take the concepts from the abstract to the concrete and engendered a sense that practical solutions exist and can be achieved with advance planning.

The discussions held with municipal leaders and resource managers helped facilitate our learning of what sea-level rise effects are being experienced today and what steps resource managers are planning for the future. The nature of these discussions included actual examples that can be used to anticipate and model the needs of other coastal communities to plan for infrastructure and natural resources for the coming decades.

Our findings from the surveys and targeted interviews are presented below.

Communities value the Albemarle-Pamlico ecosystem
Local officials in the Albemarle-Pamlico region love their communities and the rich ecosystems intrinsic to the area. They highly value the fisheries, wetlands, waters, and estuary. Local officials are receptive to approaches that help them protect their communities, as opposed to requirements from Raleigh or Washington.

Sea-level rise and climate change compete with urgent local priorities
Even those who consider the potential impacts of climate change and sea-level rise in their planning have a hard time weighing the importance of these activities against other pressing and costly issues. Agencies presenting information about these topics need to be sensitive to the issues competing for managers' time and budget and find synergies between suggested solutions to sea-level rise impacts and a county's outstanding needs.

Accurate, accessible maps and information are essential for good decisions
Many county commissioners and officials had not seen maps depicting areas at risk from sea-level rise and coastal storms. Although they expressed a desire for information, they need time to evaluate and for staff to evaluate information rather than having new information presented in public sessions. State and federal agencies developing maps, models, and other technical information need to develop a means to deliver the information to local officials and the public that is specific to the end user and is sensitive to local political dynamics.

Some local decision makers dispute climate change and sea-level rise
Not all commissioners and managers are convinced of the relevance of sea-level rise to their community, and some dispute the underlying concept. This pushback to the core concept of climate change and sea-level rise was itself instructive and should inform the project going forward.

Municipal officials may be more receptive than county officials to assistance from state and federal agencies
Some municipal elected and appointed officials are already experiencing the effects of climate change and sea-level rise on municipal infrastructure, including water, wastewater, stormwater, and street systems. They tend to be more receptive to information and assistance from state and federal agencies. Some municipalities expressed openness to pilot adaptation projects to make their infrastructure and communities more resilient to climate change.

Local leaders identified community concerns
Local leaders identified current community concerns that will be exacerbated by climate change and sea-level rise. The local leaders identified these as community concerns even if they did not identify climate change as having an impact on their community. The eight community concerns identified below are currently being impacted by sea-level rise and climate change and may represent future areas for APNEP focus.

Infrastructure readiness
Local officials are genuinely concerned about the potential impacts that climate change, especially sea-level rise, may have on drinking water resources and aging wastewater and septic system infrastructure. One fear is that sea-level rise may require water infrastructure to be replaced sooner than planned. Another is that an increase in population and economic activity will add unsupportable demand, and new infrastructure will have to be built within a limited budget. Unlike other areas of coastal and land-use planning, construction, operation, and maintenance of water infrastructure primarily falls upon the counties and towns. Sea-level rise poses similar threats to other local government infrastructure, from schools to fire stations to emergency response facilities.

Salt in drinking water
Some municipal and county water utilities are experiencing higher levels of salt (chloride) in groundwater supplies and increased water treatment costs. Many systems use reverse osmosis technology to treat drinking water. It is not clear whether the salt is coming from saltwater intrusion brought about by sea-level rise or from pumping deeper in the brackish aquifers underlying the region.

Wastewater challenges
Most residents in the region are served by septic tanks. Proper functioning of septic tanks in poorly drained coastal soils is already a problem. Local officials know that sea-level rise will aggravate the problem, but are not planning for

it, even though clean water is vital to the travel and tourism and fishing industries in the region. State policy to augment local land-use policies will be needed to ensure that septic tanks adequately treat wastewater and protect public health and the environment in the future.

Drainage and water management
Flooding, drainage, and stormwater management are existing problems in both urban and agricultural areas in the region. Local officials are under pressure "to get the water off" streets, yards, and agricultural fields after storms. They are frustrated by environmental requirements to store and treat stormwater. There are few stormwater utilities in the region, and stormwater is not comprehensively managed. Local officials seem unaware that while larger ditches do move water off property more quickly, they also deliver saltwater further inland. Agricultural drainage districts need to cooperate on modeling and water management.

Estuarine shorelines
Local officials understand that marshes and wetlands provide ecosystem services, including clean water, fish and wildlife habitat, and flood protection. They also understand that bulkheading or hardening the estuarine shoreline destroys wetlands while it protects private property. Waterfront properties are more valuable than inland properties in the APNEP region and provide more property tax revenues. Local officials want to explore policies that protect estuarine shorelines and valuable waterfront property.

Economic Development
Economic development was identified at all of the meetings as a primary concern. Local officials recognize the general economic importance of the estuary but few understand exactly how ecological conditions will benefit them directly. All understand the costs of stricter regulation, more shoreline erosion, and forgone development. Preparation and distribution of outreach materials detailing the economic value of estuaries statewide will help community leadership and resource managers to not only understand the value of their estuaries, but also to pass the knowledge along to their constituents and visitors.

Integration of state and local programs
Local officials appreciate the strong and coordinated state and local emergency response capacity for coastal storms, built on a long history of responding to coastal storms and floods. But they are not currently calling on state and local emergency managers to plan for more powerful storms and sea-level rise with greater storm surges. In addition, local and state clean water, coastal management, stormwater, flood hazard, insurance, and other programs are not integrated in order to reduce risk and damage to public health, private property, public infrastructure, and the environment.

Need for follow-up to build on this blueprint
In all of the counties and communities visited there was an overwhelming request for follow-up on the presentations. The dialogue has begun and can be more productive as it continues. A program to further these initiatives and provide the communities with greater detail on different options and funding opportunities has a high probability of favorable reception.

See Supplement B for a detailed analysis of the five surveys and a summary of the findings of each individual survey.

Recommendations

Our recommendations derive from our interactions with local government officials and staff, our research, and our survey findings. The recommendations are divided into three sections: information needs, necessary changes to governance structures, and steps for immediate implementation. The recommendations address both specific actions for the APNEP Policy Board and for other agencies that are essential for a comprehensive approach to climate change adaptation. Our recommendations recognize the complex nature of protecting coastal communities and ecosystems from climate change. Climate change will be challenging for North Carolina and will require coordinated actions on the part of federal, state, and local governments and citizens. APNEP is uniquely positioned to lead this effort.

Information Needs

Information is essential for Albemarle-Pamlico communities and individuals to plan for and implement policies that will create climate-resilient communities. Lack of information is the single consistent concern from the communities we interviewed. We recommend several information development steps that APNEP could take to improve the base of information utilized by communities to make decisions. Fundamental thinking needs to be changed from situational response to advance planning.

Improve climate change monitoring, mapping, and modeling of the region

The APNEP Policy Board *should recommend improved monitoring and mapping of sea-level rise.*

During our interviews and surveys, community decision makers used anecdotal evidence to describe the impacts of sea-level rise on their communities. Accurate, systematic data collection on sea-level rise is essential to incent community action. Increasing stations to monitor sea-level rise is as important as developing overall climate monitoring stations. We recommend APNEP Policy Board investigate expansion of sea-level rise monitoring in the APNEP region.

Basic research on marsh erosion, accretion, and upland migration would be valuable to forecasting these changes in response to sea-level rise. These observations are extremely sparse. APNEP has funded a few projects and might expand these into longer-term monitoring or experiments. The Nature Conservancy's work in the Alligator River National Wildlife Refuge is an example.

Cost-effective tools for mapping are needed. Some of the past mapping and monitoring has been conducted using traditional, albeit reliable methods. The scope and challenge of sea-level rise in the region probably require new technology such as satellite remote sensing and image processing. Few opportunities are available for researchers to conduct experiments. APNEP might invest in a feasibility demonstration.

The APNEP Policy Board *should recommend expansion of the State Climate Office's ECONet climate monitoring stations in the region.*

Local climate data will improve the ability of climate scientists to downscale global climate models and predict local impacts. Limited local climate data for the region hinders state and local planning for climate change. State programs designed to improve local data are under way, but plans for collecting data in the APNEP region are limited. The State Climate Office based at North Carolina State University is developing a statewide network of climate monitoring stations called the North Carolina Environment and Climate Observing Network (ECONet). Personal communication with Ryan Boyles, the State Climatologist and Director of the State Climate Office, indicates that current coverage of the APNEP region is insufficient to provide the information that local communities need. Ten to twenty stations would provide the local data needed. Each station costs about $15,500 and about $5,000 per year to operate.

Measure the value of coastal ecosystems, economies, and communities

The APNEP Policy Board *should ask North Carolina Department of Environment and Natural Resources (DENR), North Carolina Department of Commerce, U.S. Environmental Protection Agency (EPA), other federal agencies, scientists, and economists to periodically measure the ecosystem services produced and consumed in the Albemarle-Pamlico region and their value to the state's economy and to coastal communities in coordination with APNEP's Comprehensive Conservation Management Plan (CCMP) and Ecosystem-based Management Plan.*

The citizens and local officials in the Albemarle-Pamlico region value the rich ecosystems and their communities. They love the estuary—the fisheries, wetlands, waters—and the quality of life that the estuary provides. But to help them understand the estuary's value to their community, they need more information about its local, regional, state, and national economic importance and the ecosystem services the estuary provides. The communities understand the critical role of wetlands in protecting water quality, providing habitat for fish and wildlife, and storing water. The value of wetlands in protecting communities from sea-level rise and storms while now appreciated in Louisiana, is not fully appreciated in the region. Improved measurement and valuation of all the ecosystem services that the estuary and wetlands provide is needed.

This type of information is already in development. The Ecosystem Services Research Program (ESRP) in the U.S. Environmental Protection Agency's Office of Research and Development (ORD) is identifying and characterizing the services that ecosystems provide to humans and identifying the value that these services provide to human health and well-being in the Albemarle-Pamlico region. EPA's research could inform the effort to improve measurement and valuation of the ecosystem services in the region.

Evaluate Blue Carbon sequestration

The APNEP Policy Board *should ask scientists and economists to evaluate the potential economic costs and benefits of both preventing emissions of greenhouse gases due to the conversion of salt marshes and other coastal habitats and of sequestering carbon by restoring salt marshes and coastal habitats.*

Marine ecosystems are a significant carbon sink. One of the many ecosystem services provided by that salt marshes, submerged aquatic vegetation (SAV), oyster reefs, nearshore hard bottoms, and other coastal habitats is carbon sequestration. Emerging markets for carbon could provide a mechanism to help finance both the protection and restoration of salt marshes and coastal habitats and to create local jobs.

Develop and update maps and information

The APNEP Policy Board should work with the Division of Coastal Management, Division of Emergency Management, Federal Emergency Management Agency (FEMA), National Floodplain Mapping Program (NFMP), National Flood Insurance Program (NFIP), scientists, and others to include best available projections and maps of sea-level rise in the existing process of updating floodplain maps and flood insurance rate maps by 2013.

Most county commissioners, local officials, and the public had not seen maps prepared by U.S. EPA, North Carolina Center for Geographic Information and Analysis (for the climate ready estuary project) or The Nature Conservancy depicting areas at risk from sea-level rise and coastal storms. Fran, Floyd, and other storms provide an object lesson in the importance of accurate, reliable information from which communities can assess risk. Most state, federal, and local emergency managers and planners knew that floodplain maps and flood insurance rate maps were woefully out of date before Hurricanes Fran, Floyd, and other storms flooded many communities. However, the public and most local officials were unaware that they were relying on outdated and inaccurate information and were unaware of the risks. After their homes and businesses were flooded, many citizens discovered that they had been "moved" into the floodplain by environmental and land-use changes upstream. Accurate floodplain maps and processes to provide the information to the public and local officials would have reduced the tremendous economic and environmental damage caused by Hurricanes Fran and Floyd and other storms.

As a result of that experience, Governor Jim Hunt supported and the 2000 General Assembly required that floodplain maps and flood insurance rate maps be periodically updated and presented to local officials. The North Carolina Division of Emergency Management (DEM) has developed an effective, science-based system to develop and update floodplain maps and flood insurance rate maps and present them to the public and local officials (ncfloodmaps.com). Flood insurance rate maps (FIRM) are accurate enough to allow citizens and businesses to identify their property. Public and private decision makers now have access to the best available floodplain data and can better manage their risks. However this information can be improved by incorporating information such as future land-use changes, increased impervious surfaces, and impacts of climate change. Because the state of the "best available science" is always changing, the five-year updates help keep the information current.

Mapping objectives could be supplemented by existing historical information that provides concrete examples of sea-level rise. Historical repeat photography revealing shoreline changes that have been measured (such as at the Cape Hatteras Lighthouse), historical maps, and geological and archeological studies could all be sources for tangible evidence of sea-level rise to date and would be helpful in educating the public and state and local officials.

The lessons from Fran and Floyd also apply to the sea-level rise data, maps, and models that DEM is developing.[1] Sea-level rise projections and maps could be included in DEM's existing process of updating floodplain maps and

1. PL 110-329 appropriated $5,000,000 to the NC Division of Emergency Management in federal fiscal year 2009 to "perform a risk assessment and mitigation strategy demonstration of the potential impacts of sea-level rise in that State associated with

flood insurance rate maps and educating the public and local officials about risk. North Carolina's efforts to provide the best available information to its citizens and local officials about sea-level rise could be a model for the National Floodplain Mapping Program (NFMP) and National Flood Insurance Program (NFIP) and could qualify for some pilot funding from the Department of Homeland Security, NFMP, and/or NFIP.

In addition, a comprehensive plan for developing and updating maps needs to be developed. To accomplish this goal, a geospatial needs assessment tied to the Comprehensive Conservation and Management Plan (CCMP) should be considered to determine what are the priority data needed, at what resolution, collected by whom, and updated with what regularity. An example of a successful mapping project can be found in the Atlas of the Venice Lagoon which was done by the Venice Institute of Marine Science.

Develop maps to help the region protect its drinking water from the impacts of climate change.
The APNEP Policy Board *should ask the local water utilities, Division of Water Resources, Division of Environmental Health, EPA, university scientists, and others to develop a regional groundwater monitoring and modeling program for the region.*

The APNEP Policy Board *should ask Division of Environmental Health, Division of Emergency Management, and Center for Geographic Information and Analysis to develop detailed maps to help local water utilities and state regulatory and funding agencies evaluate the risk to drinking water infrastructure posed by sea-level rise.*

Municipal and county water utilities are experiencing higher levels of salt (chloride) in their groundwater supplies and increased water treatment costs. Many systems use reverse osmosis (RO) technology to treat drinking water. Is the salt coming from saltwater intrusion brought about by sea-level rise or from pumping deeper in the brackish aquifers underlying the region? The utilities are collecting data but lack the capacity to analyze regional trends or to develop a model to project trends. Systematic collection and analysis of local groundwater and drinking water data is needed to establish trends. The regional data and trends would be valuable to the water utilities and could be shared with EPA's Climate Ready Utilities working group.

Developing a regional groundwater monitoring and modeling program could develop into a regional drinking water network in which utilities share information and best practices and utilities with more capacity provide technical assistance to those with less capacity.

Removing increasing amounts of salt will likely increase drinking water costs in the region. Capturing and reusing rainwater and stormwater for nonpotable uses such as toilet flushing, irrigation, and cooling may both reduce the costs of using RO to treat drinking water and reduce coastal flooding and stormwater pollution. APNEP could assist the utilities in evaluating the potential for rainwater and stormwater reuse to increase affordable water supplies and to reduce water pollution.

DEH, DEM, and other agencies should help local water utilities develop plans and capital improvements to increase the resiliency of their water systems. DEM's integrated hazard risk management (IHRM) program and EPA's Climate Ready Utilities program may provide useful guidance. EPA and DEH's source water protection program do not currently consider sea-level rise, but likely will in the future. Adaptation projects should be eligible for both state revolving loan and grant funds for drinking water administered by DEH and for Department of Homeland Security grant funds.

Greenville Utilities and other major industries in the Albemarle-Pamlico region carefully monitor their intakes and the saltwater wedges in the Roanoke, Tar, and Neuse rivers. Improving hydrologic models may help them manage their future risks. While the region will not run out of water, it could run out of affordable water. Providing water, wastewater, and stormwater services to citizens in the region may become much more expensive. APNEP could work

long-term climate change, as discussed in the House report. FEMA is directed to use the study results to assess the long-term fiscal implications of climate change as it affects the frequency and impacts of natural disasters, and to disseminate information from the study to other states to inform their climate change mitigation efforts." DEM has scheduled the NC Sea Level Risk Management Study (ncsealevelrise.com) to be completed by June 2011.

with the Environmental Finance Center at UNC-CH to evaluate water rates for utilities in the region and compare costs. What is a region's ability to pay?

Develop maps that identify risk to existing septic tanks and waste water infrastructure to protect public health and water quality

The APNEP Policy Board *should ask Division of Water Quality, Division of Environmental Health, Division of Emergency Management, and Center for Geographic Information and Analysis to develop detailed maps to help county health departments, local wastewater utilities, and state regulatory and funding agencies to evaluate the risk to existing septic tanks and wastewater infrastructure posed by sea-level rise.*

Most residents in the region are served by septic tanks. Proper functioning of septic tanks in poorly drained coastal soils is already a public health and environmental problem. Sea-level rise will raise water table and aggravate the problem. It will also expand the problem. Sites that can currently adequately treat wastewater will not function in 30 or 50 years.

Clean water is vital to the travel and tourism and fishing industries in the region. State policy will be needed to ensure that septic tanks adequately treat wastewater and protect public health and the environment in the future. Areas that have or will have failing septic tanks should be mapped. New septic tanks should be designed with sea-level rise in mind. County health departments need a tool to help them evaluate the risk of sea-level rise when they are reviewing applications for new septic tanks or repair and replacement of old septic tanks. They also need clear policy from the state to address sea-level rise.

DWQ, DEM, and other agencies should help local water utilities develop plans and capital improvements to increase the resiliency of their wastewater and stormwater systems. DEM's integrated hazard risk management system and EPA's Climate Ready Utilities program may provide useful guidance. Adaption projects should be eligible for both state revolving loan and grant funds for clean water administered by DWQ and for Department of Homeland Security.

Drainage and water management

The APNEP Policy Board *should convene Division of Water Quality, Division of Soil and Water Conservation, Division of Emergency Management, Department of Transportation, Center for Geographic Information and Analysis, local soil and water conservation districts, local drainage districts, federal land managers, resource agencies, and others to increase state and local knowledge of water management in the Albemarle-Pamlico peninsula and to begin development of a more comprehensive water management system for the region.*

Flooding, drainage, and stormwater management are existing problems in both urban and agricultural areas in the region. Most of the productive farm and forest land and many of the towns in the region depend upon drainage and water management.

After storms, local officials are under pressure "to get the water off" streets, yards, and agricultural fields. There are conflicts between public safety and environmental goals. Local officials are concerned about environmental requirements to store and treat stormwater. There are few stormwater utilities in the region and stormwater is not comprehensively managed. Local officials are frustrated by environmental regulations that make clearing and dredging canals and ditches difficult or impossible.

The public and local officials seem unaware that while larger ditches and canals do move water off property more quickly after storms, they also deliver saltwater further inland. Agricultural drainage in the region is complicated. Some drainage districts depend upon other districts to move water through the system.

More intense storms will bring more water. Sea-level rise will raise water tables. Water management will become more challenging. New information, tools, and perhaps new organizations will be needed to comprehensively manage water and to understand tradeoffs between public safety and health, and environmental and economic impacts.

Developing digital maps of the stream and drainage systems, identifying and mapping areas with most severe drainage and stormwater problems, modeling water flows, and projecting future water flows and flooding are needed to help local and state officials develop a more comprehensive water management system for the region.

The U.S. Natural Resources Conservation Service's (NRCS) Wetlands Reserve Program (WRP) and other programs can finance restoration of wetlands in areas that can no longer be effectively drained. Wetlands provide clean water, habitat, flood protection, water storage, and other benefits.

Improve Agency Coordination and Efficiency

Many state, federal, local, and private agencies will have important roles and responsibilities in working with local communities to plan for and adapt to climate change and sea-level rise. Some are regulatory; some, nonregulatory. The number and diverse mandates of agencies can lead to confusion about roles and responsibilities and to inefficient and redundant program implementation. The agencies' roles and responsibilities must be clear to the public and to each other, and agency actions must be coordinated and integrated to create an effective adaptation plan. North Carolina has experience in developing a coordinated effort. Over many years and many storms North Carolina has developed an effective and coordinated state-local-federal emergency response plan and the capacity to implement it. The roles and responsibilities of the agencies are well understood. North Carolina can build upon this experience and capacity to plan for future coastal storms. We recommend establishing roles and responsibilities for agencies, identifying goals, and coordinating existing programs like the living shoreline program.

Determine agency roles and responsibilities

The APNEP Policy Board *should ask DENR to designate APNEP as the lead state agency coordinating, directing, and prioritizing state and federal nonregulatory technical and financial assistance to help protect and restore the ecosystems, economy, and communities in the region from climate change and sea-level rise. Directing demonstration projects toward priority areas of Coastal Habitat Protection Plan's and SHA's managed by DCM are good examples of ways that APNEP can help to shepherd change.*

The threat of climate change and sea-level rise to the ecosystems, economy, communities, and public health, safety, and welfare of the region makes the mission of APNEP, Division of Coastal Management and other programs more urgent. Conflicts between public and private uses will likely come to dominate the agenda of the state's coastal management program as sea-level rise, climate change, coastal storms, erosion of oceanfront and estuarine shorelines, and threats to ecosystems and private property increase. The current debate over groins and sandbags on the oceanfront will escalate and expand to estuarine shorelines. DENR should anticipate this change by designating APNEP as the lead nonregulatory state agency and designating the Division of Coastal Management (DCM) and Coastal Resources Commission (CRC) as the lead state regulatory agencies for developing, adopting, integrating, and managing sea-level rise, coastal storms, climate change, and land uses in the 20 coastal counties. As a component of this designation, the needed additional staff and funding for this monumental task must be considered, as it would be impossible to achieve at present given APNEP's current limited staff and resources.

APNEP, DCM, and the CRC are not the only agencies with responsibilities for addressing climate change. DENR should ask the Division of Water Quality (DWQ), Environmental Management Commission (EMC), Division of Marine Fisheries (DMF), Marine Fisheries Commission (MFC), Wildlife Resources Commission (WRC), and Division of Emergency Management (DEM) in the Department of Crime Control and Public Safety (DCCPS) to coordinate with the CRC/DCM in the development, adoption, integration, and implementation of adaptation policies and rules.

In order to ensure full coordination and integration, DENR should look to existing policies for opportunities to increase government efficiency. The Coastal Habitat Protection Plan (CHPP) and other policies that are adopted by the CRC, EMC, and MFC and enforced by DCM, DWQ, and DMF could provide a mechanism to spell out roles and responsibilities and to integrate adaptation policies with other policies.

Although the Coastal Habitat Protection Plan (CHPP) is a start, North Carolina has not coordinated its clean water, coastal management, flood hazard mitigation, insurance, habitat protection and restoration, infrastructure investment, and other programs to reduce future risk and damage to public health, private property, public infrastructure,

and the environment from sea-level rise, coastal storms, and other threats. We strongly recommend a fully integrated approach to building a climate ready estuary.

Establish and coordinate goals with other agencies

The APNEP Policy Board *should review these and other recommendations and set interim goals for its climate ready estuary program.*

One step towards greater interagency coordination is for APNEP to review and adopt adaptation related recommendations made by other agencies. The Coastal Resources Commission and the Division of Coastal Management convened a Science Panel on Coastal Hazards, Chaired by Margery Overton, Professor of Civil, Construction, and Environmental Engineering at North Carolina State University, to advise it on the amount and rate of sea-level rise by 2100. Jeff Warren of DCM staffed the panel. In its March 2010 report the panel concluded that the most likely scenario for 2100 is a rise in sea level of 0.4 meter to 1.4 meters (15 inches to 55 inches) above present. They further concluded that a consensus estimate of 1.0 meter (about 39 inches) by 2100 should be used for planning purposes. The CRC has asked that the consensus estimate be revised every five years. Absent another scientifically developed and reviewed estimate DENR should direct its agencies to use the CRC's estimate for planning their projects, for advising local governments, and for funding state and local projects. DENR should ask key federal agencies, including the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, Federal Emergency Management Agency, U.S. Department of Defense, and U.S. Department of the Interior to use the state's estimate or site-specific information. The state and its partners need to deliver a clear, consistent, science-based message to the public on sea-level rise. States that are addressing climate change and that are planning for and adapting to climate change and sea-level rise need technical and financial assistance and support from their federal partners. The APNEP Policy Board should adopt the recommendations of the Coastal Resources Commission's Science Panel on Coastal Hazards regarding sea-level rise.

Integrate state programs to protect and restore living ecosystems and shorelines

The APNEP Policy Board *should ask DENR to update the Coastal Habitat Protection Plan (CHPP) to identify and prioritize estuarine shorelines for protection and restoration. APNEP could sponsor living shoreline restoration projects where local governments lack the capacity to plan and manage them. APNEP could develop the science and site-specific information necessary to expedite permitting and construction of living shoreline projects for both communities and individuals. APNEP should work with local governments to develop policies that protect living shorelines and that also protect valuable waterfront properties and local property tax revenues.*

Most local officials and the public understand that marshes and wetlands provide ecosystem services, including clean water, habitat, and flood protection. Some also understand that while bulkheading or hardening the estuarine shoreline (temporarily) protects structures, it destroys the wetlands. Waterfront properties are more valuable than inland properties in the Albemarle-Pamlico region and provide more property tax revenues. Local officials want to explore policies that protect estuarine shorelines and valuable waterfront property.

In 2010 NOAA provided $5,000,000 in Recovery Act funds to the North Carolina Coastal Federation to restore 49 acres of oyster reefs in Pamlico Sound and to create jobs (Appendices 4 and 5). The Nature Conservancy has undertaken a major restoration and adaptation project on conservation lands in the Albemarle-Pamlico region (Appendix F).

The Coastal Resources Commission (CRC) adopted oceanfront setbacks based upon periodically updated erosion rates and banned hardening the oceanfront shoreline in the 1980s. Although conflict has increased in recent years, these policies have protected both the public beach and private property. The CRC has adopted water quality buffers that help protect estuarine shorelines. The CRC has debated but not adopted policies to ban hardening estuarine shorelines and to require setbacks based upon erosion rates. APNEP could provide important information to the CRC on the value of estuarine shorelines as the CRC considers policies.

The Division of Coastal Management (DCM) should compile data on the number, location, and size of bulkheads and living shorelines permitted each year.DCM should also estimate the acres and functions of the wetlands lost

due to bulkheads. This data would increase public awareness and understanding. The public and policymakers are unaware of the cumulative impacts of permitting thousands of bulkheads.

Levying wetland mitigation fees in addition to permitting fees on new and replacement bulkheads could help fund restoration of living shorelines. Recreational and commercial fishing license fees could also be used to restore habitat for fisheries.

Immediate Implementation Steps

Building a climate ready estuary depends on reliable information, an integrated government structure, and strong implementation steps. Our previous recommendations address information and governance gaps. We now turn our attention to action items necessary to implement an adaptation plan for the APNEP region.

Develop, implement, and sustain a communications plan

DENR should designate a lead agency to coordinate the development and implementation of a communications strategy to educate the public and decision makers about sea-level rise and climate change. The APNEP Policy Board *and the Office of Public Affairs in DENR should convene key state, federal, local, university, and private organizations to develop a communications plan.*

The public and decision makers need understandable, consistent information from public and private organizations about sea-level rise, climate change, the value of estuarine resources, and the risk to those resources and the communities they sustain. They also need information about what they can do individually or collectively to protect their estuary.

Many coastal residents and officials consider sea-level rise to be a "serious but not urgent" problem for the future. They believe that they face more pressing problems, and that the current rise of less than 0.2 inches per year is not compelling (sea-level rise is projected to accelerate in the future).

An effective communications plan could also tap the local knowledge, stories, and pride of the citizens of the Albemarle-Pamlico region. Citizens and communities in the region are resilient, and have worked together to rebuild and recover from many storms. They may remember huge algae blooms and fish kills in the Chowan River; now they see the river is recovering. They may remember when their tap delivered better-tasting public water (from a county or municipal RO treatment plant) instead of shallow groundwater. They may remember a farm or forest that has become a wetland or marsh. They also know that trees don't grow in Albemarle Sound. (The research and engagement that resulted in the documentary "Change in Coastal Communities: Perspectives from Down East," prepared by Gabe Cumming and Carla Norwood in 2009 with Lisa Campbell at the Duke University Marine Lab in Beaufort, is an example.)

An effective communications plan should also take into account that some traditionally disenfranchised communities living in high-risk areas may be distrustful of information about sea-level rise and climate change. They also may have limited options to elevate their homes or relocate. Special outreach by trusted sources may be needed. The messenger is as important as the message.

Although public and private educational resources are currently limited, there is great expertise available in the public and private sectors that could be effectively tapped and coordinated. DENR, Department of Cultural Resources, Department of Transportation, Partnership for the Sounds, U.S. Fish and Wildlife Service, National Park Service, and others operate many popular natural and cultural attractions and visitor centers in the region.

Many oceanfront property owners are more aware of the risk of sea-level rise than estuarine shoreline and tidal creek property owners. Sea-level rise and storm surges affect all coastal property owners. Educational programs must be designed to reach all affected property owners and residents.

These owners and residents desire information and need it presented in a forum in which they can evaluate and react. A public forum is not the ideal forum for presentation of new information. State and federal agencies develop-

ing maps, models, and other technical information need to develop an effective process to deliver the information to local officials and the public.

As part of this project, the Nicholas Institute outlined a communication plan, which is included as Supplement C to this Blueprint.

Help pilot communities adapt

The state should provide technical and financial assistance to municipalities and communities that are planning for and adapting to climate change and sea-level rise. ***The APNEP Policy Board*** *should convene state agencies that provide technical and financial assistance to local governments and develop a "climate ready communities" pilot program.*

Municipal elected and appointed officials are already experiencing the effects of climate change and sea-level rise on municipal infrastructure. Their streets flood. Their pump stations flood. They face increased infiltration and inflow in their sewer systems. They make long-range investments in public infrastructure. Municipal elected officials in the region tend to be less ideological than county officials and more receptive to information and assistance from state and federal agencies. They want help protecting and improving their communities.

Other local, state, and federal officials can learn from the experience of the communities that innovate and try to put adaptation policies into place. Many state agencies provide technical and financial assistance to local governments. DCM, DEH, DWQ, Clean Water Management Trust Fund, DWR, DOT, Division of Community Assistance in the Department of Commerce, Division of Emergency Management, SeaGrant, Rural Economic Development Center, and others provide services to local governments.

APNEP could work with other state agencies to develop a pilot program to help some municipalities plan for and adapt to climate change. APNEP could also identify and advocate for technical and financial resources on behalf of these pilot communities.

To facilitate an increase in adaptation projects DENR should direct its agencies that provide technical and financial assistance to local governments to review their criteria and make projects that plan for and adapt to climate change eligible for funding. Projects could include elevating or relocating pump stations, relocating wells, moving sewer lines, protecting drinking water treatment plants, and establishing living shorelines. DENR could also ask other state and federal agencies that provide technical and financial assistance to local governments, including USDA Rural Development, Rural Center, and Department of Homeland Security to make adaptation projects eligible for funding.

Integrating sea-level rise and stronger storms into local land-use plans and regulations will be difficult. This should also be piloted.

The experience gained in pilot communities could inform a "climate ready" communities program built upon DEM's "storm ready" communities program. DEM is moving towards integrated hazard risk management.

The state should not provide grant or loan funds for new and major expansions of infrastructure projects that will be inundated in 30 years. The Local Government Commission should not approve local debt financing for projects that will be inundated in 30 years.

Engage insurance and markets

The APNEP Policy Board *should ask the Commissioner of Insurance, National Flood Insurance Program, Division of Emergency Management, private insurance companies, and others to work together to manage risks, mitigate hazards, and maintain affordable property insurance for the residents of the region and the state.*

The Heinz Center and CERES facilitated a stakeholder dialogue between the insurance industry and environmental organizations. They adopted "Resilient Coasts: A Blueprint for Action" in 2009.

Resilient Coasts Principles are:

- Identify and fill critical gaps in scientific understanding and develop the tools and methodologies necessary for incorporating climate change into risk assessments and risk mitigation decisions
- Require risk-based land-use planning
- Design adaptable infrastructure and building code standards to meet future risk
- Strengthen ecosystems as part of a risk mitigation strategy
- Develop flexible adaptation plans
- Maintain a viable private property and casualty insurance market
- Integrate climate change impacts into due diligence for investment and trading

An amendment sponsored by Congressman Walter Jones, Sr., enabled the National Flood Insurance Program to pay for relocation of threatened structures before they were damaged by flooding and storms. The Jones amendment was effective but costly. It was repealed but should be reconsidered.

Hazard mitigation is more cost-effective and less socially disruptive than disasters. Dedicated funding is needed to both prevent construction of structures and to remove structures in high-hazard areas. Private insurance companies desire to reduce risks and could fund hazard mitigation projects. A surcharge could be levied on properties in high-risk areas. Filling wetlands and the floodplain increases flooding and stormwater. Impacts of filling floodplains could be required to be mitigated like the impacts of filling wetlands and streams are mitigated.

The floodplain buyouts after Hurricanes Fran and Floyd have not only reduced hazards to people and property they have also provided recreational and clean water benefits. The state supplemented federal floodplain buyout funds to enable lower-income residents to relocate to decent housing.

Be an advocate for the Albemarle-Pamlico region
The Albemarle-Pamlico National Estuary Program (APNEP) *should educate state, federal, and local decision makers and the public on the value and importance of the ecosystems and economy (what's at stake) to the state and nation and advocate on behalf of the region.*

The citizens and local government need both information and an organization to advocate for their ecosystems and economy. The public and state and national legislatures will inevitability ask what the costs and benefits of protecting and restoring the ecosystems and economy of the region. APNEP could provide both the information and the organizational framework needed to convey the information to the public and decision makers.

Through its One North Carolina Naturally, Ecosystem Enhancement Program, and other initiatives, DENR continues to work to improve the effectiveness of state conservation, restoration, and mitigation programs. Protecting and restoring the ecosystems of the Albemarle-Pamlico region will provide multiple public benefits, including increased resilience to climate change, clean water, flood reduction, hazard mitigation, fish and wildlife habitat, carbon sequestration, recreation, public access to public waters, and job creation. Measuring and valuing the services and public benefits that the ecosystems of the Albemarle-Pamlico region provides DENR an opportunity to practice ecosystem-based management, and to increase the public benefits that state and federal programs deliver.

Conclusion

The citizens and local officials of the Albemarle-Pamlico region need the **best available information** about climate change, sea-level rise, and risk to their property, their communities, and their infrastructure. They also need the best available information about how they can protect their region. They deserve effective **governance** by state, local, federal, and private agencies with clear roles and responsibilities. They deserve transparency and accountability. They need technical and financial resources to **implement** the policies and projects that will protect and restore their estuary, their communities, and their economy.

The nation's estuaries provide enormous environmental and economic benefits to its citizens. With support from Congress, the U.S. Environmental Protection Agency and states established the National Estuary Program—a

federal-state partnership—to protect and restore the estuarine ecosystems that support coastal communities and economies. EPA and the state of North Carolina created the Albemarle-Pamlico National Estuary Program (APNEP) in 1987 to protect and restore the second-largest estuary on the east coast.

Climate change and sea-level rise threaten the health of the nation's estuaries, coastal communities, and coastal economies. The Albemarle-Pamlico estuary is considered the third-most vulnerable to climate change and sea-level rise in the United States. In 2008 EPA established the Climate Ready Estuaries program to help states and coastal communities plan for and adapt to climate change. EPA provided a grant to APNEP to evaluate the readiness of state and local governments and to develop recommendations to improve the resilience of the region.

The APNEP Policy Board insisted that county and municipal elected and appointed officials be contacted before any adaption policies were considered. APNEP began working on CRE with representatives of several universities, EPA Region IV, and NC DENR before deciding to contract with the Nicholas Institute for Environmental Policy Solutions at Duke University to reach out to local officials to assess their awareness and concerns, to develop a communications strategy, to make specific recommendations to the APNEP Policy Board, and to develop a Blueprint for building a climate ready estuary. APNEP asked the Nicholas Institute to focus on Beaufort, Dare, Hyde, Tyrrell, and Washington counties in the Albemarle-Pamlico peninsula. These counties are predicted to have the greatest risk for adverse impacts of sea-level rise. The Nicholas Institute made presentations to county commissioners at their regularly scheduled meetings and conducted in-person and telephone interviews with municipal and other local officials in the summer and fall of 2009.

Myriad federal and state agencies, universities, and organizations are churning out information, models, maps, and projections on climate change and sea-level rise. Local, state, and private decision makers need access to the best available information in order to plan their investments and manage their risks. The APNEP Policy Board can support the development of clear, consistent information tailored to the needs of specific decision makers, including local elected officials, land-use planners, developers, homeowners, water utility managers, emergency managers, and resource managers.

The challenges of adapting to climate change and sea-level rise require new thinking by public and private decision makers. Protecting and restoring the estuarine ecosystems, coastal communities, and coastal economy of the Albemarle-Pamlico region requires an ecosystem-based management approach. Ecosystems provide many valuable environmental services. Multiple public and private programs, policies, and funding sources must be effectively coordinated, integrated, and leveraged—through the Coastal Habitat Protection Plan (CHPP) and other mechanisms—in order to maximize the public benefits of protection and restoration of the estuary. Restoring salt marshes, oyster reefs, wetlands, and other coastal habitats not only protects the estuary and its citizens, it also creates jobs. A new restoration industry could grow local economies and complement the fishing and travel and tourism industries. The APNEP Policy Board can support ecosystem-based management and help spark a new restoration economy in the region.

Adaptation to climate change should not become a new government program or planning process. Climate change and sea-level rise will affect every aspect of life in the Albemarle-Pamlico region. Just as we plan for the change in seasons, we can and must plan for climate change and sea-level rise. Successful adaptation must be integrated and implemented through existing public and private decisions. Our existing coastal management, floodplain management, emergency management, water infrastructure, and transportation infrastructure planning processes are flexible and adaptable enough for local and state decision makers to apply the best available information to make the best decisions to protect public health and safety, the coastal economy, and the estuarine system that supports them. Integrating new ideas and implementing change is the hardest part of governing. The APNEP Board can point the way towards a resilient, dynamic, successful region.

Suggested Research

Our blueprint for building a climate ready estuary system in the Albemarle-Pamlico region includes guidelines for needed research in the biophysical and social sciences. This section compiles research needs we have identified in the course of this project.

Climate Change and Sea-level Rise

Climate change and sea-level rise have the potential to dramatically impact North Carolina's marine resources, disrupt coastal economies, cause significant damage to coastal development, transform human population distribution, and affect health. In addition to suggested policy initiatives, physical studies to provide guidance to minimize effects on the Albemarle-Pamlico region's population and its natural resources must begin with investigation into these and other areas.

A 2009 study on research priorities in Florida recommended research guidelines in three key areas: water quality, ocean and ecosystems, and tools and technology. To that list we would add environmental justice and health. The following recommendations are adapted from that study, as well as other sea-level rise adaptation plans.

Research Priorities

1. Modeling of sea-level rise based on Intergovernmental Panel on Climate Change (IPCC) scenarios and development of cost estimates for resulting effects in terms of natural resource impacts and adaptation of existing coastal development. Emphasis is on collaborative, statewide efforts with peer review. These can include steps that may be necessary to improve model accuracy, such as improved topography for coastal uplands.

2. Assessing the impact on fisheries productivity from changes in North Carolina's estuarine habitats due to climate change.

3. Monitoring, modeling, and mapping of natural system responses with an emphasis on predicting effects of climate change on estuarine communities.

Water Quality

Water quality is of critical importance to North Carolina—it affects biological processes, determines the limits of human use, and supports commercial applications. Our estuarine economy is driven by our environment, and so maintaining water quality to support wetlands, marshes, fishing, and tourism activities must be a high priority.

Research Priorities

1. Research and monitoring that examine effects of excess nutrients on living coastal resources and relate them to causes and sources and to human activities. The intent is to support cost-effective resource management programs to improve oceans and human health.

2. Statewide coastal observing that guides water quality management, marine resource management, and navigation and hazard response.

3. Harmful algal bloom (HAB) research to protect tourism and commercial and recreational fisheries, and inform watershed management for ocean health.

4. Modeling of hydrodynamics, water quality, and coastal/ocean ecosystems to support better understanding of the effects of uplands activities and coastal freshwater discharges on estuarine and marine biological communities.

Ocean and Coastal Ecosystems

North Carolina's estuarine and coastal ecosystems are shaped by geology, water movement, and the interactions of plants and animals on a variety of scales, from hundreds of kilometers to millimeters. Having a comprehensive understanding of these ecosystems through reliable baseline information is critical to supporting wise management decisions.

Research Priorities

1. Improve understanding of coastal and ocean hydrology, including the linkages between freshwater input and coastal waters. Emphasis should be on water budgets, hydrologic modeling, and factors affecting and controlling freshwater input to coastal and nearshore waters.

2. Research and modeling to understand and describe linkages between ocean and coastal habitats and the living marine resources they support. One area of emphasis is the effects of wetlands and marshlands on surrounding populations. Fisheries and their linkages to habitats are an important area of these studies.

3. North Carolina's scientific community should identify thresholds where key natural systems are at risk of disruption.

Tools and Technology

Fulfilling North Carolina's need to observe and predict environmental change and the ecosystem responses of its coastal waters provides abundant opportunities for the development and implementation of cost-effective tools and technologies to understand, monitor, and improve the health of the state's resources.

Research Priorities

1. Integrated coastal and ocean observing systems. A mix of in-water platforms and buoys, shipboard surveys, remote sensing, and computer models is required for continuous monitoring of climate change, water quality, and status of marine resources. The goal is to create a sustained interdisciplinary observing system that spans all of North Carolina's waters from the outer shelf to coastal estuaries and rivers. Emphasis is on extending, integrating, and filling gaps in existing coastal observations.

   The state should ensure that our existing tide stations are maintained for the future and that new, better-distributed water-level gauges are maintained or installed to develop long-term records. Several agencies have already installed short-term gauges that should be considered for funding support and conversion to long-term operations. This will help provide better geographic coverage of our coast.

   In other areas new water-level gauges should be installed to achieve comprehensive geographic coverage. In addition, the state should consider installing monitoring stations in the estuarine system and establishing a program for continuously monitoring and measuring land subsidence on the coastal plain.

2. Development of sensors to improve the ability to determine the status and trends of our coastal waters and their inhabitants. Emphasis is on sensor development for biological and chemical sensing, as well as tagging and tracking of wildlife.

3. Integrated data management and prediction. Coordinated collection, handling, quality control, sharing, and interpretation of research and monitoring data are critical to improving the state's resource management capabilities. Centralized coordination of model development to provide prediction and user-friendly web-based posting of information and model predictions is needed to accommodate science-based decisions by management agencies and the general public.

4. Development of innovative tools and integration of data to cost-effectively map and monitor the state's coasts and oceans.

5. Development of assessment tools, particularly for assessments of biological community status and trends, for rapid assessments of natural resources, and for evaluation of management efforts.

Socioeconomic and Ecological Impacts

The IPCC has a very high confidence that coastal communities and habitats will be increasingly stressed due to climate change impacts. To address the challenges that our citizens will face, it is essential that we gauge the costs and benefits of mitigation and adaptation from an individual to societal level.

Research Priorities

1. The social and economic value of all existing and permitted built resources within the area expected to be impacted by sea-level rise.

2. The cost of protecting these resources from inundation through raising the elevation of infrastructure or implementing ecologically sustainable shoreline protection strategies.

3. The economic and ecological value of all natural resources expected to be impacted by sea-level rise.

4. The full economic impacts of changes to the complex ecosystems and their role in regulating and providing essential services to the man-made economy.

5. The cost of acquiring any upland areas needed to allow wetlands to migrate as sea levels rise or otherwise mitigating the impacts of sea-level rise on wetlands and other important habitats.

6. The costs and benefits of removing or relocating the resources that are projected to be inundated.

7. The costs and benefits of building and maintaining bulkheads, seawalls, and other hard structures to protect buildings and communities.

8. The public health consequences of climate change and projects and/or policies related to sea-level rise.

9. The costs and benefits of requiring greater disclosure of the risks posed by climate change to investors on the part of all insurance companies operating in the state of North Carolina.

10. The uncertainty about crop yields and productivity stemming from increasing temperature, decreasing water availability, and higher levels of ozone, with a focus on identifying new plant varieties more apt to thrive in a changed and changing agricultural climate.

Partner Organizations

Albemarle-Pamlico National Estuary Program

The Albemarle-Pamlico National Estuary Program (APNEP) was among the first national estuary programs established by the Environmental Protection Agency in 1987. Unlike traditional regulatory approaches to environmental protection, APNEP is a cooperative effort jointly sponsored by the NC Department of Environment and Natural Resources and the EPA in cooperation with the Virginia Department on Conservation and Recreation.

APNEP is designed to encourage local communities to take responsibility for managing the resources in their respective jurisdictions. The program is made up of representatives from federal, state, and local government agencies responsible for managing the region's resources, as well as citizens, business leaders, educators, researchers, and other community members. These stakeholders have worked to identify problems in the region, develop specific actions to address those problems, and create a formal management plan to restore and protect the estuary. APNEP staff, the policy board, and three advisory committees work together to guide the implementation of this plan.

The Nicholas Institute for Environmental Policy Solutions

The Nicholas Institute for Environmental Policy Solutions at Duke University is a nonpartisan institute founded in 2005 to help decision makers in business, industry, government, and the nonprofit sector understand their options, anticipate their choices, and make the most of opportunities for leadership in creating a more economically and environmentally sustainable future.

The Institute is led by a small team of economists, scientists, and policy experts who leverage the broad expertise of their faculty colleagues—in arts and sciences, business, engineering, environment, divinity, law, and public policy—to help Duke deliver on its commitment "to put knowledge at the service of society" in the domain of energy, environment, and sustainability.

The Nicholas Institute:

- acts as an "honest broker" by convening and fostering open, ongoing, and often off-the-record dialogue among stakeholders from all sides of an issue;
- develops and delivers timely, relevant, and sophisticated data modeling and analysis; and
- provides decision makers with unbiased evaluations of policy risks and rewards, and helps them develop innovative, practical solutions to complex challenges.

The Climate Ready Estuary Team

Bill Holman

Bill Holman is Director of State Policy at Duke University's Nicholas Institute for Environmental Policy Solutions. He has extensive experience in legislative and administrative policymaking at the state level, including serving as Secretary of the Department of Environment and Natural Resources from 1999 to 2000 and as an Assistant Secretary from 1998 to 1999. He worked as Executive Director of the NC Clean Water Management Trust Fund—a $100 million-per-year clean water financing program—from 2001 to 2006. He joined the Nicholas Institute in January 2007. Holman was appointed to the NC State Water Infrastructure Commission (SWIC) by the NC Senate in 2006, and currently chairs that body.

His current projects at the Nicholas Institute include state water allocation policy, innovative strategies to improve the protection of drinking water supplies, including Falls Lake and other supplies in the Upper Neuse watershed, and assisting state and local governments in planning for and adapting to climate change and sea-level rise.

Holman lives in Raleigh with his wife, Stephanie Bass, and dog, Sylva. He graduated magna cum laude with a BS in biology from North Carolina State University in 1978.

Amy Pickle
Amy Pickle is the Senior Attorney for State Policy at Duke University's Nicholas Institute for Environmental Policy Solutions. She has extensive experience in environmental litigation and environmental policy development at the state and federal level. She served as an Assistant Attorney General from 2001 to 2003 working on implementing the North Carolina Attorney General's environmentally superior hog waste management initiative. From 2003 to 2008, she was a Senior Attorney at the Southern Environmental Law Center, where she served as the lead water attorney working on both litigation and legislative and administrative policy advocacy. She joined the Nicholas Institute in late 2008.

Her current projects at the Nicholas Institute include state water allocation policy, innovative strategies to improve protection of drinking water supplies, coastal adaptation to climate change, and ocean governance.

Pickle lives in Raleigh with her husband and son. She graduated with honors from University of North Carolina at Chapel Hill School of Law in 2000.

Katherine McGlade
Katherine McGlade, MEM, recently graduated from Duke University's Nicholas School of the Environment, where she focused on coastal environmental issues, including policy, fisheries, and conflict resolution. Prior to attending Duke, she had a successful 25-year career in commercial real estate development, holding senior management positions at Toys R Us, Staples, and Starwood Ceruzzi Shopping Center Development.

In 2009, she opened the doors of Seachange LLC. As the world becomes more populated and modern transportation makes our marketplaces global, the field of environmental management is faced with more stakeholders whose interests are considered in the open access resource of the ocean environment. At the same time, long-term sustainability is a priority and resource extraction continues. The balancing of the diverse needs of both the people and the environment are the focus of her company. She has worked on coastal issues for a range of clients, including the National Oceanic and Atmospheric Administration (NOAA), Duke Energy, University of North Carolina, the Nicholas Institute for Environmental Policy Solutions, and the North Carolina Coastal Federation.

McGlade lives in Beaufort, North Carolina. She has an undergraduate degree from Columbia University and a earned a master's degree in Coastal Environmental Management from Duke University in 2009.

Joanna Field
Joanna Field is a coastal environmental consultant with Seachange LLC. Her lifelong interest in ocean life recently evolved into a professional commitment when she received a master's degree in environmental management from Duke University's Nicholas School of the Environment. In May 2010 she completed a fellowship with the Marine Conservation Biology Institute in Washington, D.C., where she worked on programs related to adaptive marine spatial planning, budget and appropriations, and marine debris. Other recent projects include an acoustical modeling analysis for a citizen's environmental advocacy group, a public outreach report for the largest sustainable building project in Europe, and a report on the costs and benefits of erosion control methods in estuarine North Carolina. Field's prior career in corporate communications lends itself to engage citizens and legislators in preserving the health of our oceans and its creatures.

Field holds a bachelor of fine arts degree in film and television, with honors, from New York University. She lives in New York City with her African grey parrot, Buzz, and partner, Seth.

Supplements

Supplement A: Summary of Outreach Meetings and Interviews

Washington County
2000 Census Information
Population: 13,723
Median household income: $28,865
County seat: Plymouth
Percentage of population living below poverty line: 21.8%

The Washington county commissioners heard our first presentation in July 2009. Our initial presentation contained information on rates of sea-level rise (sea-level rise) and other scientific data related to climate change. The presentation was sidetracked by a discussion of climate change—possible causes, and whether it is actually happening. Because the larger message of the climate ready estuary program was dwarfed by these discussions, we chose to make changes to the content of the presentation that minimized discussion of the science of climate change, and instead emphasized the practical changes that can be proactively made to protect North Carolina's valuable estuaries. Those changes to the presentation remained for all of the following counties. For example, our first presentation included a slide that estimated sea-level rise in the next 50–100 years. After consulting several different sources, we discovered that a wide range of prediction about sea-level rise exists in the literature. Given degrees of uncertainty in predicted sea-level rise, we felt most comfortable citing the Intergovernmental Panel on Climate Change (IPCC) estimate of approximately 1/8 inch per year. This comparatively small annual change seemed to cause county managers to assume the resiliency of the estuary would be capable of absorbing this amount of sea-level rise over time, and although we stressed that most of the infrastructure decisions made today have long-term ramifications, county commissioners and town managers felt this figure seemed easily manageable and created no sense of urgency.

We also changed the presentation to focus more on the impacts of climate change and sea-level rise. Infrastructure emerged as the most practical and pressing concern faced by counties and municipalities when considering public expenditures, rising waters, and more intense storms and floods. Sewer and water lines, storm drains, and lift stations—all aging, some inundated, and others in need of replacement—were concerns we heard across all five counties. For the presentation process, Washington County was not only our test case for developing an effective presentation, but also the incubator for the next generation of presentation, and ultimately for the overall shape of the project.

Town of Plymouth
2000 Census Information
Population: 4,107
County seat of Washington County
Percentage of population living below poverty line: 37.5%
Roanoke River

Like our Washington County Commissioners' meeting, our meeting with the Mayor of the town of Plymouth and local managers taught us much about how to approach our meetings with the individual towns. Smaller meetings allowed us to get more active feedback on the issues facing both the towns and the counties.

The town of Plymouth already experiences high water levels. During a visit to the bank of the Roanoke River, Mayor Brian Roth pointed out tree stumps in the water that previously were on dry land. He also indicated that recent flooding from storms brought water within six inches of floor level of the local sewage treatment plant. Most of the pipes leading to the plant were put in place in 1915 and many are now below the water table all the time. Lift stations in town adjacent to the river frequently flood, causing untreated sewage to overflow into the river.

The wells in Plymouth tap the Castle-Hayne aquifer approximately 150 feet below ground. Of the six wells currently servicing Plymouth and Washington counties, two recently reported elevated salinity. As a result, two new wells had to be drilled elsewhere on the aquifer. Resource managers also complained that water drainage issues had become

more complicated by the legislation banning the clearing of drainage ditches. Drainage ditches clogged with debris increased flooding after intense or prolonged rain events.

Dare County
2000 Census Information
Population: 29,967
Median household income: $42,411
County seat: Manteo
Percentage of population living below poverty line: 8%

In August 2009 the Dare County Commissioners were concerned that a presentation on climate change and sea-level rise foretold additional regulations without additional funding to meet more stringent regulations. They were quick to inform us of their view that one-size-fits-all regulation is inappropriate in North Carolina.

The commissioners expressed concern over storm damage and natural hazards. The county has formed a control group for emergency management, with representation from the incorporated towns, from southern and northern Dare County. This group meets regularly and engages in drills and assessments to maximize emergency preparedness across the county. Dare County is no stranger to natural hazards and appears to be the most prepared of all of the counties visited.

Beach erosion is a constant worry for Dare County. The beach is the county's economic engine, and county commissioners feel an acute need to protect oceanfront property owners. County commissioners expressed concerns over local areas that may be more vulnerable to higher rates of beach erosion than others due to sea-level rise. They had additional concerns about natural wash-over points that could be affected by sea-level rise and would benefit from beach nourishment. They have started to consider erosion rates in land-use plans but have not acted upon it, citing the Coastal Area Management Act (CAMA) as the governing authority on land use as it pertains to sea-level rise.

In line with the aversion to additional regulations of any kind, the Dare County Commissioners indicated that the best possible scenario was to get the maximum level of federal and state support without the paperwork and regulations to go along with them. Talking about adapting to sea-level rise and climate change, they reason, is vastly different from funding and executing the adaptation projects. For instance, several commissioners pointed out that federal stimulus projects were required to be "shovel ready" to obtain funding. That mandate created such short deadlines for the stimulus money that if you did not have a project already in the planning stages, you had no time to plan and apply. If you didn't have the money, you were unlikely to have a project in the planning stages. Going forward, notice and time to prepare and apply for federal funding opportunities would offer these counties more opportunities to plan ahead.

The Dare County Commissioners questioned the urgency and importance of climate change and sea-level rise. Initially, there was debate regarding the validity of the climate change concept. One commissioner offered the opinion that even if sea-level rise was happening, why not wait until it does and deal with it then? Generally the commissioner felt that the proposal for a new Bonner Bridge, the ban on beach driving as a result of the lawsuit between the Parks Service and the Audubon Society, and the more stringent stormwater regulations were more salient topics for discussion than climate change and sea-level rise.

Town of Manteo
2000 Census Information
Population: 1,052
Median household income: $29,803
County seat of Dare County
Percentage of population living below poverty line: 19.4%

The resource managers in Manteo expressed concerns about infrastructure when talking about climate change and sea-level rise. Sewer treatment, inundated distribution systems, flooding, and shoreline armoring were at the top of their list.

Resource managers indicated there are no lift stations for sewer lines and that the piping system is well below the water table. As a result of storm activity and associated flooding, the manhole access points frequently overflow on to the street. The system is in need of lift stations and additional municipal sewage treatment capacity. Much of the town and county are served by individual septic tanks, which are subject to failure with rising water and beach erosion.

Resource managers pointed to the need for more infrastructure to address stormwater and flooding. Flooding as a result of heavy rainfall happens frequently, a result of the failure of the existing storm drain system to handle larger volumes of water. Water often stands on the streets for days creating hazards to motorists and limiting access for biking and pedestrians. In addition, runoff of stormwater into the adjacent sound threatens aquatic life.

Manteo has more specific issues in their historic preservation district, an area that regularly floods but that also has regulations against raising structures above a certain height.

Manteo has a great deal of coastal armoring already in place, including extensive work in the Pirate's Cove area. The entire town is eligible for bulkheads since none of the township is oceanfront. Town managers are interested in the ecosystem services that can be provided by a wetland, or a sill when used instead of a bulkhead, but were not inclined to engage in discussion of limitations of the use of bulkheads as an erosion control device, once again feeling that the state is responsible for that decision.

Dare County supplies the water for the town of Manteo from the Syko and Wanchese reverse osmosis (RO) treatment plants. The source is deep wells in the Castle-Hayne aquifer. The county serves all of Roanoke Island through its contract with Quibell for $18 million.

When asked if sea-level rise maps would help to garner public attention and interest in becoming prepared for climate change, the township feels that maps showing sea-level rise will do little to galvanize the public to action because all the public really cares about is whether or not their backyard floods.

Tyrrell County
2000 Census Information
Population: 4,149
Median household income: $25,684
County seat: Columbia
Percentage of population living below poverty line: 23.3%

Tyrrell County is characterized by open farmland checkered with drainage ditches. Farming in eastern North Carolina was made possible by the introduction of heavy machinery to dig large drainage ditches to drain the water from the land to the estuaries, rivers, and sounds. Resource and regulatory agencies have tightened controls on the ability of citizens and local governments to clean out these ditches. As a result, the ditches clog with natural debris, which slows the progress of water off the land. During storm events, clogged drainage ditches create more flooding faster than free-flowing ditches. On the other hand, slower-draining water has positive environmental results, allowing more of the water to be reabsorbed into the land and benefiting from the natural filtration process. Tyrrell County officials were vocal in their request for less onerous regulation of drainage ditch clearance.

Tyrrell County has a relatively small percentage of coastline that is developed, and thus, little shoreline armoring. The commissioners made the suggestion that a credit system be developed to compensate counties that limit or prohibit bulkheading and thus preserve the ecosystem services provided by nearshore marshes and wetlands. Without this type of incentive, they argued, why should they do anything different than any of the other counties, including allowing bulkheads without resistance? This question offers a great opportunity to go back to Tyrrell County and speak to them on the topic of Payment for Ecosystem Services, an approach that has been used elsewhere to encourage communities to protect important ecosystems.

The Castle-Hayne aquifer supplies 93% of Tyrrell County's public water system. The system was put into place because of high iron levels in the well water. The public water supply is currently filtered through two reverse osmosis (RO) treatment plants. A new plant is ready for construction to replace one of the existing plants that has reached

the end of its useful life. The oldest plant currently operates under a special consent order (SCO) for not meeting EPA standards. The SCO will remain in place until the new plant is completed. The new RO plant was funded by the USDA and will discharge into the Albemarle Sound. Resource managers indicated that saltwater intrusion had been a problem into their deeper wells.

For emergency response both the water treatment plants and the wells have backup generator power. The town of Columbia's capacity for water after a catastrophic event totals three day's supply.

Town of Columbia
2000 Census Information
Population: 819
Median household income: $20,588
County seat of Tyrrell County
Percentage of population living below poverty line: 33.7%

Located on the Scuppernong River, near Albemarle Sound, the town of Columbia lies entirely within a 100-year floodplain. Water, sewage, and garbage disposal are available throughout the town limits; water is available throughout county limits.

The existing wastewater treatment plant is at capacity in the summertime due to the increased demand from two of the larger businesses in town, a crab processing facility and a beach linen washing service. Rhett White, the town manager for Columbia, indicated the town recently received a NPDES permit to increase wastewater discharge into the Scuppernong River by one-third of current totals. The increased wastewater capacity is to accommodate increased demand and projected new growth. The project will cost in excess of $6 million, but the town has not yet raised all the money needed.

The town and county water is pumped from wells tapped into the Yorktown aquifer and purified in a relatively new reverse osmosis water treatment plant. The town has recently completed a 2020 planning document, and climate change and sea-level rise were not actively considered in town deliberations over public infrastructure or land-use planning. However, there are possible effects of climate change that were considered, such as storm surge flooding and drought. Though not discussed as climate change or sea-level rise, these are part of the everyday thinking of town managers and county commissioners. The town feels it will need more water capacity in response to rising salt levels observed in their wells.

Beaufort County
2000 Census Information
Population: 44,958
Median household income: $31,066
County seat: Washington
Percentage of population living below poverty line: 19.5%

At the Beaufort County Commissioners meeting, commissioners expressed an interest in the presentation and a willingness to speak on a number of topics. Much of the discussion focused on infrastructure and regulations, but climate change and sea-level rise were discussed. Many commissioners expressed disbelief in climate change and skepticism about sea-level rise. A no-action scenario was brought up as a possibility; some speculated that the most prudent course of action might be to wait until the seawater rises to the point the area becomes uninhabitable and then move. One commissioner quoted a figure of sea-level rise in Beaufort County of 1.1 feet since 1929. Discussing the value of estuaries and wetlands, another commissioner offered the opinion that when sea level rises, wetlands can migrate, so there is no need to worry about losing them.

Beaufort County is home to North Carolina's largest phosphate mine, which is one of the largest employers in the region. There is a great deal of sensitivity to the idea that any kind of environmental regulations would affect the mine's ability to operate.

Public water is supplied by Beaufort County to 95% of its residents. The county works with the city of Washington for water treatment and distribution. Wells here are not reporting higher salinity as contrasted with the report from the town of Plymouth.

Most of the county's inhabitants rely on septic systems and the county commissioners prefer it that way. They don't want the additional responsibility of installing and maintaining a central sewer system. In the past, proximity of wells to septic systems became an issue, giving rise to the present public water system. Since the water system has taken care of the problem, there is no interest in designing a central sewer system for distribution across a wider area.

Beaufort County recently drafted and adopted a new land-use plan, which does not consider sea-level rise. However, the commissioners acknowledged that there is a need for better and more current storm surge modeling. The new land-use plan identifies 117,000 acres as special flood hazard. Current storm surge projections predict as much as 45% of the land in the county could be inundated in a single event.

In more sparsely populated counties such as Beaufort, there is not as high a degree of coastal armoring as in the more developed counties and more wetlands have been left in a natural state. These counties have considerably less wealth in their tax base and so do not have much of an issue with excess bulkhead density.

City of Washington
2008 Census Information
Population: 12,946
Median household income: $22,057
County seat of Beaufort County
Percentage of population living below poverty line: 28.7%
Pamlico River

City managers and resource managers in Washington were very interested in talking about issues associated with infrastructure. Hurricanes and other intense storm events have caused considerable flooding in Washington over the years and an aging infrastructure has been inundated time and time again.

The city runs eight wells, approximately 150–200 feet deep, into the Castle-Hayne aquifer. The city and county water systems are interconnected. City water operations make water available to 90%–95% of county residents due to the unsuitability of the soil to house both water and septic systems. Most property owners did not possess enough property to ensure adequate separation of septic and well facilities to provide safe drinking water. Water capacity within the city has recently become an issue. Officials indicated that recent drought had caused a drop in the aquifer level. At present, the system is running at 55%–60% of full capacity, allowing room for population growth. However, officials indicated they would be interested in purchasing more well sites to plan for future demand.

The city runs its own wastewater treatment plant and currently continues to treat sewage with chlorine, a common wastewater treatment methodology, but one that has the potential to adversely affect the environment. Washington's wastewater treatment plant is located quite close to the Pamlico River and much of the treated effluent is discharged into the river. Washington resource managers indicated they would like to be allowed additional discharge permits that can be pursued through the Tar Pamlico Basin Association, a group that was formed by the North Carolina Division of Water Quality to cap the total emission into the Pamlico River estuary. Officials further indicated that recent growth in the town of Chocowinity would require increased capacity.

In discussing the issue of emergency response, flooding from storm activity was clearly the biggest issue. The need for increased stormwater infrastructure was clearly expressed and a comment was made that the stormwater had nowhere to go. The county emergency management director coordinates with the city staff. Route 17 from Chocowinity to Washington easily floods and sits on very low-lying ground. Suggestions from resource managers included:

- widen Jacks Creek to allow it to absorb more stormwater runoff
- eliminate the terminology of "100-year" and "150-year" floodplains because it gives people a false sense of security

- address ditch drainage issues from damming by beavers where regulations preclude removing the dams

The number one request: more stormwater management infrastructure. And number two: provide communities with better sea-level rise and storm surge projection maps.

Hyde County
2000 Census Information
Population: 5,826
Median household income: $28,444
County seat: Swan Quarter
Percentage of population living below poverty line: 15.4%
Home of Mattamuskeet National Wildlife Refuge

We experienced technical difficulties during the presentation, and had to show the slides on a small screen. It appeared that most of the commissioners were not actively engaged in listening to the presentation, and without the assistance of the visual aids, it was difficult to keep their attention. At the end of the presentation, there weren't any questions or comments. However, we did receive a follow-up e-mail asking for us to come back and present separately to a smaller group of commissioners giving us the indication that the message did not fall on completely deaf ears. In this case, the commissioners' meeting was perhaps not the ideal venue to introduce these concepts.

Supplement B: Analysis of Five North Carolina Public Opinion Surveys and Reports and One Relevant Summary from Biloxi, Mississippi, Roundtable

Local Government–Focused
- Nicholas Institute for Environmental Policy Solutions – Targeted Interviews with Key Local Government Personnel in Five Regions of North Carolina Vulnerable to Sea-level Rise
- Nicholas School of the Environment (NSOE) ENV 280 – Climate Change: Perceptions, Knowledge, and Needs of Local Decision makers in Coastal North Carolina
- Mississippi-Alabama Sea Grant Consortium–Biloxi – Sea Level Change and Climate Planning Needs Stakeholder Workshop

General Public–Focused
- Albemarle-Pamlico Conservation and Communities Collaborative (AP3C) and APNEP – Public Listening Sessions: sea-level rise and Population Growth in North Carolina
- UNC-CH (Albemarle Ecological Field Site Capstone Report) – Perceptions of Sea-level Rise Among Adult Residents of North Carolina's Outer Banks Region
- NC DENR-DCM – Sea-level Rise Scoping Survey Final Report: Public's Perception of the Reality and Magnitude of Sea-level Rise, and Their Perceived Vulnerability to Its Effects

Local Government–Focused

Most findings and recommendations of targeted interviews were echoed by roundtable comments and NSOE survey data. No contradictions were evident, although of course there wasn't complete overlap.

Targeted interview recommendations in black *italics*; NSOE survey in blue; MS-AL roundtable in red.

- *Materials prepared for local governance should offer clear, science-based support for ideas and positions, and best management practices from regions with similar geographies and social identities.*
- Create a master document that compiles information on potential climate change impacts for coastal North Carolina communities; estimates time frames for impacts and step-by-step actions to prepare for them; and identifies reliable sources of scientific information, technical support, financial support, etc., from state or federal government or nongovernmental sources.
- Offer a series of workshops for local decision makers that serve as a forum for sharing concerns, interests, information, and knowledge.
- Need sound science on local and state level sea-level rise and communication strategy. There are still educated people in the industry who are skeptical.
- Data does not come to us in an authoritative way. It would carry more weight if it came from a trusted agency or type of authority.

- *Agencies presenting information about these topics need to be sensitive to the issues competing for managers' time and budget and find synergies between suggested solutions to sea-level rise impacts and a county's outstanding needs.*
- Need to know risk of sea-level rise, and these needs to be weighed against the impact on other things. Regret if put emphasis on sea-level rise and not look at tradeoffs. How much pavement is needed to expand bridges? What will be impact of more pavement?

- *State and federal agencies developing maps, models, and other technical information need to develop a means to deliver the information to local officials and the public that is specific to the end user and is sensitive to local political dynamics.*
- Lots of data online – what's missing is a framework to put data together in a focused way
- Need flood projection models; sea-level rise modeling in 5-year increments to 50 years
  - Include uncertainty; need better way to explain uncertainty
  - Scales should be from county to community levels
  - Web- and nonweb-based formats; customizable, like SLOSH (Sea, Lake and Overland Surges from Hurricanes)

- *Local officials are receptive to approaches that help them protect their communities, as opposed to requirements from Raleigh or Washington.*
- Empower people to make their own decisions. Empower them to make choices based on the information.

- *Some municipalities would be pen-to-pilot adaptation projects to make their infrastructure and communities more resilient to climate change.*
- *Concern for infrastructure readiness.*
- *Systematic collection and analysis of local groundwater and drinking water data is needed to establish trends. This data could be shared with EPA's Climate Ready Utilities working group.*
- *State policy will be needed to ensure that septic tanks adequately treat wastewater and protect public health and the environment in the future.*
- Many water customers have septic tanks on edge of creeks and bays.
- How will surge impact treatment plants? Do they need to be moved?

- *All of the counties were concerned about economic development. All understand the costs of stricter regulation, more shoreline erosion, and forgone development.*
- Invest in a blueway and there is two-foot sea-level rise, then was it a good investment?
- Impacts of subsidence and sea-level rise on shoreline retreat – from a built environment standpoint, what are we willing to do, where are we willing to go?
- Will have to start buying back areas near the roadways like mitigation banks.

- *Agricultural drainage districts need to cooperate on modeling and water management.*
- Discharge limits are based on existing hydrology, but this may change if sea-level rise and water movement slow; the region also has a lot of shallow water aquifers and many people are using private wells and septic systems. What is the effect of salinity on sands and deeper aquifers? If septic system is near a creek that rises, what happens?

- *Local officials want to explore policies that protect estuarine shorelines and valuable waterfront property.*
- Developers will show a plan and then sell off the lots and then the people he sold it to have filled it in and the topography and flood vulnerability has changed.

- *North Carolina needs to coordinate its clean water, coastal management, flood hazard, insurance, and other programs in order to reduce risk and damage to public health, private property, public infrastructure, and the environment.*
- Of the 13 (federal) involved agencies, is there a lead agency?

Other useful information from NSOE survey:

- 40% of respondents have been in their current position for three years or less. It would be interesting to know if this means they are in their twenties, in which case they may be more receptive to ideas about climate change.

Other useful recommendations from NSOE survey:

- Determine where local officials obtain information for decision making and educate officials indirectly by educating their information sources.
- Develop a strategy to get everyone (general public) involved. Provide incentives that may not be related to climate change but that may appeal to people who are not concerned about climate change.

Other useful comments from MS-AL roundtable:

- Outreach – bring a message that shows the community opportunities for development.
- 50% of my job is outreach and education. I use the KISS principle. What is it and how does it affect me—whatever level it may be—homeowner, city council member, whoever.

General Public–Focused
These results should be used with caution for the following reasons:

- Listening sessions were attended by an average of 15 people each. Extraordinarily small turnout for such an outreach effort
- UNC-CH survey respondents were nearly 100% from Dare County
- DENR Scoping Survey was decidedly unscientific

However, some trends emerged, as well as some contradictions.

Trends
- Majority of people think sea-level rise is occurring; causes and amount not always correct and not consistent across surveys.
- About 50% of coastal property owners believe they will be affected.
- Note: Listening Session found that people thought only those living on sound would be affected but after session considered broader social and economic impacts.
- Sea-level rise will affect future generations, ecosystems and wildlife, property values, tourism, and agriculture (UNC).
- Government should consider sea-level rise when making decisions – 60% (UNC).
- A similar number of people thought sea-level rise will affect local politics – 59% (UNC).
- Government should start planning now to address sea-level rise – 66% (DENR).
- NCRC should play lead role in state's action – 58% (DENR).
- Scientists got second-highest number of votes.
- In the supporting role category, private landowners were #1, followed by the general public.
- Most frequently selected action: produce maps of areas at most risk – 65% (DENR).
- Other actions: public education (61%); nine listening sessions specified "upstream" residents; projected sea-level rise for planning (58%); land-use plans that consider sea-level rise (58%).
- Most frequently selected state action: coastal hazard disclosure statements for real estate transactions (96%); projected sea-level rise for planning (58%); prohibiting public money for new development in at-risk areas (56%); updating flood maps (56%).
- Also: retreat, setbacks, elevation, zoning restriction (listening sessions).
- Only listening session brought up environmental justice, relocation, and job losses.
- Other good listening session comments: reframe the issue of sea-level rise and separate it from climate change.

Contradictions
Peer Education. In the listening sessions, one conclusion is that knowledgeable people can really influence their peers, and the UNC survey concludes that because there was a correlation between level of education and understanding of SDR and its threats, education efforts should target citizens who have only their GED. However, in the scoping survey free comments, there are many comments by environmental/geology/biology/state professionals about sea-level rise, and they each cite facts authoritatively . . . except they're different.

I think it is dangerous to assign teaching about sea-level rise to "educated" citizens, and imperative that a standard "party line" be agreed on for all communications related to the APNEP CRE program. Defining terms and assumptions is critical.

Responsibility. Government: "It comes back to strong local government, with good incentives from Raleigh leading to good decisions" (listening sessions).

However, same people had a lack of confidence in ability of local and state government to deal with the issue of sea-level rise.

Targeted Interviews with Key Local Government Personnel in Five Regions of North Carolina Vulnerable to Sea-level Rise

Nicholas Institute For Environmental Policy Solutions
Summer 2009

Methods

- Three professionals from the Nicholas Institute met with elected officials, citizens, and town resource managers in the five counties judged most vulnerable to sea-level rise within the APNEP region: Beaufort, Dare, Hyde, Tyrrell, and Washington counties.
- Two forums:
  - county commissioners' meetings – 20 min PowerPoint presentation and Q&A; 20–100 people at each.
  - Meetings in town managers' offices; 1–4 people at each.
- Bill Holman set up each meeting.

Findings and Recommendations

For findings and recommendations see main body of this report.

Climate Change: Perceptions, Knowledge, and Needs of Local Decision Makers in Coastal North Carolina

Nicholas School of the Environment (NSOE), ENV 280
Randy Kramer, Professor
Spring 2009

Methods

- The survey was e-mailed to 160 local decision makers in coastal cities and counties in North Carolina.
- Participants were chosen for the survey from coastal counties and cities in North Carolina using a nonrandom, nonprobability sampling method, though attempts were made to gain representation from all coastal counties in North Carolina.
- 59 surveys completed by respondents in 15 counties and 9 cities.
- 18 came from Dare county; 3 from Beaufort county; 1 from Washington county; 0 from Hyde; and 0 from Tyrrell. Of the 22 relevant responses, 81% are from Dare, 13% from Beaufort, and 6% from Washington; of the entire survey, 37% of respondents came from our five counties.

Respondent Demographics

- Working in local government: mean: 11.8 years.
- Working in current position: 0–3 years: 40%; 4–7 years: 30%; mean: 11.8 years.
- Expertise: business: 27%; public policy: 26%; land-use planning: 19%.

Findings

- 73% of surveyed local officials believe climate change is (or probably is) occurring.
- Only 38% claim to know what the potential impacts of climate change are in their communities (+20% undecided). But 60% agree or strongly agree that "climate change will affect my constituents."
- The highest percentage of respondents identified sea-level rise (70%), shore erosion (50%), and increase in storm surge (48%) as expected effects in their communities due to climate change. 38% indentified saltwater intrusion as an expected effect.
- Preparing for climate change: *undertaken*: updating floodplain maps (95%); updating stormwater controls: (44%)/ *not yet undertaken*: educating community members 44%; considering climate change when developing local land-use plans.
- Limiting factors of local government's ability to prepare community: lack of funding (48%); lack of scientific info (44%).
- The highest percentage of respondents also expressed that climate change will affect their communities' tourism (74%), future generations (72%), and economy (72%).

- 73% felt it was very, somewhat, or possibly important to constituents to prepare community for impacts of climate change.
- 63% of respondents mentioned that their local government does not consider climate change when making decisions (17% undecided); even though the majority (approximately 60%) believes that there is something their local government can do to prepare their community for climate change impacts (18% undecided).

Table 3. Percentage of respondents who selected particular time frames for local government action to address potential effects of climate change.

	Already in progress	1–5 years	6–10 years	10+ years	Never	Not sure	Does not apply
Drought	18%	20%	5%	5%	5%	27%	18%
Shore Erosion	37%	17%	5%	3%	3%	14%	20%
Flooding	41%	19%	9%	2%	0%	17%	12%
Forest Fires	9%	22%	5%	4%	2%	35%	24%
Storms	38%	29%	2%	0%	4%	16%	13%
Saltwater intrusion into aquifers	18%	21%	5%	5%	4%	32%	16%
Sea-level rise	14%	24%	7%	5%	3%	32%	15%

- 47% disagree or strongly disagree that preparation should be left to higher levels of government (19% undecided).
- One-third of surveyed local officials perceive that they do not have enough political support from their constituents to prepare their community for climate change; however, almost half of the respondents indicated that preparing the community for the potential impacts of climate change is at least somewhat important to their constituents.

Recommendations

- Although many decision makers think they do not know the impacts of climate change, many of them do have at least some knowledge of the most important impacts of climate change in their community. *This suggests that educational efforts could be focused on affirming and building upon a base of existing knowledge.*
- In terms of capacity and resources, our study found that the factors that greatly affect local officials in preparing for climate change are a lack of funding and a lack of scientific information. *In turn, outreach programs could focus on guiding local decision makers to financial resources and reliable data sources.*
  - One component of the Nicholas Institute's outreach program could focus on pointing local decision makers to reliable data sources, whether generated within different levels of government or in the nongovernmental sector (which would include academic institutions) as well as financial resources available other than those allotted for disaster relief.
- Respondents also identified activities that have not yet been undertaken but could be helpful in preparing their communities for the effects of climate change (e.g., educating community members, considering climate change when developing land-use plans, and updating water supply models). *These could be suitable activities to help local governments begin to address climate change.*
- The study found that local decision makers are unsure of the appropriate time frames within which to address the potential climate change impacts. *Consequently, an important component of an education program could be to inform local governments of when various impacts are expected to occur, and when local government should initiate action to prepare for these impacts.*
- The majority of local officials (approximately 60%) concur that climate change will affect their constituents, and the same percentage believes that as local government there is something they can do to prepare their community for potential climate change impacts. In addition, only 27% said higher levels of government should prepare the community for potential impacts of climate change. However, 63% of respondents mentioned that they do not consider climate change when making decisions as local government. *Considered together, these findings are important because although local decision makers currently do not consider climate change, they perceive that they have*

the ability and right to act, which is why approaches for adaptation and mitigation of climate change should not be top-down, but rather nested among different levels of government, including the local level.

- One-third perceive that they do not have enough political support from their constituents to prepare their community for climate change; however, almost half of the respondents indicated that preparing the community for the potential impacts of climate change is at least somewhat important to their constituents. It is also worth mentioning that a quarter of the respondents do not know what the viewpoint of their constituents is regarding local government's preparation towards climate change effects.
  - *There may be a disconnect between the preferences of constituents and local government's perception of those preferences.*

Next Steps

- Create a **master document** that compiles information on potential climate change impacts for coastal North Carolina communities; estimates time frames for impacts and step-by-step actions to prepare for them; and identifies reliable sources of scientific information, technical support, financial support, etc., from state or federal government or nongovernmental sources. This document could be created with input and help from local officials. There are some resources already available that could be adapted for application in coastal North Carolina communities.
- Determine where local officials obtain information for decision making and **educate officials indirectly** by educating their information sources.
- Create a **model plan or guidance document** for preparing for coastal climate change impacts at the local level. This plan could be based on a plan that has already been developed in another state or region.
- Conduct and disseminate results from a **case study** of a state or county that has developed and implemented a plan for preparing their coastal community for climate change. It would be important to use the participatory approach when disseminating results among local officials in coastal North Carolina. The Nicholas Institute may invite at least one of the people who were involved in developing the plan to talk about the steps they undertook and lessons learned.
- **Develop a strategy to get everyone involved.** Provide incentives that may not be related to climate change but that may appeal to people who are not concerned about climate change. One idea is to frame all this work around issues that are already salient such as development and land-use issues, the economy, and tourism.
  - **Identify and recruit extant organizations/cooperatives** to help promote a participatory approach.
- Offer a **series of workshops for local decision makers** that serve as a forum for sharing concerns, interests, information, and knowledge. Before conducting workshops, expert working groups could be convened to define the appropriate activities to conduct and material to share at the workshops and to identify the appropriate people to invite from coastal communities.
  - Workshops could involve presentations on climate change impacts that are already occurring on counties (perhaps presented by local representatives themselves); presenting the information from a case study (mentioned previously); bringing experts to talk about scientific information on climate change and its expected impacts on the Atlantic coast; discussing potential solutions and time frames for climate change impacts; or working as a group to develop a model plan or guidance document for local officials to consult when preparing their communities for potential climate change impacts.

Good Comments from Free Response to Question 17 – Any Comments about Survey

- 26 comments – 13 of them questioned assumption of climate change, nonscientific data, etc.
  - Until there is conclusive data that is agreed upon, I am not taking any steps to "prepare" for a "potential" effect. My fear for my community as a county commissioner is the environmental community's use of nonscientific data to create regulations that are harmful to my community.
  - My research indicates that model predictions are taking the place of actual measurements.
  - At the local level I think that there is a lot of skepticism about the effects of climate change and when they can (or will) be anticipated. Most of the activities that are going on within our community are not the result of climate change directly but are due to other issues that climate change would exasperate [*sic*].
- Any information, procedures, and communications on this issue should be done on a regional or state level so that efforts are coordinated and economies of scale can take place.
- Will you offer any support to local government agencies to brainstorm how to address these issues?

- I look forward to your efforts to influence decision makers at the state level with regard to accurate predictions about storm surge changes as a result of climate change.
- I think we can boost the "enthusiasm" for addressing the concerns of damage to the coast by beefing up our preparedness for disasters, relief operations, contingency planning for displaced evacuees, and more. Perhaps the state could initiate a program to integrate coastal planning with climate change in mind, a program that could include regional seminars, as well as websites with community assistance links.
- More funding should be available for remedial projects at the local level.
- Bertie is an inland county, surrounded by rivers, hard hit by Floyd and Isabel. We have experienced high incidence of tornados in recent years.

Useful Free Comments
Activities "that would help prepare community for potential impacts of climate change":

- improve flood damage prevention ordinance, update hazard mitigation plan
- floodplain mapping and storm surge modeling on recurrent basis
- disaster planning

Public Listening Sessions: Sea-Level Rise and Population Growth in North Carolina

Albemarle-Pamlico Conservation and Communities Collaborative (AP3C) and APNEP
2009

Sponsors
AP3C, APNEP, Audubon, The Conservation Fund's Resourceful Communities Program, Environmental Defense Fund (EDF), The Nature Conservancy, The Natural Resources Leadership Institute

Organizers
Lucy Roberts Henry, MEM (DENR)
Cynthia Brown, MPA (Conservation Fund)
Sharon Campbell, Synergy Training)
Marilynn Marsh Robinson, EDF

Goal
The goal of these sessions was to provide residents of the Albemarle-Pamlico watershed with an opportunity to voice their concerns about the combined impacts of sea-level rise and population growth and elicit their ideas about solutions.

Notable Facts
- The Albemarle and Pamlico sounds are part of the largest lagoon, or enclosed shallow body of water, in the world and the healthiest and second-largest estuary in the eastern United States.
- Persistent poverty and high unemployment rates and lower wages.

Outreach and Publicity Strategy
We used a multi-pronged approach for recruiting people to attend the listening sessions.

At each of the seven sites, an outreach person:

- mailed flyers to potential participants, then made follow-up telephone calls to them;
- disseminated outreach flyers to local churches;
- requested coverage by local media;
- invited local elected leadership, schoolteachers, and chamber representatives; and
- coordinated meals and scheduled a venue for the meeting.

Although the outreach person was a volunteer, we did provide funding for postage and food. The person responsible for outreach targeted councils of government, the NC Rural Center, the NC Community Development Initiative and

the NC Association of Community Development Corporations to encourage Community Development Corporations and their constituents to attend the focus groups.

AP3C partners and APNEP staff e-mailed announcements about the listening sessions to their networks and contacts. Before the listening sessions, several AP3C partners were interviewed for radio interviews and newspaper articles. Between 10 and 30 participants attended each session. The average number of participants was about 15. The participants represented diverse backgrounds. At most sessions, a handful of attendees were present from out of town, mostly from academic institutions or natural resource management organizations. There were usually at least one or two local residents with extensive knowledge of sea-level rise. The target group, those with limited or no knowledge of sea-level rise, usually represented a few additional people (unfortunately this group was underrepresented; causes and possible remedies will be discussed later). Participants also represented a diversity of ages, genders, and racial backgrounds. Most sessions had at least one senior citizen and one African-American representative, fairly equal gender balance, and a wide range of ages, with a predominance of white professionals.

Results

At each session, at least two participants were well informed on sea-level rise and able to educate their peers on subjects such as saltwater intrusion and stormwater runoff. This phenomenon of "cross-pollinating" among participants was a successful means of educating people about the issues. Instead of hearing the facts from an "outsider," they heard them from a community member and the topic gained legitimacy. If their neighbors witnessed this happening, they seemed more likely to believe it.

Question 1: What changes are you seeing and experiencing in your communities and in your environment?

- water quality issues
- increased salinity
- saltwater inundation into inland waters
- erosion
- perceived land-use and landscape changes
- wildlife – more development is occurring on the waterfront, bringing new economic challenges in terms of demand for sewage and other infrastructure
- cultural – shift in demographics

Question 2: What do you think the impacts of these changes will be on your community, as they relate to sea-level rise and population growth?

- ***Equity impacts*** – Protection and relocation (Katrina), federal distribution of funds.
- ***Environmental impacts*** – Water quality, erosion, saltwater inundation, general loss of freshwater, pollution from run-off; wetlands were expected to get squeezed between development and rising seas, new environmental health impacts.
- ***Economic impacts*** – Property loss; private property rights; loss of, or damage to, other coastal infrastructure. Damage to sewer systems, drinking water infrastructure, transportation, and military bases were dominant concerns. Property loss, changing demographics, and increased costs of sustaining infrastructure were also expressed as concerns. Increased job losses in fisheries, loss of agricultural land and the farming industry, loss of manufacturing plants on the water, and loss of tourism.
- ***Governance impacts*** – Pervasive lack of confidence in the ability of local and state government to deal with the issue of sea-level rise; at the same time, they thought it was the responsibility of government to manage a relocation and adaptation process. "It comes back to strong local government, with good incentives from Raleigh leading to good decisions."
- ***Culture and community impacts*** – Demographic changes; loss of traditional natural resource-based industries like agriculture and fishing; displaced people.

Question 3: What do you think are some of the solutions to these issues?

- ***Infrastructure solutions*** – Green infrastructure, or the use of vegetation to mediate impacts such as water quality degradation; opportunity in keeping shorelines natural; hardened shorelines.

- ***Planning and zoning solutions*** – Future projections into floodplain maps, zoning restrictions, setbacks, shift to using elevation as a zoning approach, stop development in areas that will be impacted, state disclaimer on deeds, limiting the construction of new septic tanks (restricts growth), retreat, adaptation.
- ***Policy solutions*** – Education (public, elected officials, schoolchildren, business, churches, and conservation and environmental groups); education of the development, banking, and insurance sectors; upstream (Raleigh residents); approach should address the feeling of hopelessness that people feel when thinking about this issue: reframe the issue as a people issue "to allow for innovation and creativity," to get people to understand how the issue affects them in a direct way, to engage with diverse groups and focus on community-based solutions, and to change individual actions through awareness building. Reframe the issue of sea-level rise. Most liked the separation of sea-level rise from climate change. Many felt that the issue should be looked at through a social justice lens.
- ***Mitigation solutions*** – Actions need to be taken at a global scale to reduce greenhouse gasses, change energy policies and practices, and increase alternative energy sources such as wind and solar.

Communications Lessons from Document

Those with substantial knowledge felt compelled, most likely from the deficit in information they perceived, to share what they understood about the issue. This proved to be extremely effective in some locations for providing just enough added information, articulated in a nontechnical and nonlectured way. In fact, there were two locations where informed participants managed to convince "skeptics" who were attending with the purpose of refuting the information (only to find that they were not attending a lecture and the facilitators were there to listen) of the reality of sea-level rise. The facilitation team observed how this unexpected outcome was a very powerful learning moment.

At the final session in Manteo, Sam Pearsall, a scientist from The Nature Conservancy, gave a 20-minute presentation about sea-level rise. Participants were enthusiastic about the presentation and were grateful for the information. The facilitation team concluded that it would have been helpful to meet somewhere in the middle and include a more detailed description of the sea-level rise issue. That would have satisfied the informed contingent, while not overwhelming those who were new to the issue, and would have still allowed for the shared learning that went on among participants.

After the sessions, several people said they thought this issue only impacted people with homes on the water, but in thinking about the broader social and economic issues they realized that it would affect them in a direct way. This indicates a need for education and outreach to communities that are not yet engaged.

Perceptions of Sea-level Rise Among Adult Residents of North Carolina's Outer Banks Region

Albemarle Ecological Field Site Capstone Report
December 2008
University of North Carolina at Chapel Hill
Institute for the Environment, Robert Perry, Site Director

Stats

- 232 responses; 2 from Currituck; 230 from Dare
- Newspaper clip-out; went walking through towns asking people to take survey; October 2008
- 27% in 18–30 age group; 22% 41–50; 23% 51–60
- 28% worked in sales; 13% managerial; 9% arts; 7% fishing
- "Reliability of survey weak" because of survey procedure

Findings

- 69% thought sea-level rise is occurring; 20% not sure
- All towns had more than 60% of respondents agreeing that governments should consider sea-level rise when making decisions
  - 84% of all respondents agreed that government should consider sea-level rise when making decisions
  - slightly higher percentage of people without children than those with children thought government should consider sea-level rise when making decisions
- Causes of sea-level rise: 82% natural climate change; 70% anthropogenic climate change; 46% to other natural processes (e.g., storm surges); 20% to God

- 53% felt more research is needed to determine if sea-level rise is happening
- 72% concerned about dangers it poses
- 83% will take it into consideration when making decisions in future
- Sea-level rise will affect: (top 7 of 13 choices) future generations (91%); ecosystems and wildlife (84%); property values (78%); tourism (77%); me (65%); local politics/agriculture (both 59%)

Conclusions
- May be some misconceptions as to what is causing sea-level rise
- Correlations exist between perceptions and level of education, age, children, towns of residence, rent/own, waterfront

Education
Residents with higher levels of formal education typically had a better understanding of sea-level rise and its threats. The data suggest that educational efforts should focus on residents whose highest level of completed education is high school or GED.

Comments suggest that available data and statistics have not been presented effectively, or perhaps not presented at all, to many Outer Banks residents.

Considering that those with high school or a GED as their highest level of education showed a more profound lack of understanding concerning sea-level rise, a concerted effort should be made to give adolescent residents of the Outer Banks more information about sea-level rise in a manner that is timely, accessible, and comprehensive. This could be an effort mounted by local governments throughout the Outer Banks. High school curricula that incorporate current climate data and research should be developed and implemented. Municipal governments may want to hold public forums, town hall meetings, or host a series of talks that cover the mechanisms, rates, and risks of sea-level rise to the Outer Banks region.

For example, surveys often showed that residents were confusing a rise in the vertical level of the sea with a horizontal rise in the mean high-tide line. In addition, 75% of the 51-to-60 age group felt they were informed about sea-level rise, suggesting that there is a lack of accurate information about the issue. Connecting accurate information with the term itself is vital in order to ensure that citizens have not only heard of sea-level rise, but that they are using reliable information rather than hearsay for decision-making purposes. Another problem suggested by the data is that accurate information on sea-level rise is available but not reaching certain age groups. This may be the result of media outlets focusing primarily on younger generations when communicating information about sea-level rise.

The group of respondents between the ages of 61 and 70 reported being the least concerned about sea-level rise, while 77% of respondents between the ages of 18 and 30, felt concerned about sea-level rise and only 6% were not concerned. Given that the effects of sea-level rise likely won't be felt for some time, it is understandable that younger respondents indicated higher levels of concern. It is important that government and civic leaders take into account the concerns of younger generations when considering plans to address sea-level rise.

Townships
- Kitty Hawk: 72% believe sea-level rise happening; 27% felt informed; 91% felt government should do something
- Kill Devil Hills: 73%/50%/81%
  but
- Avon: 35%; 83%/73%
- Hatteras Village: 57%/79%/71%

This could be seen as an indication that residents of this area are actually more concerned about how sea-level rise will be handled in the future rather than how it is currently affecting them. Also affecting this inconsistency is the large number of "not sure" responses to whether sea-level rise was occurring in these towns. This, coupled with the percentage of respondents in favor of government response to sea-level rise could show a public desire for government research and education.

Ownership Status
No correlation was found in this study between respondents' concerns and whether or not they lived on waterfront property.

Recommendations
Maryland and Rhode Island have both adopted extensive sea-level rise action and adaptation plans. Based on the results of this study, an in-depth government action plan that includes a strong education component would benefit Outer Banks communities.

- The most effective and necessary component of addressing resident awareness of sea-level rise may be incorporating accurate and up-to-date scientific data into high school curricula.
- Local leaders could also address education on a community-wide basis by creating outreach programs that target all ages. Possible forms of outreach include community workshops, storefront drop-in interviews, storytelling sessions, youth activities, elected official receptions, and radio call-in shows.
- A workshop geared towards providing education on sea-level rise may include interactive exercises.
- Storefront or residence drop-in interviews allow local leaders to engage with business owners or residents who may be unwilling to share their concerns in front of a larger group or simply cannot attend meetings due to a busy schedule.
- When introducing sea-level-related policy to towns on the Outer Banks, it may be beneficial to foster a "storytelling" forum, where community members exchange stories regarding their personal experiences of sea-level change, allowing residents to learn from one another's experiences.
- Targeting educational sessions toward youth will ensure awareness of sea-level rise at a younger age.
- Hosting receptions with elected officials would also be a strategic way of addressing local awareness of sea-level rise.
- Developing policies that consider sea-level rise should begin with community awareness.

Regardless of how much education residents have received on the issue of sea-level rise, it appears that the majority of respondents would encourage local government leaders to address sea-level rise. More residents were concerned about the effects of sea-level rise than felt well informed about the issue. Residents are worried about the future of the Outer Banks, an area where they have invested a great deal. Such concerns should be addressed by local leaders and policymakers.

Sea-level Rise Scoping Survey Final Report: Public's Perception of the Reality and Magnitude of Sea-level Rise, and Their Perceived Vulnerability to Its Effects

North Carolina Division of Coastal Management
2010

Methods
- Non-scientific sea-level rise perception and scoping survey, conducted in the summer of 2009.
- The survey was administered online through Survey Monkey from July 21–August 31, 2009.
- Respondents were solicited through direct e-mail, DCM's website, and various listservs. The survey also received significant coverage in the print, television, and radio media during the administration phase

Stats
- 1176 respondents, 673 of whom own NC coastal property
- 1076 NC respondents, 620 of whom own NC coastal property
- 18 out of 20 CAMA counties represented
- Beaufort: 39; Dare: 73; Hyde: 0; Tyrrell: 1; Washington: 3 (Total: 116, or 25% of CAMA respondents; 10% of all respondents)

Findings
- 805 of 1076 NC respondents, or 75%, believe that sea-level rise is occurring. Among CAMA counties, 346 of 496 respondents, or 70%, believe that sea-level rise is occurring.

  - Dare: 46/73; Beaufort: 28/39; Tyrrell: 1/1; Washington: 3/3.
- 127 of 1076 NC respondents, or 12%, do not believe that sea-level rise is occurring. Among CAMA counties, 84 of 496 respondents, or 17%, do not believe that sea-level rise is occurring.
  - Beaufort: 6/39; Dare: 16/73; Tyrrell: 0/1; Washington; 0/3.
- 407 of 1076 NC respondents, or 38%, believe that their property or finances will be affected by sea-level rise. Among CAMA counties, 169 of 496 respondents, or 34%, believe that they will be affected.
- 158 of 1076 NC respondents, or 15%, believe that sea-level rise is occurring, but do not believe that they will be affected. Among CAMA counties, 63 of 496 respondents, or 13%, believe that sea-level rise is occurring, but do not believe that they will be affected.
- 240 of 1076 NC respondents, or 22%, believe that sea-level rise is occurring, but do not know if they will be affected. Among CAMA counties, 114 of 496 respondents, or 23%, believe that sea-level rise is occurring, but do not know if they will be affected.
- 216 of 426 NC coastal property owner respondents, or 51%, believe that they will be affected by sea-level rise.
- Among CAMA counties, 146 of 307 coastal property owner respondents, or 48%, believe that they will be affected. 69 of 426 NC coastal property owner respondents, or 16%, believe that sea-level rise is occurring, but do not believe that they will be affected.
- Among CAMA counties, 59 of 307 coastal property owner respondents, or 19%, believe that sea-level rise is occurring, but do not believe that they will be affected. 141 of 426 NC coastal property owner respondents, or 33%, believe that sea-level rise is occurring, but do not know if they will be affected. Among CAMA counties, 102 of 307 coastal property owner respondents, or 46%, believe that sea-level rise is occurring, but do not know if they will be affected.
- 225 respondents who live outside of the 20 CAMA counties, but own property within the 20 CAMA counties, believe that they will be affected by sea-level rise. 71 respondents in this category do not believe that they will be affected, and 301 respondents do not know if they will be affected.
- Amount of sea-level rise (not led in question): 1–3 ft. (336, or 36%).
- <1 ft: 223, or 21%.
- Don't know: 178, or 16%.
- 719 of 1076 people, or 67%, consider the NC barrier islands north of Cape Lookout to be at high or highest risk. 660 of 1076 people, or 61%, consider the NC barrier islands south of Cape Lookout to be at high or highest risk. 411 of 1076 people, or 38%, consider the NC mainland north of the Neuse River to be at high or highest risk. 322 of 1076 people, or 30%, consider the NC mainland south of the Neuse River to be at high or highest risk.
- 66% of all NC respondents, and 59% of CAMA county respondents, believe that the state should start planning now to address sea-level rise.
- 14% of all NC respondents, and 21% of CAMA county respondents, believe that the state should not should start planning now to address sea-level rise.
- 626 of 1076 respondents, or 58%, think that NCRC should play a leading role in the state's action on sea-level rise, followed by scientists.
  - Supporting role: private landowners (#1); general public (#2).
- The most frequently selected highly recommended action was to produce maps of the areas most at risk, selected by 704 or 1076 people, or 65% of respondents.
- Other highly recommended Actions: public education (660, or 61%); using a projected amount of sea-level rise for planning purposes (625, or 58%); and requiring local land-use plans to consider sea-level rise (619, or 58%).
- Highly recommended state action: most frequent: require use of coastal hazard disclosure statements for real estate transaction (654 people, or 61%).
  - Next: Using a projected amount of sea-level rise for planning purposes (623, or 58%); prohibiting expenditure of public money for new development in at-risk areas (607, or 56%); updating state flood maps to account for sea-level rise (601, or 56%).

Useful Quotes from Free-Answer Section

- I am a professional geologist and I understand the issue. I do not, however, believe that there is a significant link between the industrial revolution, carbon emissions, sea surface temperature increases, and increased sea-level rise.

- I have been conducting FEMA flood certificates since the onset of the same. I have been monitoring mean sea-level elevations since 1962. Bench Marks at or near sea level have not changed. There have been adjustments in the government datum networks, but not the water elevation has not notably changed.
- I was a CAMA officer for Currituck County and I also work for Dare County in Buxton. The water rises every year; there are erosion rates from 6 ft. to 18 ft. a year along the different areas of the coast. There is no question that the water level is rising, the only question is how fast. The beach is an ever-changing environment, you will lose parts of the beach and you will gain in certain areas.
- I was involved in a Duke University climate study and the hydrologic cycle we observed was about 65,000 years. Ice ages and global warming are long-term events—not media events.
- I had my property surveyed by Dr. Gray's company at the Univ. of Arizona (?) and they indicate a 3-ft. rise by 2100. My personal property is 9 ft. above sea level, and my property is projected to be an island, with surrounding areas, like the road under about 1 ft. of water.
- I have been working in the coastal/environmental field every week for the past 32 years and have seen the effects of gradual sea-level rise on bulkhead placement, coastal wetland expansion, cypress tree die back and poor drainage of stormwater. In particular, the farm drainage around "down east" counties like Carteret, Hyde, Pamlico, Tyrrell, and the northeastern counties show signs that they are going tidal during even small wind tides and coastal vegetation extends inland under live oaks and pine trees in greater frequency when we perform wetland delineations.
- Kind of crazy question. We are not scientists able to do a 100-year forecast. I have been coming to Holden Beach since the 1950 when I was a kid. My grandmother lost her house to beach erosion in the 1970s because it was built too close to the ocean. If I had to guess I would guess the high-tide mark at Holden has changed 30 ft. or little more in 40 years. What that equates to in sea-level rise I have no idea, but I know I am close with this number because I have a house at Holden and the lot beside my grandmother's was never built on and there was a well head that was on it in the middle and now it is on the beach just above the high-tide mark. It was in the middle of the lot in the 1960s.
- My grandfather laid a wooden walkway directly on his canal bank along his access canal in the 1930s. At normal low tide you can still see some of the planks.
- We have a house on the east end of Holden Beach. Even though we have had several beach renourishments in the past 7 years the water still comes all the way up to our steps at high tide. It seems to have gotten worse in the past year.
- In Rodanthe this past winter, a home was taken by the ocean that was built only three years ago! This is no anomaly.
- But how is "risk" defined. Is this just about the likelihood of sea-level rise, or the probability (risk) of harmful impacts to the natural environment (e.g., saltwater intrusion into freshwater systems) and/or to human populations in coastal communities (e.g., increased flooding, contaminated water supply wells)? Defining terms is critical in a survey like this.
- Your survey is mixing and confusing the issue of erosion and sea-level rise. They are not the same and you shouldn't mix them in your survey. Erosion and shoreline modification by tides and currents built the outer banks. Careful what you judge to be "bad."
- I am the Director of Elizabeth City State University's Center for Green Research and Evaluation. We have received a $400,000 grant from the North Carolina Rural Center to promote and create a "Green Economy" in northeastern North Carolina. We are currently exploring strategies for job creation in connection with sea-level rise adaptation. We are a finalist for a Smart Growth Implementation grant from the EPA (eight finalists; three will be funded). If we are selected, EPA-hired experts will work with the communities of Elizabeth City, Winfall, and Plymouth to develop sea-level rise adaptation plans that incorporate Smart Growth principles and economic development. EPA will make its decision in early August. We will also be hosting a series of public meetings to discuss "Green Jobs" in the region, including those connected to sea-level rise adaptation, during the fall of 2009. The Majora Carter Group is partnering with ECSU on these meetings, and on our other "Green Economy-related" activities.

Notes from the Sea-level Change and Climate Planning Needs Stakeholder Workshop

Biloxi, Mississippi
March 11, 2009

Background

Twenty-two stakeholders that represented diverse perspectives provided input to 18 technical partners who work on the NOAA, USGS, and U.S. Army Corps of Engineers Climate Initiative Pilot Project in Alabama and Mississippi. The following are the raw notes from the workshop, and comments are not attributed to specific individuals but are categorized in the following four categories with specified affiliations:

Infrastructure: city planners, floodplain planners, transportation, water and sewer, power, and energy sectors
Emergency management: county, state, and federal emergency management agencies
Natural resource manager
Natural resource scientist

Question 1: What sea-level rise and inundation-related decisions or discussions are you involved in?

- This is the only discussion we've had.
- Do not have means to collect data but look at trends for minor events (tropical storms).
- Where should you build, SmartGrowth building, trails partnership; how do you invest your fund most responsibly? Invest in a blueway and there is a 2 foot sea-level rise then was it a good investment? Must seek support from outside investors; what should they tell these investors? Is there any reason to invest in this area?
- PLEASE don't use the "X year flood" terminology. One percent annual chance of flood = the 100-year flood which has a 26% chance of occurring during a 30 year period.
- Infrastructure—
  - increased salinity inflow
  - many water customers have septic tanks on edge of creeks and bays
  - circulation in the bay-will this change as a result of sea-level rise? This would be important for discharge permits
  - how will surge impact treatment plants, do they need to be moved?
- Sea-level rise hit the radar screen in the last 2-4 years; all coming into perspective after Katrina; this is not taken lightly; the number one topic is sea-level rise and storm surge-it will happen.
- Coastal Hazard Outreach Strategy Team
- Developers will show a plan and then sell off the lots and then the people he sold it to have filled it in and the topography and flood vulnerability has changed.

Natural Resources

- Concern about shellfish diseases – warming and acidification effects
- Informal discussions about sea-level rise but it hasn't been a factor in management decisions
- Reduction of emergent habitat and how that affects ecosystems
- Impacts of subsidence and sea-level rise on shoreline retreat – from a built environment standpoint, what are we willing to do, where are we willing to go?
- Where will the water go in the future?
- Purchasing buyout properties (areas that continuously flood)
- Need someone who can give us the information about barrier island migration and other changes on the coast (currents, winds, subsidence)
- Lots of data available on-line (hydrologic, geologic, etc.) – missing is a framework to put data together in a focused way

Question 2: Where do you obtain the climate information to have those discussions and make decisions?

- DFIRMS
- NRCS soil maps
- USACE did surge and SLOSH maps
- Satellite data; look at pre- and post-Katrina data

- NOAA hydrology site; want to know rainfall over different time periods; some people do not pay attention to it because they have had twelve 100-year storms in less than a 100=year period
- Each storm is very different; 500-year flood in 1998 (have had several in their lifetime and do not want to see another one)
- NOAA Storm Prediction Center
- Coastal weather research center; University of Alabama will have a new weather center shortly
- Emergency management must use NWS and National Hurricane Center for their information

Question 3: What types of additional information do you need to improve those discussions and decisions?

- Enhanced flood projection models (should project the new contours wherever they are)
  - it should update the 100 and 500 year flood areas
  - how far inland – move as far inland as it takes to capture sea-level rise (tidal influences) as far as the river goes (rivers, discharge)
  - anticipate sea-level rise five to 50 years increments so that you know when you need to redraw maps
  - Hurricane surge, how it effects these areas with incremental time frames (5, 10, 15 years)
- Do not report the data as certain; report the uncertainty in the models
  - Include the uncertainty as time increases
  - Give the percent change of sea-level rise at certain levels (comparable to the tables produced by the National Hurricane Center on predicted hurricane strength over a certain time period)
- We need a better job of explaining what that variability is; good at explaining the marginal error
- Public education/outreach to present the raw data to the public; what is the percent accuracy?
  - Frequency of storms, flood events, historical data; probability and magnitude of storm events
- Need a database for tracking water on the roads with sea-level rise
- Map showing increase of tidal area as sea-level rise increases
  - Will have to start buying back areas near the roadways like mitigation banks
- How much stormwater discharge?
- Produce a worst case to more typical scenarios and how that will affect people's homes
  - Make it usable
  - Scale should be from the county to individual community level
- How should this model be shared?
  - Both web-based and non-web formats are needed
  - Web-based so that it is available to all people and communities without much resources can still use it
  - It should also be developed in a form that it can be delivered like the SLOSH model where communities with resources and capabilities can customize it for their specific use
- Barrier islands serve as a buffer between full strength seawater and lower levels. How will loss of barrier island impact fisheries?
- Impact of losing emergent habitat on fisheries nurseries
- Changes in precipitation and impact on bacterial counts. Are wastewater systems prepared for changes in precipitation and consequent runoff? Effect on fisheries and on human health.
- Sound science on local and state-level sea-level rise and communication strategy – there are still educated people in the industry who are skeptical
- Easy to use GIS-based models (e.g., click on Gulf Shores and demonstrate what will happen in this area) for awareness of impacts to make sound planning decisions. Include adaptation strategies.
- Sea-level rise range expected over planning time frames for local jurisdictions
- Scales for management level (e.g., NPS superintendent, city, etc.) – subsetting
- How do I make sea-level rise relevant and concrete to different user groups? Show what this means to a user group – need local landmarks, local impacts. Too easy now to be vague and dismiss concerns. Need to show how it has changed in the past, how it could change in the future – use pictures.
- In delivery of message also show opportunities. Right now we just see negatives. Salt marsh will be created (some will also be lost). Need to not always be negative. Outreach is difficult if message is all negative. Audience is turned off. Don't just say I hope you are saving money because this is going to cost you. Outreach – bring a message that shows the community opportunities for development.

Question 4: Other than sea-level rise and inundation, what other climate-related decisions or discussions are you involved in?

- Infrastructure – when building highways we must submit draft environmental impacts assessment. EPA asks why put bridge over stream? How do you determine specific length of the bridge? Consultants running into problems – using 100-year floods and are asked what rationale they are using to make decisions.
- Discharge limits based on existing hydrology but this may change if sea-level rise and water movement slow; the region also has a lot of shallow water aquifers and many people are using private wells and septic systems. What is the effect of salinity on sands and deeper aquifers? If septic system is near a creek that rises, what happens?
- Acidification in the ocean-people in shellfish farming are concerned about this; estuarine acidification; changes in concentrations of aragonites.
- Any changes in precipitation, intervals short versus long, could affect irrigation, groundwater, and agriculture.
- A wise community could use models to see the risks.
- In Biloxi if you raise the sea level just a small amount, and there is more impervious surface northward with population growth there will be inland flooding. The waters are going to meet somewhere in the middle. We need to identify these areas and keep people from building in those areas;
- I like a lot of maps. It lets people visualize. Can show where people are now and where they will be with sea-level rise. Then people can imagine where they are living and how it might change.
- Present people with solutions instead of scaring them.

Need to know risk of sea-level rise and these needs to be weighed against the impact on other things. Regret if put emphasis on sea-level rise and not look at tradeoffs. How much pavement is needed to expand bridges? What will be impact of more pavement?

Question 5: What can an interagency federal climate program offer to better meet your climate science and information needs?

- ***Infrastructure*** – When I saw all of the agencies involved there is a lot of information out there. When have this many studies it gets complicated and will not do any good. Need to translate and make it available. Need to sift through and make it relevant for what you are doing.
- ***Infrastructure*** – A clearinghouse would be useful. Just in our company we support research and sometimes can't get research results to others in our company who need it.

Question 6: How can the research better inform decision making on both mitigation and adaptation?

- General comment: Apply it at a local level

Question 7: Do you need to receive climate information in a timelier manner? If so, what features are important to you in the delivery of the information (e.g., point of delivery, tailoring, and spatial resolution)?

- Need accurate data
- The confidence level is not there. I'm not doubting that it is on right track, but can't go to the bank with the data. We need to know uncertainty. Should decision makers begin to move communities out?
- Data does not come to us in an authoritative way – it's more reliable if it comes from a non-university source because a university professor may have an agenda due to funding sources. It is a matter of trust and the authority of an agency. It would carry more weight if it came from a trusted agency or type of authority.
- I don't think timeliness is as important as accuracy. Waste of money to know sea-level rise in 2009 and sea-level rise again in 2010. I think we have too much data for decision makers to assimilate. Make data useful rather than collect much more data.

Question 8: What should be the role of education in climate change science?

- Empower people to make their own decisions. Empower them to make choices based on the information.
- Discuss inches of rain. Make it relevant to each community,
- 50% of my job is outreach and education. Tough topic. I do my job using the KISS principle. What is it and how does it affect me—whatever level it may be—homeowner, city council member, whoever.
- Floodplain managers have extensive training. We just have to roll this in. Everybody is going to depend on some type of federal funding. Have national seashore system for outreach and education and monitoring
- Of the 13 federal agencies, is there a lead agency?

Supplement C: Communications and Outreach Strategy: Objectives, Findings and Recommended Actions

Strategy for Outreach and Engagement

Introduction

Recently conducted surveys and our meetings in the Albemarle-Pamlico estuary region and other coastal North Carolina communities provide valuable lessons and insights about knowledge of sea-level rise and its potential impact to the region. Our findings indicate that the public and key local government officials need reliable sources of information presented in a user-friendly and accessible format to overcome the knowledge and information gaps about sea-level rise and climate change. Documented examples of sea-level rise over historical time periods would help to lend credibility to presentations for local resource managers and officials and in turn would allow them to pass on concrete information to their constituents. In order to be effective, information highlighting specific community concerns will resonate and help instill an underlying urgency to engage in the issue.

Building a strong and clear communications strategy for the Climate Ready Estuaries Pilot Program presents APNEP with the opportunity to take a leading role in coordinating the efforts of the many different entities researching and addressing potential effects of sea-level rise and to respond to constituents' needs with practical, useful, and forward-thinking information that supports program goals and contributes to the future of communities throughout the Albemarle-Pamlico estuary region.

This strategy guides communication with diverse stakeholders in the APNEP region. In planning the strategy, we first examined overall Climate Ready Estuary program goals and assessed APNEP's current communications practices and capacity. Using our analysis from the surveys, meetings, and listening sessions, as well as best practices from similar programs in other regions, we identified distinct stakeholder constituencies, and further defined subgroups within these constituencies. This real-world profile of knowledge of and interest in the issues, political will for change, and community capabilities to be a "climate ready estuary" was then compared with overall program goals. This "gap analysis" established our proposed communications framework. We took care to frame the issue of sea-level rise in a way to promote collaborative action in the community, to counter some of the resistance we encountered on the ground, to identify key messages, and to identify communications objectives that are specific to the region and reflect our research findings.

The resulting communications and outreach strategy states each communications objective, substantiates it with a specific research finding, and suggests actions that can help APNEP achieve its program goal of facilitating a climate ready estuary.

Objectives

Primary objective of the EPA CRE Pilot Program

- To build capacity among coastal managers to improve the resilience of coastal areas for the impacts of climate change

Primary APNEP Pilot Program objectives

- To increase public and local government awareness of sea-level rise in the APNEP area
- To educate local lawmakers, resource managers, and the public about the opportunities and challenges inherent in becoming a climate ready estuary
- To compile a resource of up-to-date science on sea-level rise impacts
- To foster better understanding and cooperation among state and federal agencies, NC research institutions, and APNEP communities that depend on and are affected by changes to our estuarine systems

Existing APNEP Communications and Outreach Assessment

Communications channels

Past APNEP communications with local officials, including those related to climate change and sea-level rise information, have primarily been through the APNEP website. Communications with APNEP system communities about sea-level rise and climate change have come from the North Carolina Division of Coastal Management and Division

of Emergency Management and through three federal agencies: EPA, FEMA, and ACE, but have not been estuary-specific. The 2009 targeted interviews, coastal managers survey, and other surveys results indicate that the knowledge base of the core constituents is limited, an underlying urgency to engage in the issue lacking, and the political will to address the challenges without support.

Communication and outreach with the general public have primarily been through the APNEP website, social media (Facebook), AP3C, educators, and museums. The website is outdated, difficult to navigate, and has limited search capabilities. The Facebook page and blog are not consistently maintained. All communications channels are not segmented by constituent type and attempt to address all users' needs. Although local educators have professed enthusiasm for the goals of APNEP in the past, there is no statewide climate change and sea-level rise curriculum offering support. Estuary-focused museum programs have been in support of museum-driven initiatives, and not APNEP-driven strategies. So far, none have focused on the potential impacts of sea-level rise in the estuary. The website has been recently updated.

Communications capacity
At present, APNEP lacks the capacity to initiate and implement an effective communications and outreach strategy. Four full-time staffers with other duties and responsibilities do not have the time or technical and media training to engage in daily outreach activities, monitor recent scientific and policy events, and spearhead a communications coordination effort with the myriad other state and federal agencies that regulate and have jurisdiction over the effects of climate change.

Stakeholder Identification
There are a number of different constituencies at play in the political landscape of the Albemarle-Pamlico estuary region, each with a different awareness level of the present and potential effects of sea-level rise and its own set of responsibilities for protecting the community resource. Education and outreach objectives are more attainable when they are segmented by stakeholder group, allowing for specific messaging and engaging distinct interests. The objectives defined in the next section incorporate this stratification. While we acknowledge that communicating with all citizens is desirable, in light of realities of capacity and budget, we suggest prioritizing stakeholder communications based on magnitude of need and likelihood of acceptance. Once inroads with targeted members of the primary group are made, wider acceptance is more likely.

The first tier of stakeholders is comprised of town resource directors, including town managers; utility directors; water and sewers directors; flood plain managers; and emergency management personnel. The second tier consists of county commissioners and municipal officials. However, recognizing that it takes a very powerful and popular personality to lead a community in a new direction, and one that, based on our 2009 interviews, most community leaders have limited interest in pursuing, we highly recommend that outreach to the general public begin immediately, even in a limited capacity. A recognized path to advocacy begins with awareness, leading to consideration and engagement, before conversion, loyalty, and finally, advocacy. Even early engagement in the general population will lead to a groundswell of interest, making it an issue of importance and placing it on the agendas of county commissioner meetings.

The general public group includes permanent coastal community residents, statewide summer residents, educators, students (K-12), media, and churches.

Our final group of stakeholders is one that could most effectively be reached in parallel efforts by the APNEP board level. Political constituents consist of state legislators in the senate and house, U.S. congressional representatives, and U.S. senators.

Communications Framework and Key Messaging
Based on our findings in our 2009 targeted interviews, we concluded that it was counterproductive to frame communications in terms of the issues of sea-level rise and climate change. The uncertainties that accompany the best climate change predictions and the long time frame used in sea-level rise cause confusion and dampen motivation for action.

We worked to place a more pragmatic, contemporary spin on the framework, one that appeals to citizens'—including officials'—pride of place, recognizes their emotional attachment to the estuary, and draws a connection between the resources—the estuary—and their livelihoods.

Framework for Communication
The Albemarle-Pamlico estuary is a resource that you want to protect. It contributes to your quality of life, is a recognizable symbol of North Carolina, and is the economic engine-driver in the region, providing jobs and resources.

Current Conditions
Your community/estuary are vulnerable to environmental change. Impacts could affect your quality of life and the certainty of jobs, such as fishing, tourism, and development, and resources, such as clean water and fisheries.

Proactive Response
We need to work together to protect this valuable ecosystem. We have a long history of adapting to environmental change and we can draw on that experience to anticipate changes from sea-level rise and protect our communities. North Carolina has been constantly battered by changing weather patterns, and historically, hurricanes have caused enormous changes to the shorelines and to property. But communities adapt, and they can adapt to the changes that sea-level rise will bring.

By starting now, all citizens can take actions that will have enormous payoffs. Town resource managers can incorporate sea-level rise considerations into existing plans and programs and every member of the community can take small actions that will positively affect the health and resiliency of the estuary. Communities with an action plan in place will be better positioned to take advantage of government funding and programs to address sea-level rise and can avoid delays from more restrictive permitting requirements for community infrastructure, development, and other regulated activities.

For Leadership, a Call to Action
Make planning decisions based on future projections of what your community will look like, rather than what is has looked like in the past. Find out what works. Adapt.

Champions and Spokespeople
Identifying CRE program champions from within the constituencies will offer another way of disseminating knowledge. Peer education can often penetrate districts and divisions resistant to any regulatory authority assistance. An enthusiastic and supportive town resource manager, an early adopter of technology and knowledge could prove to be a major influence within that stakeholder group. In that role, he or she would pass on accurate information about key technologies, activities, and developments, and listen to feedback from other officials.

A communications spokesperson is different from a program champion and can be another valuable tool in a communication strategy. A spokesperson could be an effective, low-key conduit of our key message of working together to protect our common resource. We recommend recruiting a positive role model, a nonthreatening, beloved personality with proven ties to coastal North Carolina, whose participation can influence people to shift their thinking, even a little bit.

Outline of Communication Objectives, Identified Findings, and Communication Recommendations

1. Objective

- Encourage the state of North Carolina to assume a leadership role in coordinating sea-level rise research and communicating findings on an ongoing basis

Findings

- Potential impacts of sea-level rise affect infrastructure and policy that fall under state jurisdiction, e.g., wastewater treatment plants; real estate disclosures; flood hazard, insurance
- Many state and federal agencies and research institutions are working on climate change and sea-level rise initiatives

- A majority of survey respondents thought that NCRC should play the lead role in the state's actions addressing sea-level rise

Recommended Actions:
- Meet with state legislators and aides and familiarize them with the vulnerability of the estuary to sea-level rise
- Arrange meetings between elected officials and proactive town resource managers to demonstrate visible infrastructure effects
- Deploy the APNEP Board and strategic partners in pursuit of objective

2. Objective
- As the state becomes more active, it needs to provide best available information on an ongoing basis to all citizens

Findings
- There is a lot of conflicting information available, which is confusing to constituents and the general public and results in resistance to any change

Recommended Actions
- Establish a consistent message across all state and federal agencies, with agreed-upon facts and reliable basis for scientific predictions
- Coordinate efforts among programs; note and discuss both discordant and supporting findings – don't ignore them. Similarly, complementary programs should be identified and tracked.

3. Objectives
- Inform state legislators of potential obstructions to adapting to sea-level rise
- Inform elected state and federal officials of relevance of federal legislation, including the Coastal Zone Management Act, Interstate Land Sales Act, and Coastal Barriers Resources act, to local efforts in adapting to sea-level rise
- Advocate for new federal flood insurance policies that discourage development in coastal hazard areas

Findings
- The availability of flood insurance encourages building in flood prone areas

Recommended Actions

4. Objective
- Be recognized as an advocate for the region in NC General Assembly and Congress

Findings
- Local officials missed stimulus-funding opportunities because they did not have "shovel ready" projects in the pipeline

Recommended Actions
- Using intelligence from supporters in government, alert local governments to potential funding opportunities well in advance of submissions deadlines
- Include legislative updates in periodic communications

5. Objective
- Ensure local personnel are equipped to address sea-level rise challenges

Findings
- Many coastal managers have been in their current positions for less than three years.

Recommended Actions
- Form alliances and partnerships with professional associations that actively pursue solutions to infrastructure problems
- Encourage resource managers to achieve professional accreditation that will help them creatively address vulnerabilities in their communities

6. Objectives
- Build awareness that one of the most pressing issues of climate change on the APNEP counties is sea-level rise
- Convey sense of urgency in public perceptions about climate change and its effects on the natural and built environment around our estuaries

Findings
- County commissioners did not believe addressing sea-level rise was warranted by the long time frame inherent in estimated impacts.
- Need sound science on local and state level sea-level rise and communication strategy – there are still educated people in the industry who are skeptical
- Some municipalities would be open to pilot adaptation projects to make their infrastructure and communities more resilient to climate change.
- Present information in a user-friendly, customizable format

Recommended Actions
- Prepare materials for local governance that offers clear, science-based support for ideas and positions, and best management practices from regions with similar geographies and social identities.
- On August 24, 2010, winners of the Race to the Top school reform grant competition were announced by the federal Department of Education. North Carolina was awarded $400 million, in part for proposing to build networks of schools focused on math and science. Partner with existing education champions to write a math and science-based climate ready estuary curriculum that focuses on North Carolina.

7. Objectives
- Motivate town managers and county commissioners to make necessary changes in governmental investments, regulations, and practices
- Secure commitment of town managers and county commissioners to CRE project aims

Findings
- Local officials are more receptive to approaches that help them protect their communities, rather than top-down requirements imposed by Raleigh and Washington
- Most community members are not trained in GIS and do not have access to computer programs that make downloading maps easily accessible

Recommended Actions
- Educate local decision makers about specific county vulnerabilities of sea-level rise
- Provide readily available information specific to the needs of the target audience
- Work with UNC-RENCI to develop easily understood and accessible graphics showing effects of sea-level rise under different scenarios
- Agencies presenting information about these topics need to be sensitive to the issues competing for managers' time and budget and find synergies between suggested solutions to sea-level rise impacts and a county's outstanding needs.

8. Objective
- Position APNEP as source of reliable information and best management practices to NC town managers and county decision makers

Findings
- For those constituents who are proactively engaged in protecting their communities, there is no clear source of information about potential effects of sea-level rise on their community
- To be successful, the outreach and communications strategy needs a consistent message, voice, and face for the target constituents.

Recommended Actions
- Create professional practitioner portal on APNEP website. Have subpages specific to different professional roles, e.g., utility directors, town planners. Make it searchable by topic and populate with links to new information and established sources of information. Organize so visitor is not overwhelmed with data.
- Hire a full-time employee to drive the project. Duties would include supporting and coordinating educational, informational, and technology transfer programs responsive to community needs.

9. Objective
- Recognize APNEP as a go-to resource for sea-level rise problem-solving

Findings
- There is a lot of data online – what's missing is a framework to put data together in a focused way.
- Needs: Flood projection models; sea-level rise modeling in 5 year increments to 50 years
- Include uncertainty
- Scales should be from county to community levels
- Web and nonweb based formats; Customizable – like SLOSH

Recommended Actions
- Maintain communication for consistent feedback from regional governments
- Update information as it becomes available
- Have regular meetings and roundtables with informed representatives from all relevant state and federal agencies, i.e., DENR, EPA, FEMA, NC Emergency Management

10. Objective
- Strengthen sense of optimism and pride in local culture of resiliency in general public

Findings
- Some counties were extremely resistant to hearing about the need to plan for future impacts of sea-level rise

Recommended Actions
- Initially focus on counties and towns that are interested in working with us and participating in programs; continue to make resistant counties aware of the APNEP activities and outreach; when milestones have been reached or progress quantifiable, arrange for peers from pilot counties to speak with resistant county commissioners.
- Empower people to make their own decisions based on the information

Communications Channels and Outlets

Once the communications strategy is prioritized and a time line and budget are set, we suggest polling the priority constituency for its preferred method of interaction. The list below gives a broad range of possible communications channels and outlets. The appropriateness and effectiveness of each varies with the key message. Our different constituencies prefer different access methods, and it is in our best interest to understand them all. It is often useful to identify two or three potential channels per message and audience, which will allow greater flexibility when considering budget realities.

Potential Communications Channels

Press
- Press release
- Radio
- Opinion editorial
- Features

Online
- APNEP website
- Special portal or new site
- EPA website
- e-mail newsletter

Social Media
- Facebook
- Twitter

TV
- Local news stations and features

Advertising
- Print
- Radio
- Television
- Out of Home (OOH)

Print
- Brochures
- Posters
- Letters
- Leaflets
- Postcards
- Scientific report

Public Relations
- Event/Stunt
- March Madness
- "Year of" declarations
- Endorsements
- Monthly telephone calls
- Bi-monthly webinars
- Conferences
- Roundtables
- Partnerships
- License plates
- Postage stamps
- Signage (similar to NC watershed signs)

Partnerships

As mentioned earlier, it is essential that all interested and active agencies and organizations coordinate their research and actions, especially the CHPS groups: Coastal Resources Commission, emergency management, and floodplain management. There is an opportunity for APNEP to reinforce its brand and serve as an active clearinghouse and chronicler of ongoing projects.

There is also an opportunity to continue APNEP's existing strong partnerships in museums and in education.

Branding

We recommend that all CRE-related communications carry the APNEP brand; there is no need to create a new program for a new issue. In this case, the brand is: **APNEP is a clearinghouse and impartial provider of information about the affects of sea-level rise in Albemarle-Pamlico estuary communities.**

It is not necessary and may even be counterproductive to separate APNEP from DENR; however, we recommend not stressing the relationship with the EPA, given the perception our primary constituents have of the agency as a restrictive regulatory authority.

Time Line
- The overall time line for the communications strategy is five years: 2010–2015.
- We suggest reviews at the 24- and 48-month marks and revisions and updates as required.
- We recommend that immediate actions target town managers and resource directors, followed by programs for county commissioners and the general public.
- A more detailed time line should be created once priorities area greed upon and a budget is established.

Performance Indicators

We recommend conducting a survey or other outreach method two years after the communications strategy has been in effect to assess the following:

- Is APNEP perceived as a clearinghouse and impartial provider of information about the affects of sea-level rise in Albemarle-Pamlico estuary communities?

- Are town managers and local officials more able to protect their resources (the estuary) from the potential and present impacts of sea-level rise?
- Do communities makes plans based on future projections rather than past historical trends?

Results will be clear indicators of effectiveness and will point the way to revisions and additions needed to the communications strategy.

Appendices

Appendix A: Sample Climate Ready Estuary PowerPoint Presentation – Hyde County

See attached pdf

Appendix B: Literature Search and Annotated Bibliography

Among the many valuable resources available for planning a strategy to prepare for sea-level rise, the following sources proved particularly useful in preparing this blueprint. Also referenced are well-known climate change planning and adaptation websites.

Climate Change Plans, Strategies, and Reports (listed by jurisdiction)

Australia

Commonwealth of Australia. 2010. "Australia's Fifth National Communication on Climate Change." Canberra, Australia: Department of Climate Change. Details the progress made to date implementing a comprehensive strategy.

ICLEI Oceania. 2008. "Local Government Climate Change Adaptation Toolkit." Cities for Climate Protection Australia Adaptation Initiative. Offers a very practical, in-depth toolkit that uses a risk management process to plan for the impacts of climate change, with sea-level rise examples and flowcharts.

California

California Natural Resources Agency. "2009 California Climate Change Adaptation Strategy: A Report to the Governor of the state of California in Response to Executive Order S-13-2008." Sacramento, California: California Natural Resources Agency. http://www.climatechange.ca.gov/adaptation. Provides a comprehensive assessment of the state's vulnerabilities to climate change and suggestions for adaptation.

California State Lands Commission. 2009. "A Report on Sea Level Rise Preparedness: Staff Report to the California State Lands Commission." http://www.slc.ca.gov/Reports/SEA_LEVEL_Report.pdf. Gives specific recommendations for addressing sea-level rise in California. Includes highlights from other states' action plans.

San Francisco Bay Conservation and Development Commission. 2008. "A Sea Level Rise Strategy for the San Francisco Bay Region." Planning strategy from a commission without complete legal authority over affected area.

Delaware

Delaware Coastal Programs Office. 2010. "Preparing for Sea Level Rise: Development of a Sea Level Rise Initiative; Project Compendium March 2010." http://www.swc.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/SLRCompendium10_11_10.pdf. Provides an inventory and time line of projects under way as part of the state's Sea Level Rise Initiative.

Florida

Abimbola, Moji, J.W. Beever III, L. Beever, et al. 2009. "City of Punta Gorda Adaptation Plan." Southwest Florida Regional Planning Council, Charlotte Harbor National Estuary Program, Technical Report 09-4. 2009. Fort Myers FL. http://www.chnep.org/projects/climate/CRE.htm. Identifies alternative adaptations that could be undertaken to address climate change vulnerabilities in the Charlotte Harbor National Estuary and presents them in the order of prioritized agreement from public meetings.

Florida Oceans and Coastal Council. 2009. "The Effects of Climate Change on Florida's Ocean and Coastal Resources: A Special Report to the Florida Energy and Climate Commission and the People of Florida." Tallahassee, FL. http://www.floridaoceanscouncil.org/reports/Climate_Change_Report.pdf. Includes research priorities for climate change, water quality, ocean and coastal ecosystems, and tools and technology.

Florida Coastal and Ocean Coalition. 2008. "Preparing for a Sea Change in Florida: A Strategy to Cope with the Impacts of Global Warming on the State's Coastal and Marine Systems." http://flcoastalandocean.org. Recommends state, local, regional, and federal government actions to address state vulnerabilities, especially from sea-level rise.

Center for Climate Strategies. 2008. "Florida's Energy and Climate Change Action." http://www.flclimatechange.us/documents.cfm. Offers a planning framework and early action strategies.

Miami-Dade County Climate Change Advisory Task Force. 2010. "Annual Summary and Status of Recommendations." http://www.miamidade.gov/derm/climatechange/taskforce.asp. Assesses progress on recommendations from climate changeTF 2008 report with status updates as of June 2010. Surprising number of "No action taken" comments under Status; instructive for addressing potential areas of plan "stagnation."

Maine

Maine Department of Environmental Protection. 2010. "People and Nature Adapting to a Changing Climate: Charting Maine's Course." http://www.maine.gov/dep/oc/adapt/Report_final.pdf. This stakeholder-driven report offers concise and well thought out strategies and recommendations for adaptation, identifying actions with the least risk of "future regrets."

Maryland

Maryland Commission on Climate Change. 2008. "Climate Action Plan: Interim Report to the Governor and the Maryland General Assembly." http://www.mdclimatechange.us. Assesses the state's vulnerabilities and suggests early actions.

Maryland Commission on Climate Change Adaptation and Response Working Group. 2008. "Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change. Phase I: Sea-Level Rise and Coastal Storms." http://www.mdclimatechange.us. Offers an assessment of vulnerabilities and suggests next steps.

Mid-Atlantic States

Titus, J.G., K.E. Anderson, D.R. Cahoon, et al. 2009. "Coastal Sensitivity to Sea-level Rise: A Focus on the Mid-Atlantic Region." A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington, D.C.: U.S. Environmental Protection Agency. http://www.climatescience.gov/Library/sap/sap4-1/final-report/default.htm. Provides a cost-benefit analysis decision-making framework.

Communications Strategy (listed by author or organization)

Booth, C. 2009. "A Motivational Turn for Environmental Ethics." *Ethics and the Environment* 14(1): 53–78. Addresses motivational factors in nature conservation and suggests a framework for developing motivationally relevant criteria for environmental ethics.

Center for Research on Environmental Decisions. 2009. *The Psychology of Climate Change Communication: A Guide for Scientists, Journalists, Educators, Political Aides, and the Interested Public*. New York. http://www.cred.columbia.edu/guide. Discusses framing and recommends relating information to local experiences.

Climate Change Communications Working Group. 2005. *The Rules of the Game: The Principles of Climate Change Communications*. UK. http://www.futerra.co.uk/downloads/RulesOfTheGame.pdf. Provides 20 pragmatic research-based communications principles.

Colocousis, C.R., C.M. Duncan, and L.C. Hamilton. 2010. "Place Effects on Environmental Views." *Rural Sociology* 75(2): 326–347. Examines economic variables of place to explain apparent contradictions in citizens' environmental priorities.

Doppelt, B., M. Herr, and C. Pike. 2010. *Climate Communications and Behavior Change Guide*. The Climate Leadership Initiative. Eugene, Oregon. Focuses on understanding and connecting with the audience.

Granger Morgan, M., et al., eds. 2009. "Best Practice Approaches for Characterizing, Communicating, and Incorporating Scientific Uncertainty in Climate Decision Making." A Report by the Climate Change Science Program and the Subcommittee on Global Change Research. Washington, D.C.: National Oceanic and Atmospheric Administration. http://www.climatescience.gov/Library/sap/sap5-2/default.php.

Lakoff, G. 2010. "Disaster Messaging." Huffington Post. http://www.huffingtonpost.com/george-lakoff/disaster-messaging_b_639040.html? utm_source= DailyBrief&utm_campaign=070810&utm_medium= email&utm_content=BlogEntry. Discusses the difference between framing and messaging, among other topics.

Leiserowitz, A., E. Maibach, and C. Roser-Renouf. 2009. *Global Warming's Six Americas 2009: An Audience Segmentation Analysis*. Yale Project on Climate Change and the George Mason University Center for Climate Change Communication. http://www.americanprogress.org/issues/2009/05/6americas.html. Breaks the U.S. population into six segments (alarmed, 18%; concerned, 33%; cautious, 19%; disengaged, 12%; doubtful, 11%; and dismissive, 7%) and analyzes each in seven categories.

Pendleton, L., ed. 2008. *The Economic and Market Value of Coasts and Estuaries: What's At Stake?* Produced by Restore America's Estuaries, Washington, D.C. http://www.estuaries.org/the-economic-value-of-coasts-a-estuaries.html. Looks at the economic advantages of estuaries using a number of valuation indicators, including fisheries, tourism, and real estate.

Additional Online Resources

- NOAA's Digital Coast: Coastal Inundation Toolkit – http://www.csc.noaa.gov/digitalcoast/inundation
- U.S. Climate Global Change Research Program – http://www.globalchange.gov
- NOAA's Coastal Climate Adaptation website – http://collaborate.csc.noaa.gov/climateadaptation
- International Panel on Climate Change – http://www.ipcc.ch

Other Sources of Information

- NC Climate Change information – http://www.climatechange.nc.gov
- NC Albemarle-Pamlico National Estuary Program – http://portal.ncdenr.org/web/apnep
- U.S. Environmental Protection Agency's National Estuary Program – http://water.epa.gov/type/oceb/nep
- EPA's National Water Program Strategy: Response to Climate Change, September 2008 – http://water.epa.gov
- EPA's Climate Ready Utilities Working Group – http://water.epa.gov
- NC Sea Level Rise Assessment Report by Science Panel on Coastal Hazards for the Coastal Resources Commission and NC Division of Coastal Management, March 2010 – http://dcm2.enr.state.nc.us/slr/NC%20Sea-Level%20Rise%20Assessment%20Report%202010%20-%20CRC%20Science%20Panel.pdf
- NC Division of Emergency Management's Floodplain Mapping Program – http://ncfloodmaps.com
- NC Division of Emergency Management's Sea Level Rise Risk Management Study – http://www.ncsealevelrise.com
- Center for Study of Natural Hazards and Disasters at UNC-Chapel Hill – http://hazardscenter.unc.edu
- Resilient Coasts: A Blueprint for Action (2009) by The Heinz Center for Science, Economics and the Environment (http://www.heinzcenter.org) and CERES (http://www.ceres.org)
- Greater New Orleans Community Data Center (includes planning for and adapting to climate change) – http://www.gnocdc.org/TheNewOrleansIndexAtFive/index.html

Appendix C: Beaufort County Resolution

See attached pdf

Appendix D: NOAA's Fact Sheet on NC Coastal Federation Oyster Reef Restoration Project

See attached pdf

Appendix E: NC Coastal Federation's Brochure on Coastal Restoration Projects

See attached pdf

Appendix F: The Nature Conservancy Fact Sheet on Albemarle Adaption Project

See attached pdf

the Nicholas Institute

The Nicholas Institute for Environmental Policy Solutions at Duke University is a nonpartisan institute founded in 2005 to help decision makers in government, the private sector, and the nonprofit community address critical environmental challenges. The Institute responds to the demand for high-quality and timely data and acts as an "honest broker" in policy debates by convening and fostering open, ongoing dialogue between stakeholders on all sides of the issues and providing policy-relevant analysis based on academic research. The Institute's leadership and staff leverage the broad expertise of Duke University as well as public and private partners worldwide. Since its inception, the Institute has earned a distinguished reputation for its innovative approach to developing multilateral, nonpartisan, and economically viable solutions to pressing environmental challenges.

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