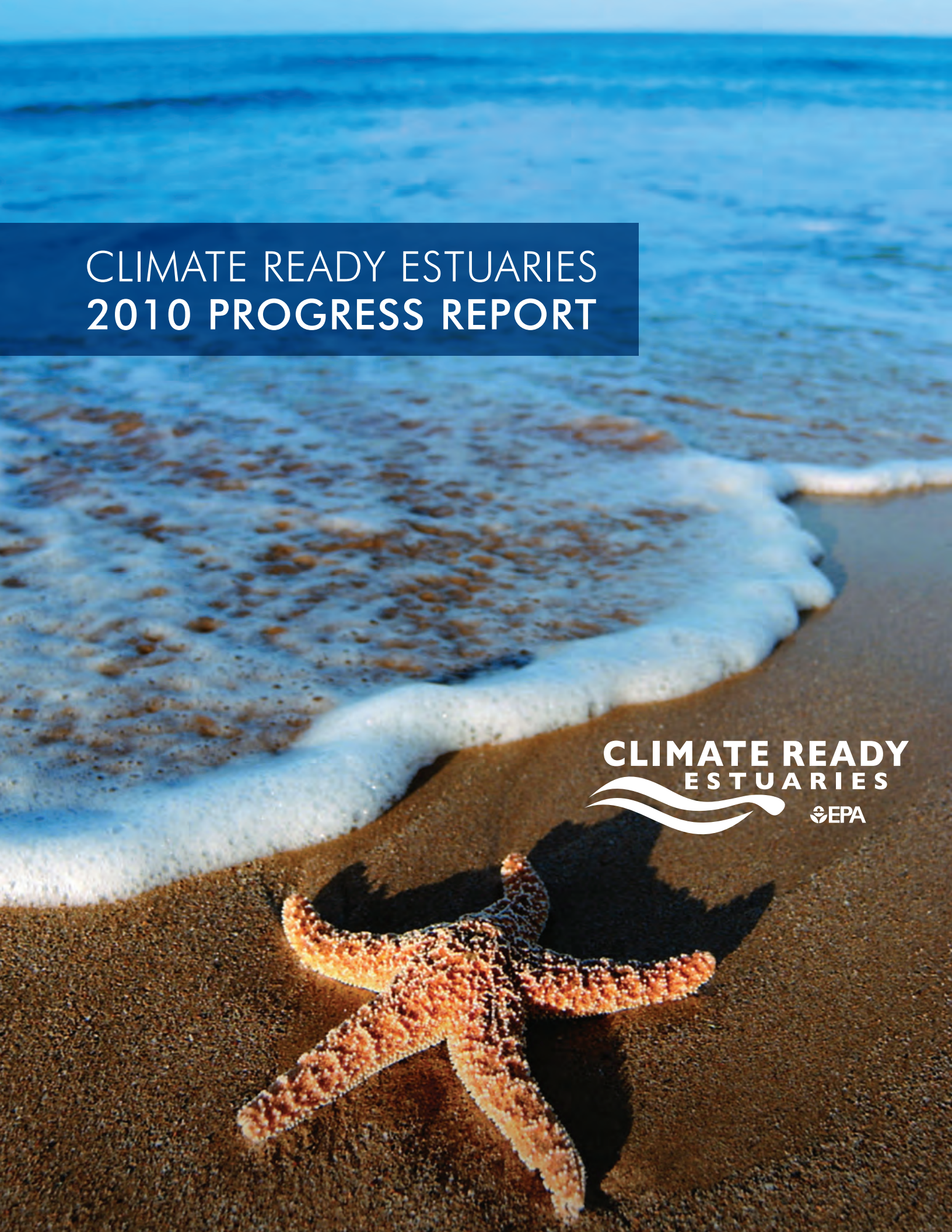
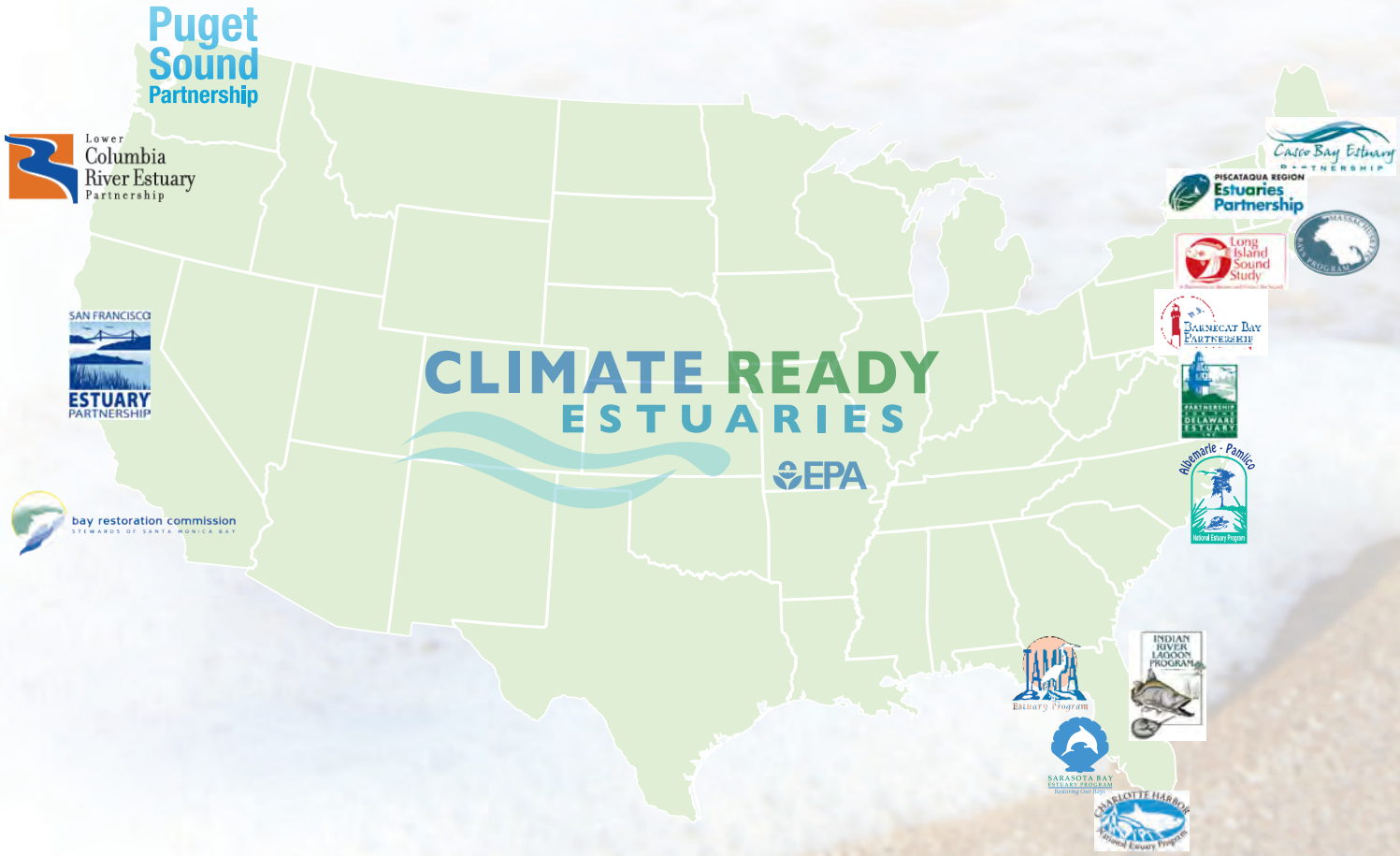
CLIMATE READY ESTUARIES
2010 PROGRESS REPORT



CLIMATE READY ESTUARIES PARTNERS, 2009-2010



Albemarle-Pamlico National Estuary Program (APNEP)

Barnegat Bay Partnership (BBP)

Casco Bay Estuary Partnership (CBEP)

Charlotte Harbor National Estuary Program (CHNEP)

Indian River Lagoon National Estuary Program (IRLNEP)

Long Island Sound Study (LISS)

Lower Columbia River Estuary Partnership (LCREP)

Massachusetts Bays Program (MBP)

Partnership for the Delaware Estuary (PDE)

Piscataqua Region Estuaries Partnership (PREP)

Puget Sound Partnership (PSP)

San Francisco Estuary Partnership (SFEP)

Santa Monica Bay Restoration Commission (SMBRC)

Sarasota Bay Estuary Program (SBEP)

Tampa Bay Estuary Program (TBEP)

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This document may be downloaded from the Climate Ready Estuaries website at:
www.epa.gov/cre/downloads/2010-CRE-Progress-Report.pdf

INTRODUCTION

Estuaries and other coastal systems are particularly vulnerable to many projected effects of climate change, including erosion and land loss from rising seas, altered frequencies and volume of precipitation, and more-intense storm events. These effects will change our coastlines, affecting the people and species that inhabit them. The likelihood of these risks necessitates that actions be taken now to help coastal communities adapt.

Climate Ready Estuaries (CRE) is a partnership between the U.S. Environmental Protection Agency (EPA) and the National Estuary Programs (NEPs) to build capacity among coastal managers to improve the resilience of coastal areas to the impacts of climate change. CRE provides tools and assistance to help NEPs and coastal communities in their efforts to:

- Assess climate change vulnerabilities
- Engage and educate stakeholders
- Develop and implement adaptation strategies
- Share lessons learned with other coastal managers

Accomplishments at a Glance

- Partnered with four new NEPs in 2010
- Distributed more than $450,000 to the Partners through start-up grants, which have been matched 1:1
- Provided more than $850,000 in direct technical assistance to Partners
- Conducted expert elicitation workshops in support of vulnerability assessment efforts for two NEPs
- Developed climate change indicators for two NEPs
- CRE projects continue to be highlighted in domestic and international circles
- Held Partners' workshop in July 2010

This document focuses on the accomplishments of the existing CRE Partners. This report complements the 2009 CRE Progress Report (**http://www.epa.gov/cre/downloads/2009-CRE-Progress-Report.pdf**); together they provide a summary on the design and accomplishments of CRE to date.

Over the past year, CRE and its NEP Partners have become increasingly involved in climate change adaptation efforts across the country and are at the cutting edge of this field. EPA has continued to provide targeted support to NEPs through grants and technical assistance, access to key resources, and tools through the CRE Web site and Coastal Toolkit. EPA has also facilitated collaboration and communication among NEP Partners and other federal, state, regional, and local organizations.

The following "Partner Accomplishments" section presents activities of the 11 NEPs that received start-up grants and/or direct technical assistance in 2008 and 2009. Details on the four new 2010 Partners are provided in the "Planned Partner Activities" section.

CRE Recognition

The White House **Council on Environmental Quality** (CEQ) recognized CRE for its work in helping resource managers to reduce their vulnerability to climate change effects.

The CEQ **Climate Change Adaptation Task Force** released a **Progress Report** outlining progress to date and recommendations of key components to include in a national strategy on climate change adaptation. The purpose of the Task Force is to develop federal recommendations for adapting to climate change impacts both domestically and internationally. CRE was cited as a good example of a federal program helping to facilitate adaptation at the local level.

More information on the Climate Change Adaptation Task Force is available at:
http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation

The Task Force Progress Report is available at:
http://www.whitehouse.gov/sites/default/files/microsites/ceq/Interagency-Climate-Change-Adaptation-Progress-Report.pdf

PARTNER ACCOMPLISHMENTS

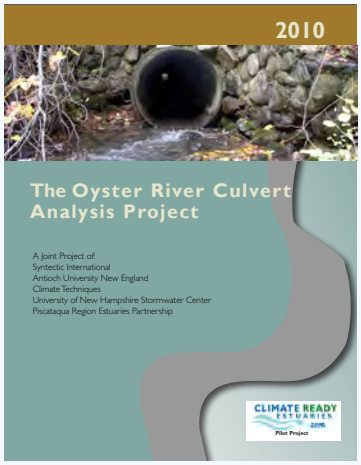
CRE Partners were involved in a variety of climate change adaptation efforts over the past year. Partner projects involved activities related to assessing vulnerability to climate change, engaging key stakeholders, development of climate change indicators and monitoring plans, and adaptation planning. The following section provides detailed descriptions of selected accomplishments for different Partners, organized according to the type of activities.

Vulnerability Assessments

Assessing the vulnerability of an estuary to climate change is an important step in the adaptation planning process. Many CRE Partners have undertaken this step in order to identify habitats and resources of concern.

Piscataqua Region Estuaries Partnership

Ongoing development in New England watersheds has increased the area of impervious surfaces such as roads, roofs, and parking lots, exacerbating run-off. Existing stormwater drainage systems, including under-road culverts, were designed according to old standards that do not account for increasing storm intensity and population growth. In March 2010, the Piscataqua Region Estuaries Partnership (PREP) completed a study (**The Oyster River Culvert Analysis Project**) assessing the capacity of existing road culverts in the Oyster River watershed to convey expected peak flows resulting from several climate change and population growth scenarios. PREP hired a technical team to identify specific road/stream-crossing culverts that might be particularly



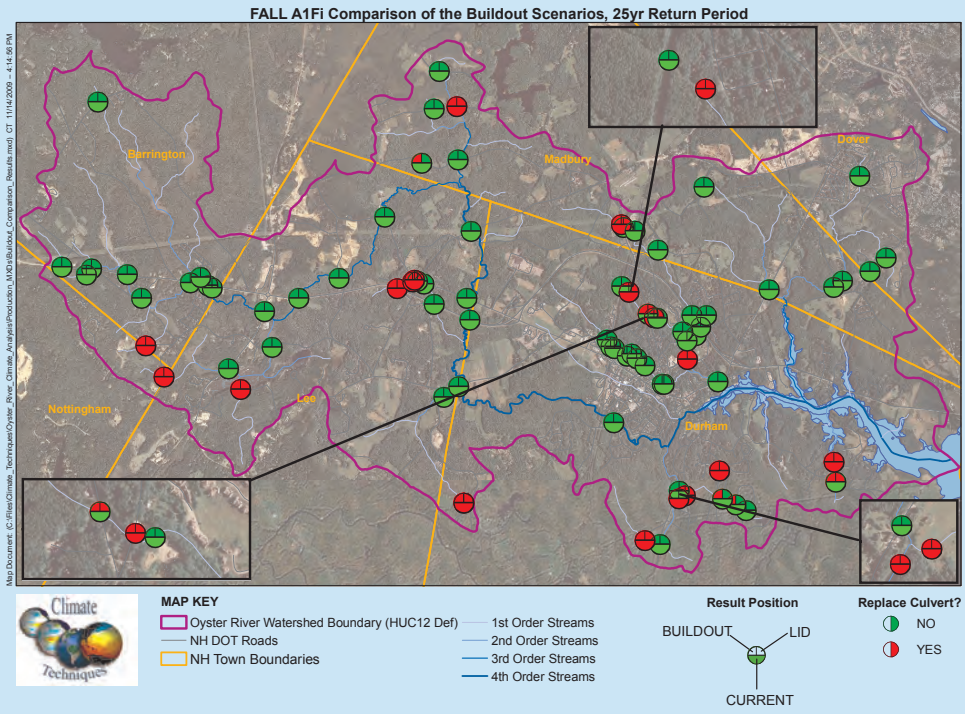
vulnerable to failure under the scenarios. The purpose of the analysis was to provide decision makers with information on how to prioritize culvert replacements and how to update design standards to account for climate change. The project raised awareness among local policy makers about the need to integrate climate change impacts into infrastructure planning, and demonstrated the adaptive potential of low-impact development.

The PREP study used a Geographic Information System (GIS) watershed model to analyze how specific culverts responded to several climate change and land use scenarios. The first step in the methodology was collecting data on culvert capacity, vegetation cover, slope, soils, permeability, roads, and land use. Next, the PREP technical team estimated run-off and peak flow rates under both current and projected precipitation and development patterns. PREP developed several scenarios with different projected development and climate change futures for use in the model. The PREP technical team then reverse-engineered culverts to determine their present capacity and the required capacity for accommodating peak flow in each scenario. Using these data, the team ranked individual culverts according to vulnerability and safety issues in order to provide decision makers with a prioritized schedule for planning culvert upgrades. The team has been communicating these results to transportation officials at state and local levels to inform future planning.

PREP's Oyster River project provides a reliable methodology for coastal communities to identify vulnerable drainage system components. In addition, the analysis demonstrated that implementing low-impact development techniques in the watershed significantly reduces the number of culverts projected to be undersized for future extreme precipitation events.

The PREP vulnerability assessment can be found at:
http://www.prep.unh.edu/resources/pdf/oyster_river_culvert-prep-10.pdf

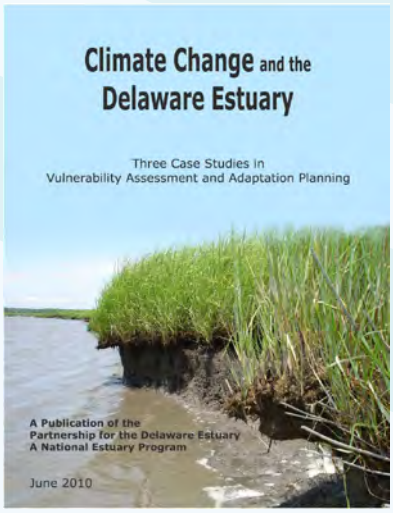
PREP Oyster River Culvert Mapping Analysis



Spatial display of undersized culverts for all land-use scenarios, for the SRES Alfi climate-changed 25-year precipitation.

Partnership for the Delaware Estuary

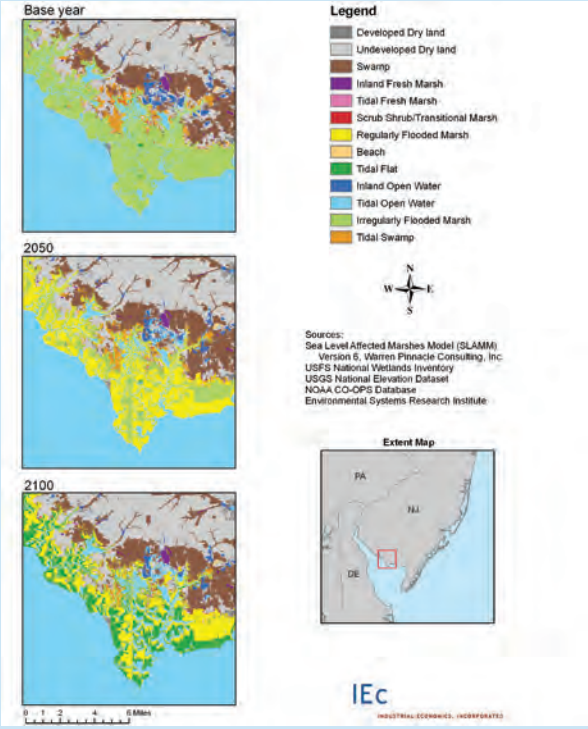
A complex balance of habitats and living resources characterizes the Delaware Estuary watershed. Tidal marsh habitats line much of the estuary and play a pivotal role in preserving water quality, preventing flooding, and supporting fish and wildlife species. However, the health of these tidal marshes appears to be compromised over much of the region, and climate change may worsen existing stressors on the estuary.



In May 2010, the Partnership for the Delaware Estuary (PDE) released **"Climate Change and the Delaware Estuary: Three Case Studies in Vulnerability Assessment and Adaptation Planning,"** a report assessing the vulnerabilities and adaptation options for three key resources in the Delaware Estuary: tidal wetlands, drinking water, and bivalve shellfish. PDE chose to assess the vulnerabilities of these key resources as examples of habitat resources, water resources, and living resources, respectively.

PDE's vulnerability assessment involved three main steps: (1) projecting the Delaware Estuary's future climate (2) assessing how these climate changes will affect natural resources in the estuary and (3) proposing adaptation options to minimize the damages resulting from these impacts. In each of the three case studies, PDE asked experts to identify and prioritize their concerns related to expected changes in climate and to similarly identify and rate adaptation options.

PDE SLAMM Modeling Analysis



The geographical coverage of 13 habitat types (see legend) in an area of southwestern New Jersey at present (1980s NWI data) and as predicted by SLAMM in 2050 and 2100.

PDE obtained up-to-date and locally relevant projections for expected changes in physical and chemical conditions between the present and 2100. Scientists and managers with expertise in each of the three case study resources next identified and ranked their concerns related to these expected changes, and were asked to suggest potential adaptation options. Information for this assessment was gathered in a workshop in September 2008, a climate session at the Delaware Estuary Science Conference in January 2009, in workgroup meetings, and through surveys. PDE conducted a literature review to augment the information contributed by the experts and compiled this information into a concise inventory of potential vulnerabilities and adaptation measures.

Survey methods and a risk assessment approach were then used to gauge relative levels of concern (for vulnerabilities) and effectiveness (for adaptation tactics) by additional resource-specific experts in the broader science and management community. Potential vulnerabilities and adaptation options were then considered in the context of ecosystem goods and services (natural capital).

Photo credit: Katy Maher, ICF International

Tidal wetlands are a unique feature of the Delaware Estuary, which contains the largest freshwater tidal prism in the world. With technical assistance from contracted experts, the Sea Level Affecting Marshes Model (SLAMM) was applied to project how the spatial extent of different coastal habitats will change as sea levels rise (see figure on page 4). In addition to significant acreage losses, PDE expects to see shifts in community species composition, desiccation of marsh sediments, and change in habitat support. To address these vulnerabilities, the case study identified six management tactics as potential adaptation strategies in tidal wetlands: watershed flow management, strategic retreat, structure setbacks, creation of buffer lands, living shorelines, and building dikes, bulkheads, and tide gates.

Water consumption by municipalities, industry, and electric utilities places multiple demands on drinking water supplies in the Delaware River, Bay, and tributaries. Key vulnerabilities for drinking water include saltwater intrusion into aquifers and freshwater habitats, inundation and damage to water infrastructure, and decreased availability in the watershed. The case study found that forest protection in the upper Delaware Basin is the single most important action needed to minimize degradation of drinking water quantity and quality. Building more water storage capacity, such as reservoirs, represents one potential adaptation priority for drinking water. The report also recommended enhanced monitoring and modeling of water resources.

Bivalve shellfish are ecologically important in the Delaware Estuary, and species such as oysters contribute significantly to the local economy. Bivalve populations have been in widespread decline in both the watershed and tidal estuary due to disease, overharvesting, habitat loss, and water quality degradation. Six aspects of bivalve health were examined for vulnerability to climate change: physiological health, reproductive success, change in habitat support, interactions with invasive species, population productivity, and shift in species composition or ranges. The assessment found that while some species may experience longer growing seasons, climate impacts such as changes in salinity, precipitation, and sea level rise are likely to contribute to the decline in many bivalve populations in the region (especially freshwater species). PDE identified several priority adaptation options for shellfish: shell planting for oysters, propagating all bivalves and seeding new reefs/beds, restoring riparian buffers for freshwater mussels, managing water flow to minimize effects of flooding on freshwater mussels and salinity on oysters and freshwater tidal bivalves, and maintaining water quality for all bivalves.

A common thread across the three case studies is the need for increased research and monitoring in order to better understand climate change impacts and their effects on the natural resources and systems

in the Delaware Estuary. Improving data will continue to be a key priority in helping to further adaptation planning. Education was also identified as a key priority through this assessment: education of resource managers and decision makers in particular, but for all stakeholders in the region as well. PDE is currently working on implementing the recommendations in this report.

The PDE vulnerability assessment report can be found at:
http://delawareestuary.org/pdf/Climate/Climate%20Change%20and%20the%20Delaware%20Estuary_PDE-10-01.pdf

Massachusetts Bays Program

The Massachusetts Bays Program (MBP) has been working with EPA's Office of Research and Development (ORD) to conduct an ecological vulnerability assessment with the goal of providing place-based information on the potential implications of climate change for estuarine ecosystems in a form that will enable managers to undertake adaptation planning. An expert elicitation workshop was held in April 2010 to assess the relative effects of climate-stressor interactions on two key salt marsh ecosystem processes using the Jeffrey's Neck Salt Marsh in Ipswich, Massachusetts, as an example location. The processes examined were sediment retention in salt marshes (as it relates to the ability of salt marshes to accrete and migrate inland as sea levels rise) and salt marsh community interactions (with a focus on plant community structure and the nesting habitat of the saltmarsh sharp-tailed sparrow). Experts were divided into two breakout groups to consider each ecosystem process separately.

Photo credit: Jeremy Martinich, U.S. EPA

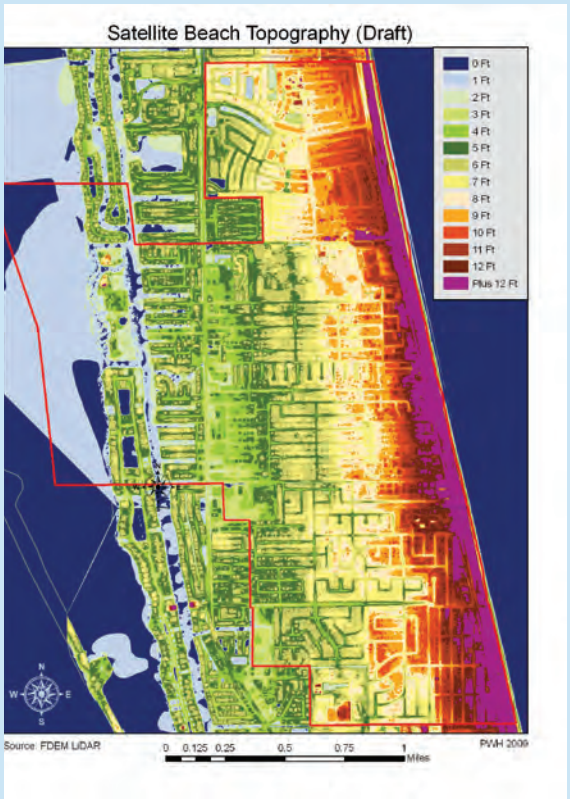
This assessment used a highly structured workshop to improve the understanding of the sensitivity of salt marsh systems across a range of plausible scenarios of climate change in a single, focused setting. The expert elicitation workshop also identified management adaptation strategies that support resilience to the potential impacts of climate change in salt marsh systems, within the context of the uncertainties of timing and intensity. The specific goals were to gather qualitative judgments of the assembled experts regarding (1) the relative influences of physical and ecological variables that regulate each process and are sensitive to climate and human stressors, (2) the relative sensitivities of each process to key stressors under baseline conditions and two future climate change scenarios, and (3) the degree of confidence in judgments about these relationships. Using this information, this project will produce a series of reports that seek to improve the understanding of the sensitivity of particular habitats and ecosystem processes to the projected impacts of climate change, improve the ability to identify adaptation management strategies that mitigate these impacts, and test the applicability of an expert elicitation approach to this type of analysis.

San Francisco Estuary Partnership

The San Francisco Estuary Partnership (SFEP) also collaborated with EPA ORD to conduct an ecological vulnerability assessment, using a process similar to that employed in MBP's assessment. SFEP held an expert elicitation style workshop in March 2010 to assess the vulnerability of ecosystem processes in two estuarine habitats. SFEP decided to focus on sediment retention in salt marshes and community interactions in mudflats. Sediment supply is a key issue in the San Francisco Estuary, as the supply is declining due to changes in land use and water management. Supply of sediment to salt marshes will be an increasingly important priority for the region, especially when considering potential climate change impacts. Similarly, the trophic dynamics of mudflats in the region will be a priority management area, as changing inundation and sediment conditions could affect availability of habitat for key species, such as shorebirds. The results from the MBP and SFEP workshops will inform adaptation planning for both NEPs, and will likely serve as examples for other communities.

Indian River Lagoon NEP

The City of Satellite Beach, Florida, is a prime example of a coastal community at risk from sea level rise. The densely populated City is on a barrier island, and is 98% developed. In order to understand the vulnerabilities the City would face as sea levels rise, Indian River Lagoon NEP (IRLNEP) assisted the City on a project designed to assess municipal vulnerability to rising sea level and initiate the planning process to properly prepare for impacts. The results of this vulnerability assessment are summarized in the report **"Municipal adaptation to sea-level rise: City of Satellite Beach, Florida."** Using a GIS platform, IRLNEP and the City constructed a three-dimensional model of Satellite Beach. To emulate three dimensions, landscape elevation was added to the base map using Light Detection and Ranging (LiDAR) and associated aerial photographs. The assessment also used the LiDAR data to illustrate the cumulative percent of land area as a function of elevation, and to estimate the extent of municipal submergence associated with a particular rise in sea level. The assessment identified critical assets in the City in order to determine which sea level rise scenarios would affect key buildings, facilities, and services.



City of Satellite Beach topography based upon LiDAR data acquired by Florida Division of Emergency Management.

Results indicate submergence of about 5% of the landscape under a 2 ft (0.6 m) rise, 25% under a 4 ft (1.2 m) rise, and 52% under a 6 ft (1.8 m) rise in sea level. The City will work to address these projected impacts through adaptation planning and management. As an initial step, the Comprehensive Planning Advisory Board, a volunteer citizen committee serving as the City's local planning authority, has approved a series of updates and revisions to the City's Comprehensive Plan. If approved by the City Council, the amendments will provide a legal basis for implementing an adaptive management plan and specific actions designed to mitigate the City's vulnerability to sea level rise.

The IRLNEP/City of Satellite Beach vulnerability assessment report is available at:
http://spacecoastclimatechange.com/documents/100730_CSB_CRE_Final_Report.pdf

Lessons Learned From Vulnerability Assessment Efforts

Vulnerability assessments can help to identify key concerns for an estuary and may also assist in identifying information needs. General lessons learned for these efforts include:

- Recognize that non-climate drivers, such as development, pollution, and population growth, often exacerbate climate change vulnerabilities.
- When working with limited data, use readily available scientific best professional judgment to help support decision making. Surveying both local and regional experts and stakeholders can assist in building knowledge, as they have access to some of the most up-to-date information and research.
- Focus on emergency and disaster management, which is one area where NEPs can work with local and state governments to incorporate climate change issues. Vulnerability and risk assessment can help identify areas that need targeted adaptation that also supports and uses emergency planning experts and resources.
- Collaborate with and use local partners, such as universities, non-profits, Sea Grants, and National Estuarine Research Reserves to fill information gaps.
- Determine scope – vulnerability assessments do not necessarily have to be broad in scope. Focusing on the vulnerability of a specific resource, such as horseshoe crabs in the Delaware Estuary or culverts in the Oyster River Watershed, may generate momentum for adaptation.

Stakeholder Engagement

All CRE Partners are involved in some type of stakeholder engagement effort, working to increase communication, outreach, and education on climate change impacts and adaptation. NEPs often focus these efforts on a variety of key audiences, depending on regionally specific needs. In particular, several Partners have been involved with activities targeted toward the general public. These efforts often work to distill and communicate technical information to coastal communities, including information on local climate impacts, risks, and potential adaptation solutions. Stakeholder engagement projects may also be directed toward policy makers or other key decision makers in the community. Some of the activities undertaken by CRE Partners relating to communication, outreach, and education on climate change are described in more detail below.

Barnegat Bay Partnership

The Barnegat Bay Partnership (BBP) has sought a multi-faceted approach to develop a climate adaptation strategy for its estuary. BBP's core CRE goal is to work with its partners to complement and enhance ongoing activities within the State of New Jersey, especially in a way that would engage local and county officials and stakeholders. These activities include assessing local needs and integrating the impacts of climate change and sea level rise into existing planning practices.

BBP and the **Jacques Cousteau National Estuarine Research Reserve (JC NERR)** are assisting the Ocean County Office of Emergency Management in the redrafting of the "Ocean County Multi-Jurisdictional Natural Hazards Mitigation Plan," which is required to ensure public safety from hazards. Approved county and local plans allow access to the Federal Emergency Management Agency (FEMA) and other state and federal funding support.

Photo credit: Martha Maxwell-Doyle, BBP

BBP, in collaboration with JC NERR, the New Jersey Coastal Management Office, and other key agency partners, has been conducting a series of outreach and technical activities. A **"Preparing Your Community in the Face of Climate Change"** conference was co-hosted in April 2010. This conference resulted in an initial assessment of local stakeholder knowledge and support for climate change action. Building on the knowledge gained through the conference, BBP and JC NERR are holding facilitated public listening sessions and have developed a stakeholder survey to assess regional knowledge, attitudes, and interest in local issues related to climate change. NOAA's Coastal Services Center (CSC) has been providing critical technical input and guidance in the development of the public sessions and survey. The survey was administered using Marine Academy of Technology & Environmental Science high school students at BBP's annual Barnegat Bay Festival and more recently in a mass e-mailing to JC NERR's and BBP's contacts.

The partnership with JC NERR enabled BBP to use additional resources and the two organizations to take advantage of their individual strengths. BBP's close relationships with local and regional partners, and its history of building public officials' support for action, paired well with JC NERR's **"Coastal Training Program"** and its strong technical expertise and resources for meeting facilitation and surveys, as well as with the broader sociological and economic expertise from NOAA's CSC. The joint efforts and resources that each organization was able to contribute have stimulated an effective dialogue within the local stakeholder community and the state legislators on climate effects and options for action. The process to complete the county hazard plan is ongoing as consensus builds and better information is developed and disseminated.

Information on the BBP/JC NERR climate change conference is available at:
http://www.jcnerr.org/education/coastaltraining/climatechange_conference.html

Information on the JC NERR Coastal Training Program is available at:
http://www.jcnerr.org/education/coastaltraining/index.html

Albemarle-Pamlico NEP

The diverse populations of inland, coastal, and barrier island residents within the Albemarle-Pamlico Watershed share different perceptions of the effects of sea level rise and population growth in their communities, ranging from limited understanding or knowledge to highly informed of potential impacts on the environment, economy, and culture. The Albemarle-Pamlico NEP (APNEP) set out to understand the range of perceptions about how climate change and sea level rise will affect the estuary, and test ideas for effective outreach to different communities. The Albemarle-Pamlico Conservation and Communities Collaborative (AP3C), in partnership with APNEP, hosted seven public listening sessions to hear residents' concerns about sea level rise and population growth, elicit their ideas about solutions, and provide recommendations to improve future public outreach and education projects.

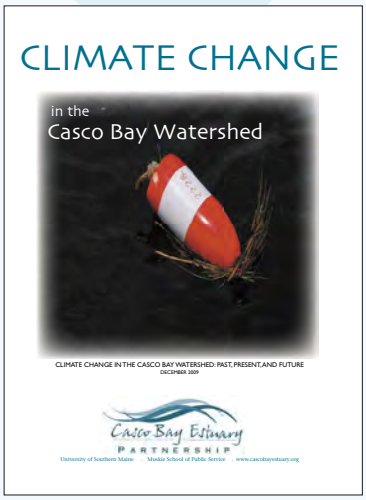
More than 100 residents attended the sessions, representing a broad array of backgrounds and knowledge about the issues. AP3C and APNEP produced a report, **"Public Listening Sessions: Sea Level Rise and Population Growth in North Carolina,"** describing the design, findings, and recommendations from the sessions. Their principal recommendations address three issues: (1) outreach, (2) working with local officials, and (3) addressing sea level rise impacts in the watershed. The report recommends training outreach volunteers how to communicate the issues' importance to coastal plain residents, providing additional volunteers to allow for more direct access (especially to community and elected officials), and selecting outreach volunteers with more capacity and resources (including stipends) to do the outreach. Very few local officials attended the sessions, and participants highlighted the need to provide education to local officials on the impacts of sea level rise and engage local officials in discourse with the public on these issues. Developing informal and effective mechanisms to present sea level rise and coastal flooding maps to local officials would be an important step in engaging that audience. Addressing sea level rise impacts will require action in a number of areas, though APNEP can provide particular assistance in education and outreach to various audiences. Key audiences that will be important to address include underprivileged communities, local officials, schools, and coastal communities. AP3C and APNEP concluded that future outreach efforts should include a more detailed presentation and discussion of the sea level rise issue.

The listening sessions report also suggested several next steps: (1) provide job training to residents of the coastal plain, in particular targeting lower income residents, to provide skills to build green infrastructure and provide other sea level rise adaptation services; (2) provide contracting and certification assistance to coastal plain residents, so that they can access state and federal funds for sea level rise adaptation and mitigation projects; and (3) promote incentive programs to pay coastal residents, in particular farmers, for managing their land in a way that allows for wetlands to migrate inland.

The report on the APNEP listening sessions is available at:
http://www.apnep.org/pages/PublicListeningSessionsReport.pdf

Casco Bay Estuary Partnership

The Casco Bay Estuary Partnership (CBEP) identified a critical unmet need in the Casco Bay watershed to deliver reliable and useful information about climate change and its effects on natural resources to key local decision makers. Informal discussions with CBEP partners, especially those involved with local government and community planning, suggested that key decisions are often made without any awareness of long-term implications with respect to climate change.



CBEP has produced a report, **"Climate Change in the Casco Bay Watershed: Past, Present, and Future,"** that describes climate change projections for the Casco Bay region. As a scientific resource for local citizens and officials, this report describes how the climate of Casco Bay's watershed has changed over the past century and is likely to change in the future. CBEP has also worked to identify related adaptation efforts underway in the region and the state.

To build local support for adaptation, CBEP set out to develop a climate change stakeholder outreach plan targeting local decision makers and integrating consideration of ecosystem resilience into broader messages about climate change. These outreach and stakeholder engagement efforts will help inform the development of a climate change adaptation plan for the estuary. Many Maine organizations and agencies are already engaged in efforts to spur local decision makers to take climate change into consideration in their day-to-day and long-term planning. CBEP thus sought to identify the estuary's unique "niche" in adaptation outreach. CBEP met with stakeholders and spoke with members of potential target audiences to define information needs and evaluate best pathways for communication on climate change adaptation.


Photo credit: Katy Maher, ICF International

CBEP identified two key audiences for targeted outreach efforts: the land conservation community and the water resources and water infrastructure communities. Both audiences have been introduced to climate issues via professional organizations and other sources, but CBEP realized that practical efforts to incorporate

climate change into their operations had hardly begun. Many land trusts are small, largely volunteer-led organizations with limited planning capacity. Similar constraints exist within the water resources and water infrastructure communities, where key decisions about water resources are often made with little time by municipal staff to think about the long term.

Subsequent efforts will focus on working with these communities to integrate awareness of projected changes in climate into their activities. This process entails: (1) creating networks within the two main target audiences, (2) creating communication mechanisms to sustain those networks into the future, and (3) developing and communicating approaches to climate planning that are feasible for small organizations.

CBEP plans to host a facilitated meeting for each target audience. The goal of the meetings will be to begin building, for each target audience, a community that will work together to address vulnerabilities to climate change and to allow that community to identify its own needs and strategies. The meetings will provide an opportunity for CBEP to begin delivering some of its key messages to each audience, while at the same time providing an opportunity for the members of the land conservation and water resources communities to communicate to CBEP what information or resources they need in order to adapt to climate change.

The CBEP climate change report can be found at:
http://www.cascobay.usm.maine.edu/pdfs/climate_change_in_casco_bay.pdf

Other Stakeholder Engagement Efforts


Photo credit: Katy Maher, ICF International

Charlotte Harbor NEP (CHNEP) conducted several public workshops using interactive exercises to engage the public in helping to consider and prioritize vulnerabilities and adaptation strategies. The outcomes of these workshops informed the development of the Punta Gorda Adaptation Plan. The Long Island Sound Study (LISS) similarly supported a series of workshops to discuss local climate change vulnerability and options for improving resilience in order to develop an adaptation plan for the Town of Groton, Connecticut. Both of these efforts are described in more detail in the Adaptation Planning section.

Expert elicitation workshops held by MBP and SFEP brought together regional experts to examine key ecosystem vulnerabilities under climate change scenarios. PDE engaged scientists and managers to identify and prioritize their concerns related to expected changes in physical conditions for resources of concern. Further details on the MBP, SFEP, and PDE efforts are provided in the Vulnerability Assessments section.

The Tampa Bay Estuary Program (TBEP) reached out to key stakeholders to determine information needs in order to develop a handbook for Gulf Coast communities to assist in incorporating climate change effects into habitat restoration and protection. As a new 2010 Partner, the Sarasota Bay Estuary Program (SBEP) is developing a visualization tool to help educate stakeholders and the public about sea level rise risks and preparing best practice approaches to goals, objectives, and policy options for sea level rise adaptation planning.

Lessons Learned From Stakeholder Engagement Efforts

Each CRE Partner that has undertaken stakeholder engagement activities has developed its own lessons learned on locally specific issues and key audiences. General lessons learned for these efforts include:

- Leverage existing efforts. Some regions have many different organizations already working on climate change and adaptation, including work on acquiring data/information, stakeholder engagement, and education/outreach. Several NEPs have learned the value in leveraging these existing activities and organizations through partnerships and division of labor on different efforts.
- Focus on local issues. It can be more effective to communicate about local impacts to communities (e.g., flooding, drought) rather than tackling the broader issue of climate change. Presenting local evidence of climate change (e.g., changes in seasonal events or animal behavior, local projections of wetland loss) to local officials and the general public is often a useful approach to build support for adaptation.
- Link climate change adaptation messages to clean water supply and stormwater drainage. This can be an effective way to engage local decision makers, as constituents are increasingly concerned about these issues.
- Target entities most responsible for construction and maintenance of public infrastructure (e.g., municipalities, counties or regional authorities) first to encourage greater willingness to engage on the impacts of sea level rise due to the significant fiscal implication of infrastructure loss or damage.
- Conduct meetings or phone calls with key stakeholders to help identify what stakeholders are already working on and their key needs for undertaking climate change adaptation. For some NEPs, these meetings revealed that stakeholders need specific targeted technical assistance on adaptation techniques rather than data or information on impacts.

Climate Change Indicators and Monitoring

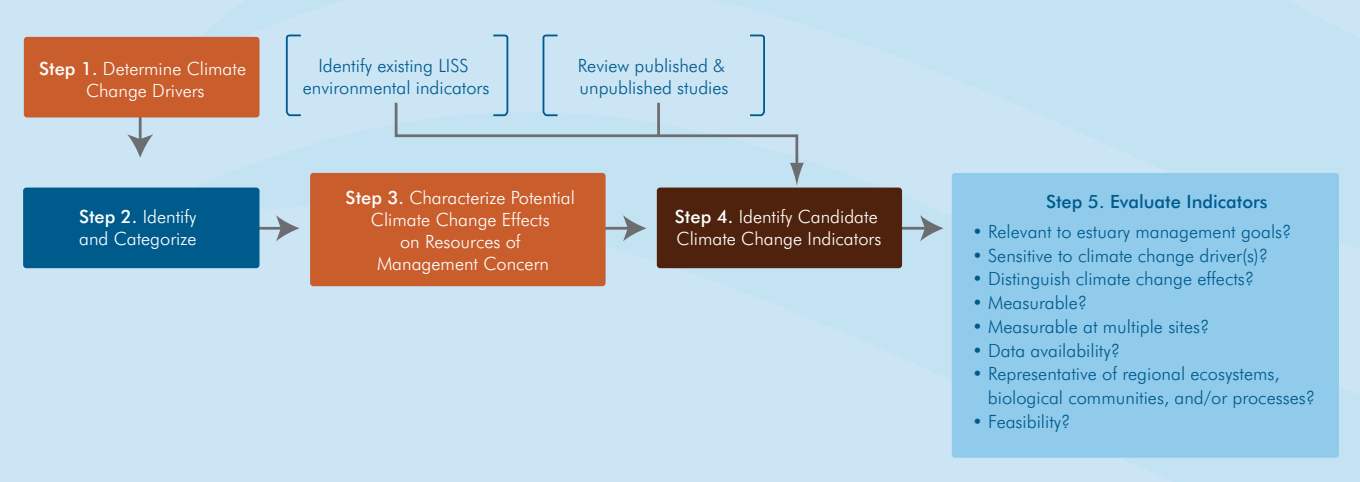
Several NEPs focused their efforts on the development of climate change indicators and monitoring strategies. The purpose of climate change indicators is to measure the effects of natural and manmade stressors on a system and to convey scientific information on the current status of conditions and on changes and trends in these conditions over time.

Long Island Sound Study

In order to better understand current and future changes in the region, LISS determined that a key first step was to develop a set of climate change indicators and a plan for monitoring those changes. The NEP recognized early on that developing the capacity to track these changes would be critical for the success of future adaptation strategies.

LISS worked to develop a systematic process for identifying and evaluating candidate indicators, in which it considered the lessons learned from other programs and consulted a number of documents that provide recommendations for developing environmental indicators. Most of these documents present some form of

the pressure-state-response framework for selecting indicators, which LISS adapted for use in developing a list of climate change indicators. The five-step process that LISS undertook for indicator identification and evaluation is illustrated in the flow chart below.



LISS is now working with technical committees in Connecticut and New York to prioritize the list of indicators identified through this process, test pilot indicators, and, in the longer term, establish a Long-Island-Sound-wide monitoring network.

Charlotte Harbor NEP

To build upon climate change and disaster preparedness work already underway by the Southwest Florida Regional Planning Council (SWFRPC), CHNEP worked to develop information to better enable federal, state, regional, and local agencies to plan for future climate change impacts to coastal resources and communities.

CHNEP set out to develop a list of three to five climate change indicators for its estuary and a monitoring plan to measure changes in those indicators. CHNEP sought to build on its previous work to address climate change (including a **vulnerability assessment**) and incorporate climate indicators into its ongoing monitoring efforts. The climate change indicator selection process began with the development of a large list of potential indicators, many of which were conceived as part of ongoing environmental indicator development efforts in Charlotte Harbor.

CHNEP then created a survey to facilitate stakeholder evaluation of this broad list of 172 indicators. The survey asked stakeholders to rank individual indicators on a scale of relevance to climate change (highly relevant, relevant, of interest, not relevant, or not enough information to know). The survey results and a CHNEP sub-committee helped to narrow the list of candidate indicators down to 18. CHNEP Policy Committee and Management Committee members were asked to complete a second survey to further narrow the list to five climate change indicators, which resulted in the following proposed indicators: changes in precipitation patterns, sea level rise, water temperature, phenology, and coastal erosion rates. The NEP then developed short summaries describing the indicator, the available data products, data gaps, and targets for each of these five indicators.

In fall 2010, the CHNEP Management Committee approved five climate change indicators: changes to precipitation trend/patterns, including extreme precipitation; sea level rise; water temperature; phenology; and habitat migration.

The CHNEP environmental indicators report is available at:
http://www.chnep.org/projects/climate/ClimateChangeIndicatorclimateaddendum_10-25-10.pdf

The CHNEP vulnerability assessment reports are available at:
http://www.chnep.org/projects/climate/VulnerabilityAssessment2-19-10.pdf

http://www.chnep.org/projects/climate/ClimateChangeVulnerabilityAssessment.pdf

Lessons Learned From Climate Change Indicators and Monitoring Efforts

Photo credit: Jeremy Martinich, U.S. EPA

The development of climate change indicators for estuaries is still an evolving field, but there have already been a number of lessons learned from the CRE Partners:

- Identify desired climate change information outputs prior to the beginning of the indicator selection process. For example, determine whether any outreach materials will be needed to communicate information on indicators, or how indicators will need to be incorporated into different types of management documents.
- Consider conducting a climate change vulnerability assessment prior to developing climate change indicators. A vulnerability assessment may be useful in order to ensure that the candidate list of indicators is comprehensive and to identify variables that are indicative of consequences rather than drivers.
- Explore the development of conceptual ecological models (CEMs) of climate change prior to developing indicators. CEMs are an excellent way to organize thought and visually portray complex relationships. CEMs are organized in a hierarchical way among drivers, stressors, ecological effects, key attributes, and measures. The measures point the way to key indicators of climate change.
- Draw up a universe of candidate indicators from which to consider. Identify any factors that are uncertain (such as the direct tie to climate change or available monitoring), as these factors will be important to consider later. Additional candidates can be added to the list as the process evolves.
- Obtain as much public and scientific input as possible on selecting a subset of indicators for more intense review. Citizens will help to keep the list relevant to public interests.
- Recognize that regional efforts that cross state lines often require additional involvement from government agencies and other key stakeholders. The involvement of key local, state, and regional organizations is important during the initial stages of any indicator development process.

Adaptation Planning

Coastal resource managers can reduce climate change risks and improve resilience by developing and implementing adaptation plans. Adaptation plans are linked to management goals detailed in each NEP's Comprehensive Conservation and Management Plan (CCMP), such as maintaining water quality of marshes and wetlands, protecting coastal development, preserving habitat, or controlling invasive species

Long Island Sound Study

LISS was interested in promoting local efforts to prepare and implement coastal adaptation plans in communities along Long Island Sound. In particular, the NEP wanted to better understand the division of responsibilities between federal, state, local, and private sector groups to more effectively involve and respond to the needs of different parts of the community.

Photo credit: Mark Parker, Connecticut DEP

LISS, **ICLEI-Local Governments for Sustainability**, the Town of Groton, Connecticut, and the **Connecticut Department of Environmental Protection (DEP)** supported **three workshops** to train and educate government officials at all levels for climate change adaptation in a small city. LISS, ICLEI, and Connecticut DEP formed a partnership with the Town of Groton to develop a climate adaptation plan. The effort was designed to complement the Town's ongoing sustainability and development planning and to engage representatives from federal, state, and municipal governments in adaptation planning. The workshops were intended to identify and gain local support for the specific steps that Groton (or a similar city) would need to take to adapt to climate change and clarify roles of citizens as well as local, state, and federal levels of government to implement the plan. The workshops were also designed to test how stakeholders would respond to various presentations from local and national technical experts and planners, as a potential model for other local governments and adaptation initiatives.

The first workshop was held in January 2010 and included eight presentations on projected climate change impacts to the Connecticut coast, coastal hazards, and adaptation responses at local and state levels. The second workshop in March included four presentations on vulnerabilities and the potential costs of taking "no action" versus adaptation actions. It concluded with a guided discussion on selecting adaptation actions for Groton. The final workshop in June featured presentations on the comparative costs of adaptation based on ideas generated at the earlier workshop, and a summary of next steps for developing the plan. The workshops generated several overall conclusions including:

- Local acceptance of climate change science and general comfort with the existing model projections was sufficient for planning actions.
- Horizontal communication within agencies at various levels—for example, between EPA headquarters and regional offices—was even more of a need than vertical communication between government levels.
- State agencies can provide support to adaptation efforts in addition to helping obtain federal and local support. For example, Connecticut completed a state park vulnerability assessment, formed an Office of Long Island Sound Programs Climate Change Group, and succeeded in involving the Department of Transportation in ongoing efforts at the state level.
- Additional broad-application tools are needed and will be developed, including an Adaptation Resource Toolkit.

Local officials in Groton have agreed to continue the work, and have initiated several actions recommended from the workshops:

- Develop zoning to incentivize development away from coastal hazards.
- Use preliminary risk assessment to identify impacts to specific asset sectors.
- Pursue additional resources and relationships to support future planning from non-governmental organizations (e.g., ICLEI) and state (e.g., Connecticut Department of Transportation) and federal agencies (e.g., Department of Energy).
- Use the Plan of Conservation and Development (Connecticut's 10-year comprehensive plan update) to incorporate "Themes for Resilience" that address climate adaptation.
- Raise public awareness of flood-prone areas as part of the FEMA digital mapping update and complete an outreach strategy for notifications to affected properties.
- Pursue inclusion of adaptation curriculum in schools and review school sites in light of adaptation issues.
- Engage scientific and conservation organizations, such as The Nature Conservancy, that are working on similar efforts.

Information on the three Groton workshops is available at:
http://www.icleiusa.org/action-center/planning/climate-adaptation-planning-resources/groton-connecticut-coastal-climate-adaptation-workshop-presentations

Charlotte Harbor NEP

CHNEP worked in cooperation with SWFRPC to develop an adaptation plan for the City of Punta Gorda, Florida. The City of Punta Gorda was heavily affected by Hurricane Charley in 2004, which highlighted the importance of examining key vulnerabilities and priorities for future planning. The City of Punta Gorda adopted language in its **Comprehensive Plan** to address these issues in the **Conservation and Coastal Management Element**. Specifically:

- Objective 2.4.2: Address the impact of sea level rise, and seek strategies to combat its effects on the shoreline of the City.
- Policy 2.4.2.1: The City will work with SWFRPC to determine the potential sea level rise impacts on the Coastal Planning Area.
- Measurement: Completion and implementation of developed coastal studies or development of model scenarios.

The **City of Punta Gorda Adaptation Plan** was subsequently developed to meet the objectives laid out in the Comprehensive Plan. CHNEP invited residents and others concerned with issues faced by the City to help prepare recommendations to respond to changes in the climate using innovative and creative workshops and online surveys. The City approved the adaptation plan in November 2009; however, additional steps were needed to implement that plan. The City wanted to ensure continued implementation of the plan and engage other southwest Florida communities in adaptation planning. This involved linking CHNEP into other state, regional, and local planning efforts on climate change. As a result of the Adaptation Plan, the City committed to incorporating the adaptation strategies into the Florida state process known as the Evaluation and Appraisal Report, which it will complete in 2011.

CHNEP and the City of Punta Gorda worked with the University of Florida (UF) Levin College of Law to develop specific comprehensive plan language to address climate change adaptation. UF students and their professors drafted the language, CHNEP ensured that the language incorporated findings from their previous adaptation work, and the City ensured that the language was practical from its perspective. CHNEP followed up by hosting a **workshop** to educate urban planners about the comprehensive plan language on climate change, strategies such as rolling easements, and new Florida legislation regarding energy efficiency. Planners received an incentive to attend, in the form of certification maintenance credits offered by the American Institute of Certified Planners.

Neighboring Lee County has expressed interest in building on the Punta Gorda Adaptation Plan example, and in January 2010 contracted the SWFRPC to develop the "Lee County Climate Change Resiliency Strategy," which will identify potential climate change resilience strategies through coordination and consultation with local government leadership in 39 Lee County departments and divisions. Finally, CHNEP continues to partner with its host agency, the SWFRPC, to seek funds to develop a Resiliency Strategy template for the region.

The CHNEP vulnerability assessment reports are available at:
http://www.chnep.org/projects/climate/VulnerabilityAssessment2-19-10.pdf

http://www.chnep.org/projects/climate/ClimateChangeVulnerabilityAssessment.pdf

The City of Punta Gorda Adaptation Plan is available at:
http://www.chnep.org/projects/climate/PuntaGordaAdaptationPlan.pdf

The workshop agenda with the presentations, including the model language, is available at:
http://www.chnep.org/projects/climate/CRE%20Comp%20Plan-Ordinance%20Workshop.htm

Lessons Learned From Adaptation Planning Efforts

Adaptation plans may contain a wide range of adaptation actions that are designed to reduce adverse impacts or exploit beneficial opportunities resulting from climate change. Adaptation planning efforts require coordination and collaboration at many levels. Lessons learned from the CRE Partners include:

- Start small. Demonstrating assessment and planning in one innovative community can generate interest to replicate and build on the effort for a much larger region.
- Build adaptation planning into other local, state, and/or federal planning efforts, in order to:
    - Ensure that climate change planning becomes a part of routine activities that public officials and citizens already support, and
    - Bring more resources to the effort and more easily achieve consensus.
- Incorporate adaptation into restoration efforts already underway. This may be a key management option for reducing vulnerability to future climate change impacts.
- Recognize that small steps do lead to future progress. Initiation of a climate adaptation process in one place will tend to generate interest and other financial and technical support, often from unlikely sources.
- Practice adaptive management. As new partners join and support fledgling adaptation efforts, process managers may have to adapt the initial scope and content of their work; often expanding and refocusing the overall effort to incorporate the interests of these new partners and to ensure their support for adaptation.

PLANNED PARTNER ACTIVITIES

In 2010, EPA provided technical assistance and funding for adaptation planning via grant amendments to seven NEPs, including CHNEP, IRLNEP, LISS, SBEP, Santa Monica Bay Restoration Commission (SMBRC), Lower Columbia River Estuary Partnership (LCREP), and Puget Sound Partnership (PSP). Four of these seven NEPs are new to CRE, and are undertaking the following activities:

Lower Columbia River Estuary Partnership

LCREP is incorporating climate change into the estuary program's CCMP to guide climate change adaptation efforts and identify strategies to facilitate implementation.

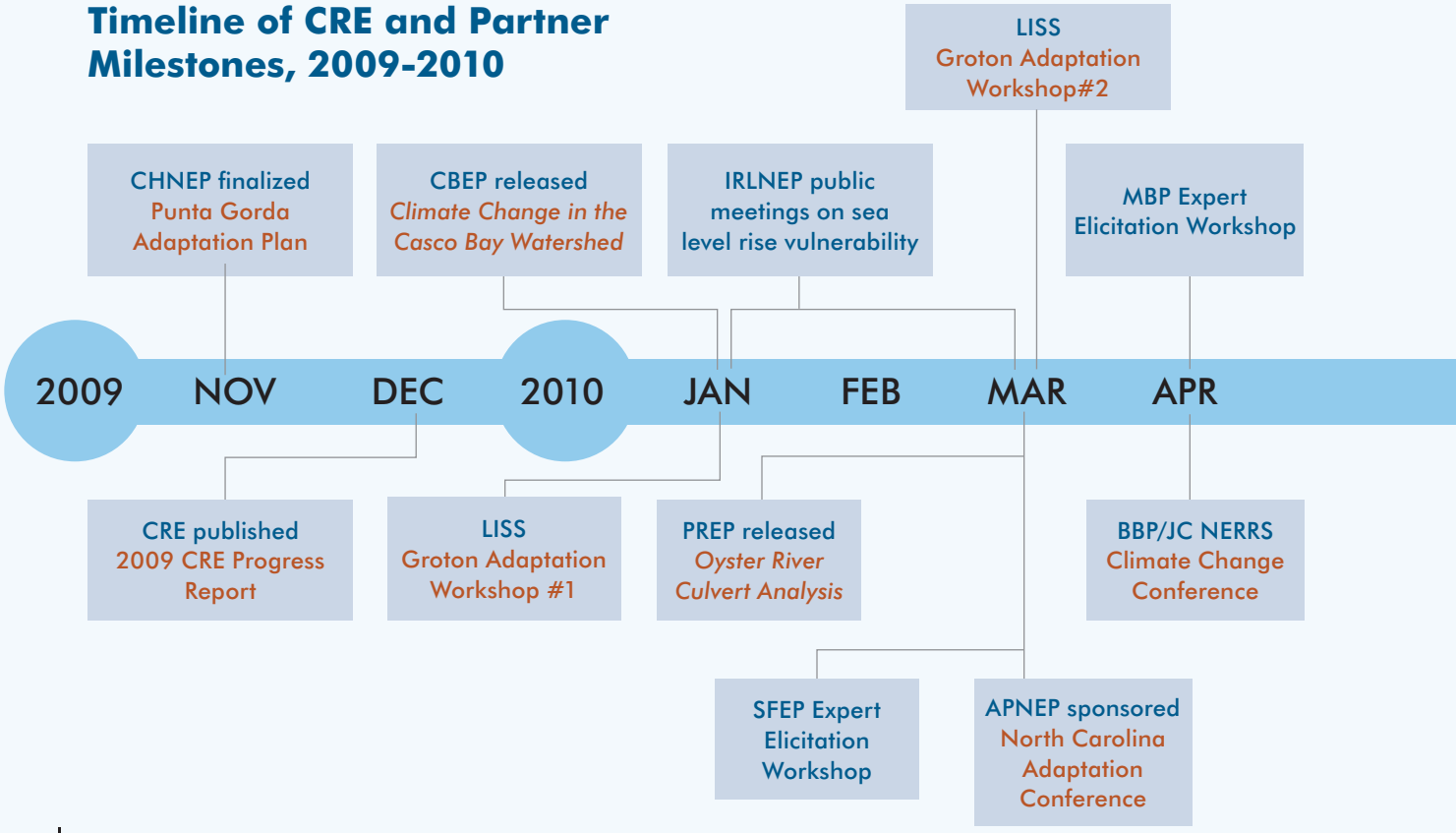
PugetSoundPartnership
our sound, our community, our chance

PSP is incorporating climate change adaptation needs into the Puget Sound 2020 Action Agenda strategies and near-term actions that guide regional recovery activities. PSP is also planning to develop adaptation guidance for habitat restoration projects and identify climate change indicators for its regional monitoring program.

bay restoration commission
STEWARDS OF SANTA MONICA BAY

SMBRC is investigating the vulnerability of local wetlands to sea level rise, as well as impacts of precipitation change on the hydrological regime of the wetland and the watershed. The results of this investigation will inform wetland and watershed managers' decision making and will be incorporated into the Los Angeles Regional Collaborative for Climate Action and Sustainability climate action plan.

Timeline of CRE and Partner Milestones, 2009-2010

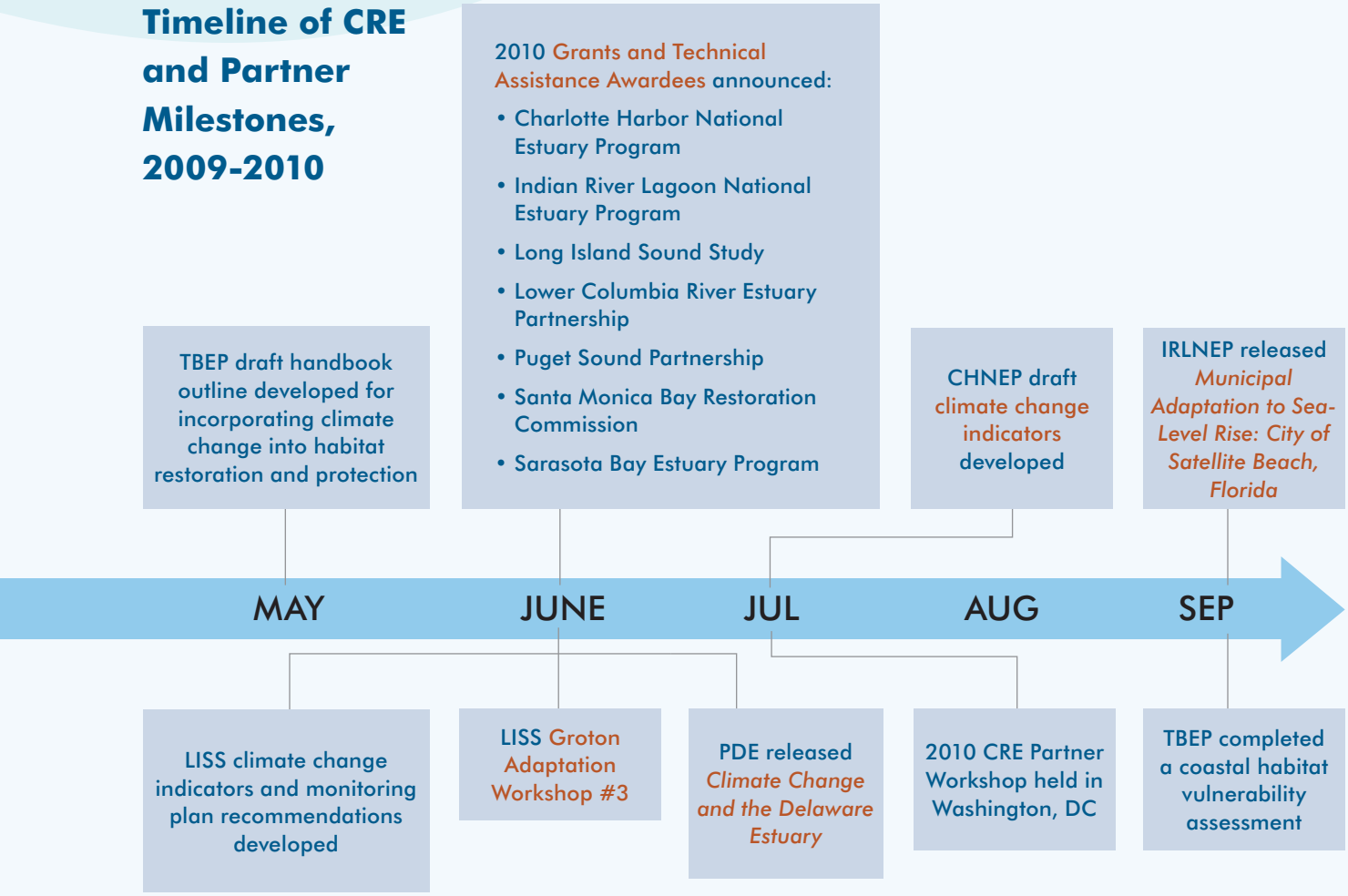


SARASOTA BAY ESTUARY PROGRAM
Restoring Our Bays

SBEP is developing a sea level rise and storm surge visualization tool for Sarasota and Manatee counties to enhance public and stakeholder outreach and education efforts. Working with Mote Marine Laboratory, SBEP will also develop an adaptation plan that supports updates to local comprehensive plans for integrating adaptation strategies.

The existing CRE partners receiving funding for 2010 are undertaking projects that aim to implement adaptation based on previously conducted vulnerability assessments and other work. For example, CHNEP will work to develop conceptual ecological models to help bridge the gap between vulnerability assessments and adaptation plans, moving toward the goal of implementing adaptation strategies on the ground. IRLNEP is applying SLAMM to project losses and gains in coastal habitat types in comparison with baseline conditions. This information will inform future land-use and conservation plans. LISS will create an adaptation toolkit for municipal governments to inform adaptation efforts and to follow up on recommendations from work performed in 2009.

Timeline of CRE and Partner Milestones, 2009-2010



CRE PARTNER WEBSITES

Albemarle-Pamlico National Estuary Program	http://www.apnep.org/
Barnegat Bay Partnership	http://bbp.ocean.edu/
Casco Bay Estuary Partnership	http://www.cascobay.usm.maine.edu/
Charlotte Harbor National Estuary Program	http://www.chnep.org/
Indian River Lagoon National Estuary Program	http://www.sjrwmd.com/itsyourlagoon/index.html
Long Island Sound Study	http://www.longislandsoundstudy.net/
Lower Columbia River Estuary Partnership	http://www.lcrep.org
Massachusetts Bays Program	http://www.mass.gov/envir/massbays/
Partnership for the Delaware Estuary	http://www.delawareestuary.org/
Piscataqua Region Estuaries Partnership	http://www.prep.unh.edu/
Puget Sound Partnership	http://www.psp.wa.gov/
San Francisco Estuary Partnership	http://www.sfestuary.org/
Santa Monica Bay Restoration Commission	http://www.santamonicabay.org/smbay/
Sarasota Bay Estuary Program	http://www.sarasotabay.org/
Tampa Bay Estuary Program	http://www.tbep.org/

For more information on CRE, please visit our website: www.epa.gov/cre

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CLIMATE READY ESTUARIES

EPA

Office of Air and Radiation
Office of Water
EPA 430-R-10-012
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