

1ST ANNUAL CAPE COASTAL CONFERENCE

JUNE 13-14, 2013

**STATE OF THE CAPE:  
CHANGING WATERS & SHORELINES**

**BOOK OF ABSTRACTS**

# **CONFERENCE PLANNING TEAM**

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**Waquoit Bay National Estuarine Research Reserve**

**Judith McDowell, Director**  
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**Erin Jackson, Special Projects Coordinator**  
**Cape Cod Commission**

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**Massachusetts Office of Coastal Zone Management**

## *Day 1 - Thursday, June 13*

### **State of the Cape's Bays and Estuaries: Threats and Impacts to Coastal Ecosystem Health**

**Dr. Chris Neill, Director, Ecosystems Center, Marine Biological Laboratory**

Water quality and the ecological health in the estuaries and coastal bays of Cape Cod have been declining for many decades. Studies conducted in Woods Hole and elsewhere have identified increasing amounts of dissolved nitrogen from coastal watersheds as the primary driver of this decline. Because nitrogen limits the production of algae in saline coastal waters, increased nitrogen loads cause a series of events that include increased growth of phytoplankton, attached and free living macroalgae; increased turbidity; more frequent hypoxic events; decreased growth and eventual elimination of native eelgrass; and loss of the fish and shellfish that depend on eelgrass as nursery habitat. New evidence also indicates that chronic nitrogen inputs can damage salt marshes, which stabilize coastlines and provide additional nursery habitat and scenic values. Long-term trends in water quality have been documented by widespread and high-quality monitoring carried out by citizen volunteers in collaboration with local universities and non-profit groups. Watershed models show that atmospheric deposition, fertilizer, and nitrogen originating from septic systems (which make up more than 90 percent of wastewater treatment on Cape Cod) are the dominant sources of inputs to coastal waters. Models also show that restoring estuaries to conditions that existed before widespread loss of eelgrass will require removal of high proportions (>70 percent in most cases) of nitrogen inputs. Because fertilizer makes up a small proportion of total nitrogen inputs (in the range of about 10 percent) and because the bulk of atmospheric inputs cannot be controlled locally, strategies to achieve large reductions in nitrogen inputs from wastewater have been the subject of most local remediation and restoration efforts. Evidence from the New England region indicates that dramatic reductions in nitrogen inputs to coastal waters will restore water quality and rebuild ecosystem functions lost from nitrogen pollution. The current state of watershed science on Cape Cod provides a very strong and reliable framework for understanding declines in ecosystem functions and guiding restoration efforts. Both the designing of future restoration projects as experiments and the careful and long-term monitoring of restoration efforts will have great value for maximizing restoration while minimizing costs.

### **State of the Cape's Ponds: What Have We Learned through the Ponds and Lakes Stewardship (PALS) Program?**

**Ed Eichner, Senior Water Scientist, School for Marine Science & Technology, UMASS-Dartmouth**

Cape Cod has approximately 1,000 ponds. These ponds provide a host of community and environmental services ranging from recreational activities like swimming, fishing, and boating, to natural nitrogen attenuation protecting our estuaries. Management of these resources and their services, however, has generally been inadvertent and ad hoc, focused on individual components rather than holistic or integrated management strategies. Development of the Cape Cod Pond and Lake Stewards (PALS) Program over 10 years ago began the process of understanding the resources and has created momentum and attention to actively address their management in selected towns, but challenges remain ahead to integrate this management into the current discussions of changes in wastewater management and TMDLs.

## **Cape Cod Wetlands: Challenges and Opportunities**

**Jeremy Bell, Restoration Specialist, MA DFG Department of Ecological Restoration**

Our understanding of wetlands habitats is becoming increasingly complex, and so are the ecological problems facing them. The importance of wetlands will be described, followed by a discussion of the major stressors as well as opportunities to reduce the impact of those stressors for both ecological and economic benefits.

## **Water Quality Assessment of River Herring Spawning and Nursery Habitat**

**Brad Chase, Senior Marine Fisheries Biologist, MA Division of Marine Fisheries**

Water resources are deeply connected to the economic health of Cape Cod through vital uses for municipal water supply, recreation, wastewater management, and supporting aquatic life. The importance of supporting aquatic life makes sense to us all, but impacts are not easy to identify and manifest slowly in the public eye. River herring are a species of sea-run or diadromous fish that have experienced widespread reductions in New England with poor documentation of population trends and limited understanding of the causal factors. River herring require adequate freshwater habitat, in terms of quality and quantity, to complete their life history as they migrate from the ocean to spawn in coastal water bodies. Watershed alterations and the ensuing degradation of river herring spawning, nursery and migratory habitat is a suspected contributor to the declining health of fish runs.

Following the decline in river herring populations, public interest is growing to restoring these traditional and popular fish runs. Recent restoration efforts have focused on structural solutions to migration impediments, but less guidance is available on the role water and habitat quality have in restoring anadromous fish habitat and populations. A Quality Assurance Program Plan (QAPP) was developed by the Massachusetts Division of Marine Fisheries to monitor diadromous fish habitat in coastal watersheds and approved by the Massachusetts Department of Environmental Protection. The QAPP relate species life history requirements to state and federal water quality criteria. The project goals include developing a standardized process to classify habitats based on their suitability for diadromous fish and to contribute to water quality remediation and habitat restoration efforts in Massachusetts. The monitoring includes classifications for fish passage, stream flow, eutrophication and protocols for recording long-term water temperatures in the coastal rivers. Fifteen habitat assessments have been conducted or are ongoing to date. Site selection has been driven both by questions on restoration potential and the goal of developing data distributions to relate water and habitat quality to water body and landscape characteristics and to watersheds with spawning run counts.

## **Addressing Resource Management Challenges and Nutrient Pollution on the Cape: DEP's Response**

**Kenneth Kimmell, Commissioner, MA Department of Environmental Protection**

This talk will discuss a regional planning initiative that will guide the development and implementation of a cost-effective solution that addresses the serious nutrient problems that exist in watersheds across the Cape. MassDEP is partnering with the Cape Cod Commission to update an area-wide management plan. Commissioner Kimmell will highlight key elements of the approach including local involvement and incorporation of alternative approaches.

**Area Wide 208 Water Quality Management Plan Update**  
**Erin Jackson, Special Projects Coordinator, Cape Cod Commission**

The Section 208 Area-Wide Water Quality Management Plan Update is a State sponsored process to identify strategies and approaches for managing nutrient pollution on Cape Cod. A draft 208 Plan Update will be completed over the next 12 months. This presentation will include process and work plan details, as well as project milestones and tentative workshop timeframes.

**Watershed: MVP for Community Wastewater Management and Decision-Making**  
**Tom Cambareri, Scott Michaud, and James Sherrard, Cape Cod Commission Water Resources Program**

Meeting the challenge of finding acceptable and affordable solutions to coastal water quality requires both scientific/engineering expertise and citizen input to evaluate a variety of strategies and scenarios. Watershed MVP is a web-based interactive mapping application that combines, land-use and water-use data, and general cost information in a flexible format that enables the user to develop and compare various wastewater management scenarios. Watershed:MVP is the result of several decades of effort to quantify the impact of nitrogen from septic systems on the water resources of Cape Cod Sole Source Aquifer. Nitrogen loading methods that started with public drinking water supply protection in the 1970s which were improved and verified and applied to coastal water quality assessments have now been incorporated into this version of Watershed:MVP. Several example applications of Watershed:MVP will be presented.

**Tackling Collaboration Challenges to Address Nitrogen Loading in Shared Watersheds**  
**Edward Leonard, P.E., Sr. Project Manager, Wright-Pierce**

Water quality has deteriorated on Cape Cod as the population has grown over the past 4 decades. Massachusetts DEP has completed many watershed technical reports to study and document how much nitrogen must be removed in order to restore balance and to meet State water quality goals. Municipalities have been engaged in wastewater planning for the past 5 to 15 years. Yet there remain challenges to collaboration among municipalities to address nutrient loadings in shared watersheds. This presentation will explore several concepts which could help facilitate cooperation and progress among towns in shared watersheds.

**Modern Climate Change: Science and Global to Local Impacts**  
**Dr. Fiamma Straneo, Oceanographer, Woods Hole Oceanographic Institution**

Modern climate change is one of the greatest challenges facing societies worldwide. Understanding the science, addressing its impacts and identifying mitigation strategies will require unprecedented coordination between scientists, industries, policy makers and citizens across the world. A public informed on the science and the issues at stake is a key step in this challenge. In this talk, I will review the basic scientific evidence for and understanding of modern climate change and discuss predictions from the global to the local level – including evidence of change and predictions for the regional coastal oceans and ecosystems.

**Rising Seas, Rising Challenges: Understanding the Global Threat of Sea Level Rise**  
**Dr. Jerry Mitrovica, Harvard University**

This talk will explain the phenomenon of sea level rise; causes, trends and impacts. It will also examine how sea level rise is expected to accelerate under a changing climate and implications for coastal communities.

**Will the Cape Fall Into The Sea? Future Sea Level Rise and Coastal Change on Cape Cod**  
**Dr. Rob Thieler, Coastal Geologist, United States Geological Survey**

Sea-level rise is one of the most certain outcomes of climate change. Recent sea-level rise projections have a broad range, between 8 inches and 6.6 feet by 2100. The coastal zone is dynamic and the response of coastal areas to sea-level rise is more complex than simple inundation. Erosion is virtually certain to be the dominant coastal change. Other changes include bluff erosion, overwash, island breaching, and threshold crossing, where coastal change becomes rapid and unpredictable. The future of coastal wetlands will be determined by a number of factors, and local data are needed to develop local management plans. Coastal habitats will change due to sea-level rise, which can have an adverse effect on a range of species. The changes will be determined by the natural abilities of habitats to change and by coastal management practices.

The experience of Falmouth, Massachusetts is illustrative of the history and issues facing towns on Cape Cod. Over the past 150 years, the Falmouth shoreline has been developed in a manner that has significantly impaired the ability of the coast to evolve in response to natural processes, leading to an overall decrease in the viability and resilience of the coastal system. The natural processes that build and maintain beaches have become largely inoperative due to the presence of jetties, groins, and coastal armoring. Although groins and jetties trap sand on their upstream western sides, downstream beaches become starved of sand because their continued erosion is no longer offset by an upstream supply of sediment. Sand supply is further interrupted by armoring with seawalls and revetments. These problems will be exacerbated by rising sea-level. A Town-sponsored working group presented a long-term vision for the Falmouth coast that includes restoration of natural sediment processes wherever possible, relocation of vulnerable infrastructure, and improving public access along the entire shoreline. This vision could be realized over coming decades and improve the sustainability and resilience of the coastal zone.

**Tracking Natural Community Response to Sea Level Rise in Waquoit Bay**  
**James Rassman, Stewardship Coordinator, Waquoit Bay Research Reserve**

The Waquoit Bay National Estuarine Research Reserve System has actively positioned itself through its Salt Marsh Observatory to observe, analyze and track potential impacts from climate change such as increased sea level, increased storm frequency and intensity, and other human caused stressors including deteriorating water quality. The ultimate goal of these monitoring efforts is to help determine the Reserve's vulnerabilities to climate change, and to translate our understanding to better inform decision making by coastal communities and coastal managers. To that end, the Reserve has recently installed a wide range of instruments and associated data collection efforts at its Salt Marsh Observatory located at South Cape Beach State Park in Mashpee, MA. Although most data sets being developed are less than two years old there are interesting indicators of natural community response to climate change stressors emerging. This session will introduce the Reserve's monitoring efforts and designs, present early findings, and discuss how this local data could be used by coastal decision makers.

## **Trends in Shoreline Change and Hazard Impacts: Hot Spots and Management Challenges**

**Greg Berman, Coastal Processes Specialist, Woods Hole Sea Grant and Cape Cod Cooperative Extension**

This presentation will follow several talks on global and regional impacts of sea level rise and coastal hazards. Now we will drill down to the local level and examine some of the issues that towns on Cape Cod are currently dealing with and the management techniques being used. While coastal processes such as erosion, sediment transport, and beach migration do not observe town boundaries, this virtual tour of Cape Cod will stop at each of the 15 towns in Barnstable County.

## **Storm Surge Risk Modeling and Coastal Engineering Adaptations in a Changing Climate**

**Kirk Bosma, Coastal Engineer, Woods Hole Group**

Numerous coastal communities have developed, or started to develop, Coastal Climate Adaptation Plans that integrate projected sea-level rise influences into their planning process. In many coastal areas, the adverse impacts of climate change and sea-level rise may be reduced by a careful response to the increased threat of storm induced flood damage. The identification of appropriate adaptive actions (e.g. abandonment, retreat, elevation, protection, and engineering approaches) depends largely on an understanding of the present and future surge-induced flood risk. In particular, an accurate and precise assessment of the exceedance probability of storm surge water surface elevations, provided at high spatial resolution, helps decision makers identify areas of existing vulnerability requiring immediate action, as well as, areas that benefit from future vulnerability planning. Armed with this detailed information, adaptation strategies and coastal engineering alternatives can be developed that address present and future risks. Coastal protection and flood management alternatives include, but are not limited to, structural alternatives, adaptable and modular engineering concepts, flood proofing, bioengineered technology, managed retreat/relocation, elevating, flow control structures, and evacuation plans. Engineering solutions can be focused on alternatives that are adaptable with time. These concepts provide alternatives and planning approaches to mitigate, minimize, or adapt to effects of sea level rise and storm events.

## ***Day 2 - Friday, June 14***

### ***Concurrent Session A:***

### ***Exploring Shellfish Aquaculture as a Nitrogen Management Option***

**Nitrogen in Shellfish and Key Considerations for Aquaculture Projects - What Are We Learning from Local Research?**

**Josh Reitsma, Marine Resource Specialist & Diane Murphy, Fisheries and Aquaculture Specialist, Cape Cod Cooperative Extension and Woods Hole Sea Grant**

As nitrogen entering coastal waters of Cape Cod continues to be an issue, attention has been generated toward potential options which may help alleviate stress to impacted estuaries. With Cape Cod's long history of shellfish harvest, the propagation or culture of filter feeding bivalves represents a unique opportunity to potentially help alleviate a growing problem and also generate economic activity. What is the potential value of shellfish culture, harvest or restoration and how would shellfish be credited? In response to these questions CCCE/WHSG sought locally derived information, recently testing oysters and quahogs from various Cape Cod area sources to quantify nitrogen content stored in their tissues which would represent a net removal from a water body if harvested.

Results indicated local oysters have an average of 0.69% nitrogen by total dry weight (about 0.28gN/animal) and quahogs an average of 0.67% nitrogen by total dry weight (about 0.22gN/animal). Averages did vary by season and to a lesser extent by location or grow out method. These results will be discussed in greater detail and in the larger context of how shellfish aquaculture may help nitrogen-loaded water bodies as well as its limitations. In addition to quantifying N-removal in shellfish at harvest CCCE/WHSG is also working on a web-based tool to help resource managers and communities visualize the shellfish and gear necessary to reach their nitrogen reduction goals.

### **Shellfish and Water Quality Restoration in the Town of Mashpee**

**Rick York, Shellfish Constable, Town of Mashpee**

Shellfish aquaculture projects in the Town of Mashpee, MA have the goals of restoration of shellfish populations and water quality. The oyster aquaculture in the Mashpee River has restored the oyster fishery that was lost in the 1980s and reduced eutrophication from nitrogen loading as the oysters filter algae for food. Increased seeding resulted in the harvest of more than 500,000 oysters in 2008 removing over 250 kg of nitrogen from the estuary based on analysis of the nitrogen content of oysters from the river. This was about 5% of the 5,000 kg nitrogen reduction required to restore water quality in the river as specified in the Massachusetts Estuaries Project (MEP) and the TMDL Nitrogen (DEP) Reports for the Popponesset Bay area. Increased seeding by with the goal of annual fishery harvests of oysters removing 500 kg nitrogen combined with planned increased annual harvests of oysters removing 2,000 kg of nitrogen from the Mashpee Wampanoag Tribe's commercial shellfish farm at the mouth of the river would total 2,500 kg nitrogen or about half of the nitrogen removal required to restore water quality in the river. Future seeding of quahogs (hard clams) in Ockway Bay for fishery harvests, and planned harvests of quahogs from the Tribe's shellfish farm in Popponesset Bay would remove all of the nitrogen required to restore water quality in those areas. Quahog seeding for fisheries harvests in the Great River, Little River, Hamblin and Jehu Pond estuaries in the Waquoit Bay area to remove all of the nitrogen required to restore water quality in those areas is also planned. Water quality monitoring is a continuation of the monitoring for the MEP Reports in a collaboration of the Town, Tribe and UMass Dartmouth SMAST.

### **Falmouth Shellfish Aquaculture Demonstration Project: Concept, Preparation and Progress**

**Ron Zweig, Town of Falmouth Water Quality Management Committee**

Estuary water quality has degraded in Falmouth, across Cape Cod and much of the coastal northeast US outside of major cities due to excessive effluent discharges for the main part from household septic systems. Traditional practices such as sewer and sewage treatment systems are considered the standard bearer to mitigate these adverse environmental impacts due to these coastal developments. Due to the high investment, operating, maintenance, repair and upgrade costs of these systems, interest has arisen across the region in search of lower cost, sustainable approaches to managing these wastewater discharges. One of the alternate options gaining increasing interest is the use of shellfish aquaculture to improve water quality through managing it directly in the estuaries and addressing the problem through a systems dynamics analytical approach based on ecological and economic principles. This presentation will (1) provide details on the concept in the context of current knowledge; (2) will identify the regulatory frameworks and gaps needed to be filled through the planned research as it pertains particularly to assignment of nitrogen reduction credit for shellfish aquaculture; (3) review the coordination activities among government boards, departments, committee and local civic organizations; and (4) will describe the planned activities in Falmouth and the progress toward meeting the objective and the pertinent outcomes.

## ***Concurrent Session B:***

### ***Restoring Water Quality Using Different Tools and Planning Approaches***

#### **Locally Led Coastal Habitat Restoration to Improve Water Quality on Cape Cod**

**Donald Liptack, District Conservationist, USDA, Natural Resources Conservation Service**

The Cape Cod Water Resources Restoration Project is an estimated \$30 million 10 year initiative that will improve water quality for shellfish growing areas, restore degraded salt marshes and improve fish access to spawning habitat across Cape Cod. Extensive planning and local, state and federal support helped secure an initial \$6.5 million in Recovery Act funding in 2010 to begin implementation on 25 of the 76 identified and prioritized project sites in fifteen towns across Barnstable County. Initial funding for planning was provided through the USDA Natural Resources Conservation Service Watershed Operations Program (PL. 83-566). To date, about 75% of the project sites have been constructed with the remaining work either under construction or soon to be begin. Water quality, floral and faunal monitoring is being conducted to compare pre and post implementation improvements.

#### **Using Innovative Demonstration Projects to Inform Decision-Making on Wastewater Solutions in the Town of Falmouth: Permeable Reactive Barriers and Inlet Widening**

**Jerry Potamis, Wastewater Superintendent, Town of Falmouth**

Falmouth like many Cape Cod communities is facing enormous costs to help restore and protect our estuaries in a manner that is economically sustainable and affordable. This has to be accomplished in a manner that meets the law and proven and scientific and engineering principles for a municipal-wide application, and is also acceptable to our residents - the bill payers. This talk will review the status of our Permeable Reactive Barriers and Inlet Widening projects for reducing total nitrogen impacts to our estuaries. Funding for these studies was part of \$2.7 million approved by the Town to investigate demonstration projects while proceeding on a parallel track with centralized sewer design and construction. The Town has also initiated eco toilet and aquaculture projects. A poster on the eco-toilet project provides an update on that demonstration project. A presentation on the aquaculture demonstration project will be provided as part of the Concurrent Session A which focuses on the role of aquaculture in addressing nitrogen loading.

#### **Using an Integrated Approach for Water, Wastewater, Ponds and Land Use Planning – Brewster Case Study**

**Sue Leven, Town Planner, Town of Brewster and Mark Nelson, Principal, Horsley Witten Group**

The Town of Brewster is holistically managing its water resources and is developing an Integrated Water Resource Management Plan to address water quality and water availability issues facing the town. This approach was deliberately selected over a Comprehensive Wastewater Management Plan as the town recognized that pollution impacting the town's fresh water ponds and coastal embayments is not just from septic systems but also from stormwater runoff, fertilizers and historical land use practices. Selecting an integrated approach allows the Town to evaluate issues and potential solutions on a town-wide or watershed basis as necessary to find solutions to restore water quality in ponds and estuaries and to continue to protect drinking water supplies. It also recognizes the fact that each of these resources is connected through groundwater which provides much of the water and associated pollutants entering ponds, estuaries and drinking water wells. Solutions to protect one resource need to be developed in consideration of how they impact other resources. Updates on plans for fresh water ponds, Pleasant Bay, and evaluation of sea level rise on septic system operation will be discussed.

## **Algae Control by Phosphorous Inactivation: Cape Cod Results and Lessons**

**Ken Wagner, Water Resources Manager, Water Resource Services**

Internally generated loads of phosphorus (P) occur mainly in summer in water devoid of oxygen, can represent a major source of phosphorus, tend to depress the ratio of nitrogen to phosphorus in ponds, and can foster algal blooms, especially cyanobacteria. The features of most Cape Cod ponds make them susceptible to internal P loading (limited stream flow, low flushing rates, deep enough to stratify and lose oxygen at the bottom, accumulated P-rich sediment) and related cyanobacteria blooms. Inactivating the phosphorus in the surficial sediment can reduce internal P loading and limit the frequency and severity of algae blooms. The most common way to inactivate sediment P is with aluminum compounds, as they bind P and make it unavailable even without oxygen present, and do not release P under the range of normally occurring water quality conditions. Much has been learned about how to plan and conduct aluminum treatments over the last 20 years. Key aspects include assessment of P sources to confirm the importance of internal loading, testing to determine the appropriate aluminum dose, and selection and application of aluminum compounds to manage pond pH and keep reactive aluminum levels below toxicity thresholds during treatment. Seven ponds have been treated on Cape Cod between 1995 and 2012. All have successfully reduced internal P loading and improved water clarity, but not without some deviation from expectations. The first treatment involved a fish kill, something that is completely avoidable. Fall treatments have been required in most cases, but spring treatments would be more immediately effective. Longevity of benefits is not indefinite, but is roughly predictable, and estimates for older treatments have proven fairly reliable. Aluminum treatments do not make a system infertile, but rather shift nutrient levels and ratios to a more moderate and desirable condition.

## **Solar Water Circulators for Mitigation of Coastal Eutrophication in Santuit Pond, Town of Mashpee**

**Rick York, Shellfish Constable, Town of Mashpee**

Blue-green algae blooms in Santuit Pond, a 170 acre eutrophic fresh water pond, are phosphorous limited with most of the phosphorous load coming from the pond bottom sediments. AECOM Environmental consultants estimated that water circulators should cut the total phosphorous load in half by mixing oxygenated water to the pond bottom. Phosphorous flux from sediments is greater under the anaerobic bottom water conditions recorded during monitoring for assessment. After 6 SolarBee solar powered water circulators were installed in 2012, water quality improved with average summer Secchi disk visibilities increasing to about a meter from an average of about 0.5 meter in previous years without the circulators. Improvement was observed all the way to the top of the food chain with healthier larger fish.

## ***Concurrent Session C:***

### ***Adapting to a Changing Climate: How Do We Do It?***

#### **Unpacking Adaptation Planning: Moving From Theory to Practice**

**Lisa Dickson, PG, Vice President, Sustainability, Kleinfelder**

Recent extreme weather events, such as Hurricanes Sandy, Irene and the winter storm Nemo, have created a keen focus on the link between climate and the resiliency of both the built and natural worlds. The resulting damage incurred by these extreme events often creates an urgency to build against future impacts. However, jumping to adaptation solutions without fully understanding the most critical elements can result in the expenditure of

limited funds on less pressing needs. This talk will outline an approach to develop meaningful and implementable resiliency plans.

Climate Change projects consist of three basic components: (1) climate change projections; (2) vulnerability assessment; and (3) adaptation planning. The vulnerability assessment is crucial given the need to prioritize actions because of the limited funding that will be available to prepare for climate change impacts. It must allow for comparison of quantifiable and qualitative data, different types of infrastructure (e.g., utilities versus facilities), infrastructure versus operations/services, and consideration of critical aspects that may lie outside of an entity's jurisdiction (e.g., energy and transportation systems). Public health, social resiliency and economic data may also be part of the analysis. The vulnerability assessment identifies the most at-risk elements which will be the focus of the resiliency efforts. The feasibility of each resiliency investment plan should be judged using a combination of criteria including engineering feasibility, regulatory constraints, economic impacts (including cost of construction, avoided costs, costs of interrupted service, etc.), synergy with other initiatives, actions that are within the entity's jurisdiction, and actions that will require additional partnering. While the focus is often on technical analyses, stakeholder engagement is equally important. Climate change cuts across geographic, political, social and economic boundaries. Successful implementation of adaptation plans requires "buy-in" and support from numerous parties. Trying to build consensus among such varying interest groups is difficult but necessary to generate support and commitment for the required capital investment.

### **Case Study – Sea Level Rise Planning on the South Shore**

**Paul Halkiotis, AICP, Town Planner, Town of Marshfield**

Marshfield Town Planner, Paul Halkiotis will discuss the on-going efforts that the Town of Marshfield MA has been undertaking to plan for sea level rise. In the spring of 2010 a 500' section of sea wall failed and left homes 10' behind the wall vulnerable to coastal hazards. Voters approved \$1.3M at a Special Town Meeting to rebuild the 50 year old failed sea wall. During construction an adjacent section failed. Marshfield has 2.4 miles of sea walls. At a cost of \$3,000 per linear foot, I warned the Selectmen that sea level rise would continue to impact the sea walls and the Town needed to undertake some long range planning to determine how and where sea level rise would impact our town. With no money and time to engage in a long range planning effort I teamed up with the Planners from Duxbury and Scituate to apply for a grant to study the issue. The presentation will focus on the efforts of the three towns on the South Shore to tackle one of the most serious and costly issues that will face generations to come, adapting to sea level rise.

### **Collaborative Approaches for Addressing Climate Risk**

**Patrick Field, Managing Director, Consensus Building Institute**

Potential climate change impacts to communities pose a particularly vexing public collaboration problem. The potential impacts appear often distant in time, highly uncertain, sporadic, and often intangible. When municipalities have numerous, immediate problems to solve from declining tax bases to pressing infrastructure needs, tomorrow's risk can seem terribly far away. The Consensus Building Institute (CBI) suggests there is a way to use a "no regrets" strategy within existing planning efforts to incorporate potential climate change impacts. Municipalities can focus on those potential impacts, be that flooding or storm surges that already face the community and are already real and pertinent to residents. There are multiple tools and techniques that can be brought to bear on for local communities in facing an uncertain climate future. Municipalities only need to incorporate additional climate change considerations into existing planning, not necessarily undertake entirely new and different planning processes.

**Effectively Communicating Complicated Issues**  
**Roger Stephenson, Stephenson Strategic Communications**

What does it take to get community members and employees engaged...and to move them towards the ultimate desired behaviors of involvement, acceptance and serving as ambassadors for your cause or issue? This session will discuss the psychology and theory behind behavior change and what is required to move people from awareness to action; the impact of one-way and two-way communication on the decision making process; the importance of cultivating relationships with opinion leaders who can serve as third party advocates and the practical applications of developing and implementing messaging campaigns that will break through the clutter in our over-communicated world.

**POSTER SESSION**

**ABSTRACTS**

## **Monitoring the Health of Our Waters: Cape Cod Bay and Nantucket Sound**

**Authors: Amy S. Costa, Marc S. Costa, Jennifer A. Burkhardt, Patricia E. Hughes**

**Provincetown Center for Coastal Studies**

The Provincetown Center for Coastal Studies has been tracking changes in the water quality of Cape Cod Bay since 2006. In 2010, this monitoring program was expanded to include the waters of Nantucket Sound. Over 70 stations located along the shoreline and throughout the Bay and Sound are monitored for water quality by PCCS staff and citizen scientists. Data on water temperature, salinity, dissolved oxygen, pH, water clarity, chlorophyll, nitrogen, and phosphorous are collected regularly. A Seasonal Kendall Trend Analysis test of a subset of these parameters indicated that 29% of the stations monitored are showing a decline in water quality, 6% are showing an improvement, 65% have not shown a significant change during this study period. Additionally, in recognition of the emerging threat of environmental pollution from pharmaceuticals, PCCS began monitoring for select pharmaceutical contaminants in both Cape Cod Bay and Nantucket Sound. Contaminants have been detected at the majority of sites sampled.

## **In-ground Wastewater Disposal Enhances Mercury Loadings to Cape Ponds and Bays**

**Author: Carl Lamborg, Woods Hole Oceanographic Institution**

Many fish on Cape Cod contain more mercury (Hg) than is safe for children and pregnant women to eat. This includes some species of fish not normally thought of as being high in Hg in general. My research, in collaboration with USGS, Sea Grant, the WHOI Coastal Ocean Institute and WBNERR, suggests that Cape Cod ponds and bays receive more Hg than in other locations as a result of elevated concentrations and fluxes in groundwater. Most recently, we have uncovered evidence which suggests that the in-ground disposal of wastewater, so common on Cape Cod, results in the generation of biogeochemical conditions in our aquifer that promotes the mobilization of Hg out of the watershed and into ponds and bays.

## **The Massachusetts Bay Outfall: 1992-2012 Monitoring Results**

**Authors: Andrea Rex, Wendy Leo, Jianjun Wang, Massachusetts Water Resources Authority**

MWRA's Boston Harbor Project and the Massachusetts Bay Outfall have allowed Boston Harbor to recover from decades of near-shore discharge of inadequately treated municipal waste. Ensuring that the pollution problem was solved, not just moved, included several elements. First, the amount of pollutants discharged was reduced, through industrial pretreatment and by building a modern, effective sewage treatment plant. Moving the discharge offshore into deeper water allows any remaining pollutants to be quickly diluted to background levels in the immediate area of the discharge. In addition, nutrients in the wastewater are trapped below the pycnocline for much of the year, making them less available to spur excessive algal growth. Finally, an extensive monitoring program ensures that no adverse impacts have occurred. Over twenty years of monitoring – twelve since the Massachusetts Bay outfall started operation – have clearly demonstrated that the project was successful in improving Boston Harbor without affecting Massachusetts and Cape Cod Bays.

## **Identifying Opportunities for Innovative Stormwater and Wastewater Management: A GIS Parcel Screening Analysis**

**Author: Cape Cod Commission**

The Cape Cod Commission received a technical assistance grant from EPA in 2012 to develop conceptual designs using green infrastructure (GI) technologies to reduce nitrogen from stormwater and wastewater within Environmental Justice communities. The environmental consulting firm Tetra Tech assisted Commission staff in developing a GIS-based screening process to identify potential GI sites within the Lewis Bay and Parkers River watersheds. Field assessments and public workshops resulted in selection of two sites for development of the conceptual design plans, cost estimates, and regulatory pathways for the selected technologies. Commission staff also recently assisted the town of Barnstable in applying for a 319 DEP stormwater grant to complete the design and construction of an advanced bio-retention area at the Horace Mann charter school in Hyannis, MA.

Based on additional research, the GI siting criteria have been refined and are being applied at the watershed level to support wastewater planning in the Cape Cod 208 wastewater plan update. The practices identified have been selected based on their high nitrogen removal efficiencies and represent a range of practices that are applicable in a wide variety of conditions. Using the revised criteria, potential sites for one of these technologies, constructed wetlands, is illustrated for the Three Bays watershed in the town of Barnstable.

## **Falmouth's Eco-toilet Demonstration Program**

**Author: Win Munro, Falmouth Water Quality Management Committee**

Falmouth's Eco-Toilet Demonstration Program is an important piece of our effort to find a way to reduce extensive and expensive reliance on municipal sewerage to clean up our estuaries and meet state-mandated TMDLs. Other nitrogen reduction initiatives Falmouth is exploring include inlet widening, oyster aquaculture, permeable reactive barriers, fertilizer reduction, stormwater management, and advanced denitrifying septic systems. If these initiatives are successful, we will have created the scientific knowledge; the technological know-how; the business, financial and regulatory infrastructure; and the civic and political will to reduce both the cost and the time frame for cleaning up our estuaries and meeting state-mandated TMDLs.

This presentation presents answers to the following questions about the Falmouth Eco-toilet Demonstration Program: Why has Falmouth included eco-toilets in its alternative nitrogen reduction tools and initiatives? What is the role of eco-toilets in the mix of alternative technologies and initiatives for reducing the need for sewerage? What are the specific goals and objectives of the Eco-toilet Demonstration Program? How does the Program work, and what has it accomplished so far? What might be the wider significance of the Program for other Cape towns also struggling with cleaning up estuaries and meeting TMDLs.

## **Coastal Sediment Management Planning: Community Goals and Priorities Identified through the Cape Cod Ocean Management Planning Process**

**Presenter: Heather McElroy, Cape Cod Commission**

The Cape Cod Ocean Management Plan (CCOMP) was adopted in October 2011; the outcome of an 18 month planning process looking at new development potential in the ocean waters offshore Cape Cod. One of the new development activities authorized by the Massachusetts Ocean Act of 2008 is sand mining for the purposes of beach nourishment. The Oceans Act of 2008, and later the CCOMP, recognized that the demand for clean, compatible sediment for beach nourishment may increase as the effects of erosion, exacerbated by changing storm

patterns and sea level rise, are felt along our coastlines. Through a public engagement and planning process, policy makers on Cape Cod determined goals and policies addressing sediment management along our dynamic coastline. The CCOMP and the Cape Cod Regional Policy Plan support future efforts to characterize coastal sediment transport processes, identify sea-level rise adaptation strategies, and prioritize areas where beach nourishment is needed in order to inform the need for and siting of sand mining projects.

**End User Engagement for Improved Projections of Local Sea-Level Change and Tropical Cyclone Activity**  
**Authors: Greg Berman, Woods Hole Sea Grant Program and Jeff Donnelly, Woods Hole Oceanographic Institution**

This project will provide regional and local predictions of future coastal storm activity and sea-level rise to users of our nation's and, in particular, our region's marine and coastal resources in order to promote wise utilization and conservation of those resources. By developing reciprocal relationships between resource users/managers and technical information producers we are facilitating end-user engagement and generating informed tools for users/managers of those resources.

**Response of the Waquoit Bay Subterranean Estuary to Sea Level Variability**  
**Author: Meagan Eagle Gonneea, Woods Hole Oceanographic Institution**

Within coastal aquifers there are two interacting water masses. The fresh water lens (terrestrial groundwater) is supplied by inland recharge and overlies a salt wedge (marine groundwater), with dispersive mixing occurring at the interface. The extent of mixing within coastal aquifers and surface water exchange is driven by an elevation gradient between the aquifer and sea level, with temporal variability on the scale of months to years (i.e. greater than tidal) thought to be controlled by terrestrial groundwater levels. We monitored the position of the mixing zone in the coastal aquifer of Waquoit Bay, MA, USA, for 4 years and observed that an increase in hydraulic gradient led to an overall seaward movement of the interface, resulting in low salinity conditions, while a decrease in head led to landward movement of the interface and high salinity groundwater at this location. Our results indicate that seasonal scale variability in sea level, not groundwater level, is the dominant variable driving the hydraulic gradient, which in turn modulates discharge from unconfined coastal aquifers. In addition, the coastal aquifer time series demonstrated a direct response to the 2009-2010 El Nino event, which elevated sea level on the US eastern seaboard for over a year. Over this time period, we observed enhanced discharge of two chemical tracers, barium and radium, concurrent with marine intrusion due to elevated sea level. Thus the physical and chemical behavior of coastal aquifers appears to be sensitive to external climate forcing.

**The New England Climate Adaptation Project**  
**Authors: Katherine Buckingham and Danya Rumore, Massachusetts Institute of Technology**

The New England Climate Adaptation Project is a two-year action research project investigating the effectiveness of tailored, science-based role-play simulations as a tool for catalyzing collective coastal climate change adaptation. This project is a collaborative effort involving the Consensus Building Institute, the Massachusetts Institute of Technology, the National Estuarine Research Reserve System, and four partner towns New England towns: Barnstable, Massachusetts; Cranston, Rhode Island; Dover, New Hampshire; and Wells, Maine. Together, we are working to 1) assess the local climate change risk facing our partner communities; 2) evaluate local concern about climate change, potential barriers to adaptation, and resources for risk management; 3) educate and engage the public in our partner towns through use of role-play simulations, an experiential learning technique; and 4) evaluate the effectiveness of this intervention as a way for stimulating collective adaptation planning and implementation. We believe that, in addition to helping our partner communities more effectively manage

climate change risk; the findings of this project will provide valuable insights into techniques for effectively engaging communities in public learning, risk management, and collaborative decision-making in the context of climate adaptation.

### **Bringing Wetlands to Market: Nitrogen and Coastal Blue Carbon Project**

**Authors: BWM Project Team**

**Alison Leschen<sup>1</sup>, Jim Tang<sup>2</sup>, Kevin Kroeger<sup>3</sup>, Serena Moseman-Valtierra<sup>4</sup>, Omar Abdul-Aziz<sup>5</sup>, Steve Emmett-Mattox<sup>6</sup>, Steve Crooks<sup>7</sup>, Tom Walker<sup>8</sup>, Kate Morkeski<sup>2</sup>, Jessie Gunnard<sup>2</sup>, Neil Ganju<sup>3</sup>, Jim Rassman<sup>1</sup>, Jordan Mora<sup>1</sup>, Chris Weidman<sup>1</sup>, Kate Harvey<sup>1</sup>, Meg Gardner<sup>9</sup> and Tonna-Marie Rogers<sup>1</sup>**

**1 Waquoit Bay National Estuarine Research Reserve, 2 Marine Biological Laboratory, 3 United States Geological Survey, 4 University of Rhode Island, 5 Florida International University, 6 Restore America's Estuaries, 7 ESA PWA, 8 Manomet Center for Conservation Sciences, 9 University of New Hampshire**

Bringing Wetlands to Market: Nitrogen and Coastal Blue Carbon (BWM), is a three-year project being led by the Waquoit Bay National Estuarine Research Reserve that will examine the relationship between salt marshes, climate change, and nitrogen pollution – critical issues facing Cape Cod, MA and many coastal communities today. The project team is creating information and tools that coastal decision-makers can use to design effective wetlands protection and restoration projects, incentivize greenhouse gas reductions, and manage nitrogen pollution.

### **Measuring Greenhouse Gas Fluxes in Sage Lot Pond in Waquoit Bay**

**Authors: Katharine Egan<sup>1</sup>, Serena Moseman-Valtierra<sup>1</sup>, Tim Lima<sup>1</sup>, Jim Tang<sup>2</sup>, Kevin Kroeger<sup>3</sup>, Kate Morkeski<sup>2</sup>**

**1 University of Rhode Island; 2 Marine Biological Laboratory; 3 United States Geological Survey**

Greenhouse gases (GHGs) are constantly being emitted into the atmosphere from salt marshes through human degradation and natural causes. “Blue carbon” is stored in coastal wetlands, and when they become degraded, salt marshes release the stored up carbon. There is a zonation pattern in salt marshes, and the different plant life, soil properties, chemical properties, and tidal effects from each zone could have an effect on how GHG fluxes differ. Ongoing research is analyzing GHGs in Sage Lot Pond located at the Waquoit Bay National Estuarine Research Reserve in Massachusetts by zonation of the marsh and through spatial variation to understand how our coastal wetlands in New England contribute to global climate change.

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