SESSION SIX: Hands on Learning (Concurrent Mini-Workshops)
Participants should select one of the following Session Six mini-workshops

Understanding the Economics: Application of the Economic Analysis

Under the Bringing Wetlands to Market Project, team member Tom Walker, Consulting Economist from the Manomet Center for Conservation Sciences, conducted an economic analysis of the greenhouse gas benefits of a tidal restoration project with specific focus on the potential value of methane reductions from those projects. Learn more about the economic valuation process, findings from the Cape Cod's Herring River case study, and discuss how restoration practitioners might use this approach for evaluating the economic value of blue carbon from salt marsh tidal restoration projects.

PRESENTER: *Tom Walker, Consulting Economist, Manomet Center for Conservation Sciences*

FACILITATOR:
Kate Harvey, Waquoit Bay National Estuarine Research Reserve

Applying the Tidal Wetland and Seagrass Restoration Methodology

The Bringing Wetlands to Market Project partner Restore America's Estuary developed a first of its kind Methodology that enables project developers to receive carbon credits for tidal wetland and seagrass restoration projects. This session will walk participants through the key considerations and features of the new methodology and explore how it might be used in the New England region.

PRESENTERS: *Steve Emmett-Mattox, Senior Director for Strategic Planning and Programs, Restore America's Estuaries, Steve Crooks, Ph.D., Climate Program Manager, ESA, Inc.*

FACILITATOR: *Tonna-Marie Rogers, Waquoit Bay National Estuarine Research Reserve*

Innovations in Science and Field Work from the BWM Project and Additional Science Questions

The Bringing Wetlands to Market Project used some cutting edge tools to conduct blue carbon-related research at the Waquoit Bay National Estuarine Research Reserve. From a low-cost boardwalk designed to reduce the impact of research on the wetland to the latest technology and devices including a gas chamber and analyzers. Learn about these innovations and explore what additional science questions this research has raised.

This mini workshop is a repeat of the presentation offered in Session Five.

PRESENTERS: *Meagan Eagle Gonneea, Ph.D., US Geological Survey; Kevin Kroeger, Ph.D., US Geological Survey; Serena Moseman-Valtierra, Ph.D., University of Rhode Island; Jim Rassman, Waquoit Bay National Estuarine Research Reserve; Jim Tang, Ph.D., Marine Biological Laboratory*

FACILITATOR:
Jordan Mora, Waquoit Bay National Estuarine Research Reserve

Communicating and Educating About Blue Carbon: Delving Deeper into the "Bringing Wetlands to Market: STEM Curriculum Linking Wetlands and Climate Change"

During this session, participants will get a chance to try out activities from the "Bringing Wetlands to Market: STEM Curriculum" (http://wbnerrwetlandscarbon.net/teachers/) which was designed for high school level students but can be adapted for other ages, including adults. These learning modules introduce many different aspects of the project and provide teaching ideas and activities, as well as a wealth of media resources, for sharing it with teachers and students. The blue carbon concept and research being done to advance knowledge of blue carbon fit perfectly into the Next Generation Science Standards through the Science and Engineering Practices and Disciplinary Core Ideas. The modules cover the topics of carbon sequestration, carbon cycle, salt marsh values including the concept of blue carbon, the nitrogen cycle, and sea level rise. This on-line curriculum includes engineering activities as well as a section on doing an "Adopt-a-Wetland" stewardship/field study activity. This session is open to all workshop participants.

Teachers who wish to earn PDPs should contact Joan Muller at joan.muller@state.ma.us for details.

PRESENTER: *Joan Muller, Education Coordinator, Waquoit Bay National Estuarine Research Reserve*

conference ABSTRACTS

Keynote - Blue Carbon: A New Tool for the Coastal Manager & Policymaker's Toolkit

DAVID YOSKOWITZ, PH.D. – *Chief Economist, National Oceanic and Atmospheric Administration (NOAA)*
Endowed Chair for Socio-Economics, Harte Research Institute for Gulf of Mexico Studies

Our coastal wetlands and submerged aquatic vegetation are constantly under pressure from changing climate, development, tropical storms, and human caused events, to name a few. At the same time there is seemingly fewer resources to protect or enhance these habitats. Can Blue Carbon be part of the solution? Blue Carbon must help drive change in order to have resilient coasts and economies. Alignment with federal and state policies is necessary but not sufficient. Working with the private sector and NGOs to protect or enhance a suite of ecosystem services, including blue carbon, will help achieve achieve broader conservation goals and positively impact community well-being.

Keynote - The State of Blue Carbon Science

LISAMARIE WINDHAM-MYERS, PH.D. – *Research Ecologist, U.S. Geological Survey (USGS)*

Great strides have been made in the last decade towards better documentation and understanding of the important role of coastal vegetated ecosystems in carbon cycling at global scales. Despite the complicated dynamics of carbon fluxes among water, soil, plant, and atmosphere components at the land-ocean margin, improvements in data collection and integration across global to local to microbial scales have advanced our understanding of how, when, and where carbon is sequestered in coastal wetlands. The first steps of tracking carbon fluxes and documenting net greenhouse gas budgets in coastal environments are complex but critical to model development. Ultimately, these integrated assessments are the key to predicting and projecting carbon fluxes with changing climate and land-use decisions. This talk will review the historic context, current inventory, and future scenarios for coastal wetlands in providing significant ecosystem services in "net negative emissions" of greenhouse gases.

Bringing Wetlands to Market: Nitrogen & Coastal Blue Carbon - Bridging Science, Policy & Management

TONNA-MARIE SURGEON ROGERS– *Coastal Training Program Manager, Waquoit Bay National Estuarine Research Reserve*

This presentation will provide an overview of the Bringing Wetlands to Market project highlighting the motivation for the study, main research questions addressed and the collaborative process used to engage with researchers and potential end users of the science. The talk will emphasize how the project was grounded in stakeholder interest throughout its implementation, lessons learned as well as opportunities the project offers to link research findings and blue carbon to land management, conservation and climate change planning efforts at the national, state and local levels.

Building a Salt Marsh Greenhouse Gas Budget: Quantifying Emissions in Response to Nitrogen Loading

JIANWU (JIM) TANG, PH.D. – *Associate Scientist, Marine Biological Laboratory*

Salt marshes play an important role in global and regional carbon and nitrogen cycling. We tested the hypothesis that anthropogenic nitrogen loading alters greenhouse gas (GHG, including CO_2, CH_4, and N_2O) emissions and carbon sequestration in salt marshes. We measured GHG emissions biweekly for two growing seasons across a nitrogen-loading gradient of four *Spartina* salt marshes in Waquoit Bay, Massachusetts. In addition, we conducted nitrogen addition experiments in a pristine marsh by adding low and high nitrate to triplicate plots during the summer. The GHG flux measurements were made in situ with a state-of-the-art mobile gas measurement system. We found that the salt marsh was a strong carbon sink. The differences in gas emissions across the nitrogen gradient were not significant, but strong pulse emissions of N_2O were observed after nitrogen was artificially added to the marsh.

Building a Salt Marsh Greenhouse Gas Budget: Quantifying the Role of Tidal Exchanges of Carbon & Greenhouse Gases

KEVIN KROEGER, PH.D. – *Research Biogeochemist, USGS Woods Hole Coastal & Marine Science Center*

Coastal wetlands are prime candidates for greenhouse gas emission offsets as they display extraordinarily high rates of carbon (C) sequestration. Lack of scientific data about rates of and controls on C sequestration in tidal wetlands, as well as substantial temporal and spatial heterogeneity, complicate use of C registries. Among our research objectives is to construct carbon and GHG budgets for salt marshes, based on measurements of GHG exchanges with the atmosphere, carbon storage in soils, and lateral (tidal) exchanges of gases, carbon, and sediment. In this presentation, emphasis is on rate and source of tidal exchanges between salt marshes and estuaries. High frequency data reveal important variability in fluxes on a range of timescales, including between consecutive tide cycles. Results indicate that tidal exchange of dissolved carbon is a large, and previously underestimated, term in the salt marsh carbon budget.

Examining Relationships Between Greenhouse Gas Fluxes & Plant Zones

SERENA MOSEMAN-VALTIERRA, PH.D. – *Assistant Professor, Biological Sciences, University of Rhode Island*

Coastal wetlands are visibly defined by distinct plant community zones. These plant- defined zones might serve as proxies or indicators for Blue Carbon accounting efforts, either because plants directly affect carbon fluxes or indirectly track steep environmental gradients. We compared greenhouse gas fluxes (CO_2, N_2O, and CH_4 fluxes) between *S. patens*- dominated high marsh and *S. alterniflora* low marsh. We also compared *P.australis*- invaded zones and permanently inundated marsh ponds. Methane fluxes were generally low in both native marsh zones and ponds (< 50 mmol CH_4 m^{-2} h^{-1}) while N_2O emissions were rare. However, CO_2 uptake and CH_4 emissions from *P. australis* zones were typically more than an order of magnitude greater than those of either native marsh zone. Thus, shifts in plant communities can substantially affect carbon emissions.

conference ABSTRACTS

SESSION FIVE: Hands on Learning (Concurrent Mini-Workshops)

Participants should select one of the following Session Five mini-workshops

Modeling Greenhouse Gas Fluxes and Carbon Storage in Wetlands

Under the Bringing Wetlands to Market Project, team member Omar Abdul Aziz, with the assistance of Khandker S. Ishtiaq, developed a user-friendly model to predict the greenhouse gas (GHG) fluxes and carbon sequestration from the coastal wetland ecosystems. The model uses several basic parameters to determine the blue carbon budget in systems similar to those found in the Waquoit Bay and New England region. In this mini session, learn more about how to use the model - an Excel Spreadsheet tool- and discuss how this simple ecological engineering tool can be used for coastal carbon management under a changing climate, sea level and environment.

PRESENTERS: *Omar Abdul Aziz,Ph.D., Assistant Professor of Ecological and Water Resources Engineering, Department of Civil & Environmental Engineering, Florida International University (FIU); Khandker S. Ishtiaq, Graduate Research Assistant, Ecological & Water Resources Engineering Lab (EWREL), Department of Civil & Environmental Engineering, FIU.*

FACILITATOR:
Kate Harvey, Waquoit Bay National Estuarine Research Reserve

Innovations in Science and Field Work from the BWM Project and Additional Science Questions

The Bringing Wetlands to Market Project used some cutting edge approaches to conduct blue carbon-related research at the Waquoit Bay National Estuarine Research Reserve. From a low-cost boardwalk designed to reduce the impact of research on the wetland to new instrumentation including a gas chamber and analyzers. Learn about these innovations and explore what additional science questions this research has raised.

This mini workshop will be repeated and offered during both Sessions Five and Six.

PRESENTERS: *Meagan Eagle Gonneea, Ph.D., US Geological Survey; Kevin Kroeger, Ph.D., US Geological Survey; Serena Moseman-Valtierra, Ph.D., University of Rhode Island; Jim Rassman, Waquoit Bay National Estuarine Research Reserve; Jim Tang, Ph.D., Marine Biological Laboratory*

FACILITATOR:
Jordan Mora, Waquoit Bay National Estuarine Research Reserve

Blue Carbon Projects - Examples of Policy and Projects from the U.S. and around the World

While still a relatively new concept, blue carbon is attracting growing attention from policy makers and project developers around the world. This session will offer some examples of where blue carbon is being coupled to support other policy objectives, such as climate change adaptation, sea level rise, and share how the global community is thinking about different projects (real and potential).

PRESENTERS AND FACILITATORS: *Steve Crooks, Ph.D., Climate Program Manager, ESA, Inc.; Ariana Sutton-Grier, Ph.D. Research Faculty, University of Maryland in the Earth System Science Interdisciplinary Center, Ecosystem Science Adviser, National Ocean Service, NOAA*

Communicating and Educating About Blue Carbon

The members of the Bringing Wetlands to Market Project Team have led numerous workshops, webinars, and other outreach and education activities in New England and across the nation. Tonna-Marie Rogers, Collaboration Lead for the project, will share some of the outreach products developed as well as communication lessons learned over the past three years. Joan Muller, Education Coordinator at Waquoit Bay Reserve will introduce participants to an on-line high school teaching module that she helped develop based on the Bringing Wetlands to Market project. She'll relate some success stories from teachers who took a summer workshop at the Reserve and piloted the activities with their classes.

PRESENTERS AND FACILITATORS: *Joan Muller, Education Coordinator, Waquoit Bay National Estuarine Research Reserve; Tonna Marie Rogers, Coastal Training Program Coordinator, Waquoit Bay National Estuarine Research Reserve*

Building a Salt Marsh Greenhouse Gas Budget: Nitrogen Impacts on Carbon Storage

KEVIN KROEGER, PH.D. – *Research Biogeochemist, USGS Woods Hole Coastal & Marine Science Center*

SERENA MOSEMAN-VALTIERRA, PH.D. – *Assistant Professor, Biological Sciences, University of Rhode Island*

JIANWU (JIM) TANG, PH.D. – *Associate Scientist, Marine Biological Laboratory*

The Bringing Wetlands to Market Field Team will share their findings related to the nitrogen impacts alters greenhouse gas (GHG, including CO_2, CH_4, and N_2O) emissions and carbon sequestration in salt marshes.

What's Next for Blue Carbon in New England: Panel Discussion

JON KACHMAR– *Massachusetts Coastal Program Director, The Nature Conservancy*

AISLING O'SHEA – *Global Warming Solutions Manager, Massachusetts Executive Office of Energy & Environmental Affairs*

TIM PURINTON – *Director, Massachusetts Department of Fish and Game, Division of Ecological Restoration*

KRISTIN WILSON, PH.D. – *Research Coordinator, Wells National Estuarine Research Reserve*

MODERATOR - STEVE CROOKS PH.D. – *Climate Change Program Manager, ESA, Inc.*

In this closing interactive plenary discussion representatives from state agencies, land management, conservation and research organizations will share perspectives on integrating blue carbon with their work and opportunities they see to advance this work through policy, partnerships, demonstration projects and future research. The discussion will frame blue carbon within the broader context of preserving wetland ecosystem services and involve the audience in thinking about and identifying a variety of ways that blue carbon can be linked to coastal management, conservation and climate resilience goals.

conference ABSTRACTS

Introduction to Coastal Blue Carbon Markets & Carbon Finance

STEVE EMMETT-MATTOX – *Senior Director for Strategic Planning, Restore America's Estuaries*

Carbon markets provide financial incentives for projects that have greenhouse gas benefits, such as many of the planned tidal wetland and seagrass restoration efforts. In the U.S., the market is primarily voluntary, and credits are issued by one of three carbon standards – the Verified Carbon Standard, the American Carbon Registry, and the Climate Action Reserve. This session will describe the voluntary carbon markets and standards and opportunities to access carbon finance for coastal habitat restoration

Bringing Blue Carbon to Market: An Introduction to the Tidal Wetland & Seagrass Restoration Methodology & Guidance Document

STEVE EMMETT-MATTOX – *Senior Director for Strategic Planning, Restore America's Estuaries*
STEVE CROOKS, PH.D. – *Climate Change Program Manager, ESA, Inc.*

Through the Bringing Wetlands Market Project, RAE, Dr. Crooks, and other experts developed the first global greenhouse gas offsets methodology for tidal wetland and seagrass projects. The methodology enables restoration projects to receive carbon offsets for the greenhouse gas benefits of the project, and could provide new financial incentives for priority restoration efforts. This presentation will describe the scope of the methodology, allowable project activities, greenhouse gas accounting methods, sea level rise and coastal resilience considerations, and other factors. The methodology is under review by the Verified Carbon Standard and final approval is expected this summer.

A Model to Help You Determine Your Wetland's Carbon Budget

OMAR I. ABDUL-AZIZ, PH.D. – *Assistant Professor of Ecological and Water Resources Engineering, Department of Civil & Environmental Engineering, Florida International University (FIU)*

A user-friendly model has been developed on MS Excel to predict the greenhouse gas (GHG) fluxes and carbon sequestration from coastal wetland ecosystems. A systematic method was employed to first identify the dominant controls of wetland GHG fluxes and quantify their relative linkages with various hydro-climatic, sea level, biogeochemical and ecological drivers. Knowledge of the dominant controls was then leveraged to develop minimalistic non-linear models to predict wetland carbon dioxide (CO_2) and methane (CH_4) fluxes. The models were tested with field data for multiple sites and seasons, as collected from the Waquoit Bay, MA through an extensive field campaign during 2012-13. The Excel Spreadsheet model is a simple ecological engineering tool for coastal carbon management under a changing climate, sea level and environment. In particular, it is expected to aid coastal managers determine the blue carbon budget in the salt marshes in Waquoit Bay and New England region.

Blue Carbon Economics of Salt Marsh Restoration: Herring River Restoration Case Study

TIM SMITH – *Restoration Ecologist, Cape Cod National Seashore, National Parks Service*
THOMAS WALKER – *Consulting Economist, Manomet Center for Conservation Sciences*

Restoration of historic flows to tidally restricted salt marshes has the potential to yield valuable greenhouse gas (GHG) benefits. The available literature indicates that conversion of freshwater or brackish marshes to higher salinity systems can significantly reduce methane emissions. When economic valuation techniques are applied to reductions in methane emissions, the resulting dollar benefit values on a per hectare basis are relatively high when compared with soil carbon accumulation, and may represent a relatively cost-effective coastal blue carbon approach. To illustrate the potential value of methane reductions from tidal restoration projects, this discussion will share findings from a case study conducted for a restoration project currently under development at Cape Cod's Herring River. The analysis is intended to provide restoration practitioners with an approach for evaluating the economic value of blue carbon from salt marsh tidal restoration projects.

Considerations in Planning a Blue Carbon Project

STEVE CROOKS, PH.D. – *Climate Change Program Manager, ESA, Inc.*

Blue carbon policy and management interventions can be deployed in all coastal settings leading to reductions in greenhouse gas (GHG) emissions. However, not all coastal projects will be feasible as carbon finance projects and other policy approaches may be more appropriate. In this presentation we shall explore best practice principles and examples for connecting GHG emissions reductions with wetlands restoration / conservation activities.

Salt Marsh Response to Sea Level Rise and Implications for Blue Carbon

MEAGAN EAGLE GONNEEA, PH.D. – *Postdoctoral Fellow, United States Geological Survey*

In a resilient salt marsh, salt marsh vertical growth increases to keep pace with sea level and have an enhanced capacity to bury carbon. We measured vertical growth and carbon burial in organic rich marshes, which have limited sediment supply and a small tidal range, two factors hypothesized to make marshes vulnerable to sea level rise and marsh drowning. We observed an increase in accretion, with modern rates up to four times greater than the early 1900's. However, all marsh sites have dropped within the tidal frame during the past 80 years, with marshes at the lowest elevation falling the most. In recent decades, the marsh elevation within the tidal frame has stabilized and carbon burial has increased, despite ongoing sea level rise, suggesting that marsh growth has accelerated in response to sea level rise. This finding has important implications for marsh survival and the longevity of carbon storage within salt marshes.

conference ABSTRACTS

Climate and Coastal Resilience National Policy Opportunities for Coastal Blue Carbon

ARIANA SUTTON-GRIER, PH.D. – *Research Faculty, University of Maryland in the Earth System Science Interdisciplinary Center; Ecosystem Science Adviser, National Ocean Service, NOAA*

This presentation will focus on work to date at the federal level to examine how to incorporate coastal blue carbon into the implementation of federal policy efforts. This will include an analysis of how blue carbon can be incorporated into existing federal policies such as the Clean Water Act and the Coastal Zone Management Act, including a discussion of how incorporation could impact decision making and outcomes. In addition, this presentation will focus on some emerging policy opportunities including incorporation of coastal wetland carbon in U.S. national climate and resilience efforts, and early steps to incorporate coastal wetlands into the U.S. national greenhouse gas inventory. There will also be a brief discussion of potential opportunities where coastal blue carbon may be able to play a role in state or regional policy efforts.

Nitrogen Impacts on Marshes: Field and Greenhouse Findings and Implications for Management

CATHLEEN WIGAND, PH.D. – *Research Ecologist, U.S. Environmental Protection Agency, Narragansett, RI*

Increasing nutrients and accelerated sea level rise (SLR) can cause marsh loss in some coastal systems. Responses to nutrients and SLR are complex and vary with soil matrix, marsh elevation, sediment inputs, and hydroperiod. I describe field and greenhouse studies examining single- or multiple-stressor effects of nutrients and accelerated SLR on *Spartina* above- and below-ground biomass and organic matter accumulation. Nutrient additions significantly increased belowground production and organic matter accumulation in minerogenic salt marshes, but decreased below-ground production in some organogenic marshes. Low belowground production in organic-rich soils can contribute to marsh loss. I propose a threshold response in belowground production in *Spartina* driven by sulfide accumulation in organic-rich soils under waterlogged conditions. Understanding these sometimes complex non linear responses to stressors will assist in developing predictive models to address marsh losses and assist in making restoration and climate adaptation decisions.

Nitrogen and CO_2 Impacts on Marshes: Findings From Plum Island and Jamaica Bay and Implications for Management

THOMAS MOZDZER, PH.D. – *Assistant Professor of Biology, Bryn Mawr College*

Coastal plant communities are highly sensitive to environmental change. In addition to omnipresent changes in CO_2 and N enrichment, coastal wetlands are simultaneously being invaded by an introduced lineage of the common reed, *Phragmites australis*, that is known to alter ecosystem structure and function. To predict responses of tidal marshes to interacting global change factors, we have initiated an experiment on the Chesapeake Bay in which *Phragmites* and the native community experience current and near future CO_2 and N conditions. We have observed accelerated invasion rates, biomass production, and carbon fixation in response to both N and elevated CO_2. Given the observed strong invasion response to N, management efforts to limit *Phragmites* invasion should target reductions in N loading. However, decreased N loading may also reduce ecosystem primary production, potentially limiting soil accretion rates, and thereby altering the resilience of the marsh to relative sea level rise.