Salt Marsh Response & Resilience to Changing Conditions: Prospects for Management

Workshop Proceedings

Thursday, April 26, 2018 | Portsmouth, NH

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- Paul E. Stacey, Footprints In The Water LLC
- Dr. Megan Tyrrell, Waquoit Bay (MA) NERR
- Tonna-Marie Rogers, Waquoit Bay NERR
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- Dr. Cathleen Wigand, US EPA
- Dr. Elizabeth Watson, Drexel University
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- Dr. Susan Adamowicz, US Fish & Wildlife Service
- Dr. David Burdick, University of New Hampshire
- Dr. R. Scott Warren, Connecticut College Temple Professor Emeritus of Botany
- Rachel Stevens, Great Bay NERR
- Dr. Mark H. Stolt, University of Rhode Island
- Caitlin Chaffee, RI Coastal Resources Management Council
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- Ron Rozsa, Plant Community Ecologist
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- Dr. Megan Tyrrell & Tonna-Marie Rogers, Waquoit Bay NERR
- Dr. Chris Feurt, Wells NERR

Cover images (clockwise from left): Great Bay NERR salt marsh (Kelle Loughlin); Coggeshall Marsh erosion (Narragansett Bay NERR); Coggeshall Marsh restoration (Narragansett Bay NERR); field exercise (Wells NERR); salt marsh (Wells NERR)

Contents

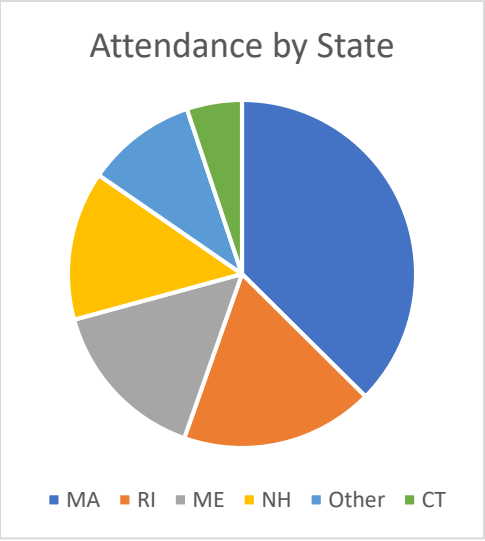
Overview

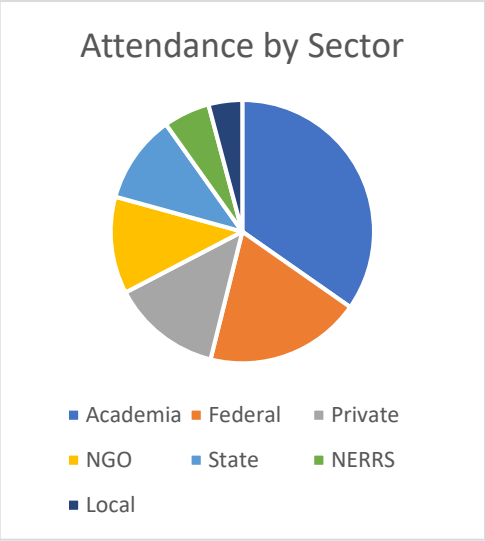
There is compelling evidence that New England coastal ecosystems are facing mounting challenges from pervasive anthropogenic stressors caused by climate change, development, habitat alteration, invasive species and other drivers. The accelerated rate of sea level rise warrants particular attention as it degrades salt marsh health and resilience by altering hydrology and salinity regimes and increasing erosive forces. Southern New England salt marshes are among the most vulnerable in the country (Watson et al. 2017); a review and assessment of ecological response, structural and functional change, resilience mechanisms and management strategies of these important ecosystems is timely and critical to their future.

To build capacity for improved conservation and to guide more effective management and adaptation strategies for New England salt marshes, the New England National Estuarine Research Reserves (NERRs) hosted a regional workshop for researchers, natural resource managers, restoration practitioners, and policy makers in conjunction with the New England Estuarine Research Society (NEERS) 2018 spring meeting. Participants discussed the impacts of sea level rise and related stressors on salt marshes and explored steps to sustain their capacity to adapt and maintain resilience in the context of inevitable change. The role of regionally-collaborative research and monitoring was also discussed as critical to scientific understanding that supports effective management outcomes.

The objectives of the workshop were to:

- Describe the effects of sea level rise and related stressors on New England salt marshes as documented through research and monitoring efforts;
- Discuss management/adaptation/recovery/restoration practices and lessons learned from projects throughout the region;
- Explore monitoring and assessment strategies of proposed and implemented actions; and
- Identify coordination, collaboration, and partnership opportunities.





The workshop attracted 195 people, by far the largest audience ever present at a NEERS event, most of whom attended the full 2.5-day meeting. Attendees hailed from all five New England coasts (as well several other states) and represented a variety of research and management disciplines. While academia represented the largest segment of participants, many key federal and state agencies and non-governmental organizations were present, as well as several local and private entities (Appendix F).

The workshop included 17 oral presentations and three discussion sessions that explored the following questions:

1) **How are coastal marshes in New England faring?**
2) **How are we building coastal marsh resilience throughout the region?**

3) **What monitoring and assessment strategies are being used in the region?**

This proceedings report summarizes the formal presentations and information shared among participants throughout the day. The workshop agenda may be found in Appendix A and the presentation abstracts and associated questions and comments in Appendix B. All workshop materials (including PowerPoint presentations) may be found at http://nbnerr.org/ctp/programs/salt-marsh/.

Synthesis of Group Discussions

The goal of the facilitated group (table) discussions was to provide workshop participants with an opportunity to reflect and build upon individual topics and issues and to share knowledge, pose questions, and generate ideas for enhanced research, monitoring and management. Discussions were structured to garner the greatest amount of dialogue over a relatively short period of time. Each group of approximately 8-10 participants, guided by a facilitator and notetaker, tackled three questions:

- Now that you have heard what is happening in all the states, what do you see as one or two of the most important things we should be doing together as a region?
- Do you know of important studies or projects that are building marsh resilience that were not highlighted but important for everyone to know about? Please share one or two and a contact person and organization.
- What should we prioritize regarding monitoring? Are there indicators of marsh health, resilience or adaptive capacity that we do not currently measure or analyze or existing indicators that could be further emphasized?

The main themes that emerged, integrated across all groups (detailed in Appendix D), are summarized by question below.

1. Now that you have heard what is happening in all the states, what do you see as one or two of the most important things we should be doing together as a region?

The discussions, though diverse, centered on three main themes:

- Increase regional collaboration among practitioners
- Set priorities for salt marsh research, conservation and adaptation efforts
- Improve public communication and engagement for salt marsh protection

Workshop attendees expressed strong support for increasing and sustaining communication and collaboration with their colleagues across the region. Information and resource-sharing for the development and use of consistent assessment methodologies with standardized metrics would lead to more robust and comparable results across state lines. Attendees stressed the importance of collaboratively-set priorities for management such as preserving marsh migration corridors, active marsh restoration, and revising state regulations and policy to remove impediments to more innovative implementation to abate marsh degradation and loss.

Importantly, attendees spoke at length of increasing public awareness of salt marsh values and services and the public engagement and investment in protecting these critical ecosystems that might follow. Attendees suggested many options, such as working closely with social scientists to learn effective public outreach messaging techniques to promote the values of salt marshes and the need to continue research, monitoring, and resource stewardship programs. Including the topic in educational curricula (perhaps even in national education standards), how citizen science can help make the connection between human well-being and healthy marshes, and our collective role in ensuring marsh viability into the future for the derived benefits to society were all raised as important to consider.

2. Do you know of important studies or projects that are building marsh resilience that were not highlighted but important for everyone to know about? Please share one or two and a contact person and organization.
Please see "Question 2" in Appendix D for a complete list of studies and projects generated by participants in response to this question.

3. What should we prioritize regarding monitoring? Are there indicators of marsh health, resilience or adaptive capacity that we do not currently measure or analyze or existing indicators that could be further built out?
This large and motivated audience offered copious suggestions for new and standard monitoring variables and methodologies. Major themes focused on:

- Documenting post-storm and king tide conditions through monitoring water levels and the deposition and erosion of sediment
- Building monitoring and modeling protocols to develop sediment budgets
- Applying the USGS Unvegetated-Vegetated Marsh Ratio protocol (UVVR[1]; Ganju et al. 2017), touted as an important and predictive metric for assessing more than just National Wildlife Refuge marshes where it is currently used
- Assessing the effects of boat wakes, changing currents, and other hydrologic processes on salt marsh edge erosion and slumping
- Adequate monitoring of ecotones (transitions between mudflats and low marsh, low marsh and high marsh, and high marsh and upland were suggested) that may be caused by sea level rise
- Monitoring vegetation changes caused by invasive species such as exotic crabs and other influential groups or species (e.g., *Geukensia*, *Melampus*)

Modelling geomorphic factors that influence marshes resonated with many in the audience; points related to soil and sediment impacts were mentioned numerous times in the subsequent discussions. Many questions were raised regarding protocols to calculate sediment budgets and suggestions for applying the UVVR protocol to help set management priorities for vulnerable marshes. Participants in many discussion groups expressed a strong interest in better understanding sediment movement and soil chemistry.

Regarding ecotone monitoring for marsh migration, several approaches were suggested. Elphick and Field (2014) developed a methodology for the New England region and Wasson et al. (2013) for central California, among others. The study designs and methods described in the two cited papers could be quickly adopted for other New England marsh monitoring programs. For example, at the Waquoit Bay NERR, additional permanent monitoring plots were simply added to the upper portions of the existing marsh transects and a red cedar

[1] UVVR is a rapid assessment technique that uses remote sensing to compare the ratio of ponds, channels and tidal flats to marsh vegetation that can help determine which marshes are most resistant or resilient to changing conditions.

monitoring program was developed to track growth and survival of individual trees in the upland transition zone.

Crab-driven vegetation loss drew many remarks on the general lack of monitoring and assessment of burrowing crab density. Crab burrows have been readily counted by several groups/projects that have added this component to their monitoring. For example, in 2017, fifteen NERRs counted burrows and conducted pit trap sampling in conjunction with their salt marsh sentinel site monitoring. In New England, documenting direct negative effects of burrowing crab species such as *Carcinus maenas* or *Uca* spp. may be warranted to assess impacts to marsh plant recolonization or peat bank stability. Early studies (e.g. Bertness [1985], Bertness and Miller [1984]) examined the relationship between burrowing crabs and salt marsh vegetation, which may be revisited to assess trends over the past three decades.

Connections were made between post-storm conditions and the need for greater public involvement (see also Question 1). It was suggested that because they are visually striking, storms and king tide events provide opportunities for effectively engaging a variety of audiences, compared to creating actionable science, which often draws a limited response. Extreme events are easily documented through digital media and storytelling and could help stimulate political will for coastal resilience planning, restoration, or managed retreat, especially when human well-being is threatened and cost consequences are high. However, massive storm-driven sediment deposition events lack a consistent assessment approach and monitoring effort. A tractable, detailed rapid assessment protocol could be designed for episodic events and fill a science and monitoring gap if properly planned and implemented. Also suggested were less commonly assessed variables such as porewater, groundwater level, soil chemistry, thatch layer, and belowground biomass (preferably using acoustics to make non-destructive measurements) that might be appropriate for before-after-control-impact (BACI)-type assessments that are commonly used for restoration projects.

Evaluation Results

Participants were encouraged to complete an electronic evaluation form that was delivered via email after the workshop, providing an opportunity to offer feedback on the overall effectiveness of the event (Appendix E). The electronic evaluations yielded a 29% response rate and were overall very positive, as indicated by the following:

- 98% of the respondents either strongly agreed (67%) or agreed (31%) that participating in the workshop was a good use of their time.
- 100% of the respondents said that their knowledge of the topic increased as a result of attending the workshop (A great deal: 24%; A lot: 39%; Some: 33%; A little: 4%).
- 76% of the respondents said “yes,” 19% said “maybe,” and 4% said “no” when asked if they learned something at the workshop that they plan to apply in their work. One respondent selected “Prefer not to answer/not applicable.”

Below are some responses to open-ended questions and reflections entered in the “comment” fields (each bullet point represents the cumulative comments from one respondent):

- “A really valuable workshop for understanding the latest marsh science and appreciating the urgency of marsh loss.”
- “An amazing about of information was conveyed and there was still time for dialogue. I am trained in genetics and am working on eDNA studies. This conference was very helpful in providing a crucial ecology perspective to my work; science is all about collaboration these days and the organizers of this event did a great job taking experts from different disciplines to offer their experiences and opinions. Congratulations and thank you for a great symposium! There are trade-

offs between going broad vs. deep into such a complex topic, and I think you achieved an appropriate and effective balance for a one-day symposium."

- "As an educator I was pleased with variety of information provided. Great presentations! My work is in this field and I loved hearing about what everyone is doing. Excellent job of time control."
- "Great to see colleagues give an overview of their state, followed by novel research and restoration approaches. In my mind the symposium had something for everyone, including researchers, practitioners, and decision-makers. As a researcher I appreciated learning about aspects of marsh ecology that are outside my area of expertise, new assessment methodologies, and collaborative opportunities. I loved all the marsh resilience and restoration work that was presented. I'm interested in seeing how all these projects progress and continually learning about new projects within this field. Please hold this workshop again!! Great job organizing the symposium, it was extremely informative."
- "I am a seasonal research assistant in the NERR system and started in March 2018. I was very glad to attend this workshop - I learned a lot about salt marsh ecology and management practices. Great workshop, great speakers."
- "Learning about regional salt marsh research in one day was a benefit- I learned a lot. Great workshop. Great presentations and the break-out discussions were worthwhile."
- "The meeting was very well run and kept on schedule! Kudos to you for that. The presentations were all interesting and the round table discussions were insightful."
- "This workshop was packed with important information presented by top salt marsh scientists."
- "Well organized with timely, very important theme and specific topics."
- "What a wonderful event!!! I was able to get new material to help bolster my thesis work and am eternally grateful for the opportunity! Nice job pulling off a great workshop!"
- "Wow -- this was a rock star of a workshop. Thanks for all the difficult work in getting it organized. Please continue to follow up on these salt marsh workshops every few years."
- "One of the best NEERS special symposia I've attended in 20 years of membership. Thanks to NERRS for co-sponsoring!"
- "Really nice workshop. I enjoyed the presentations and format."
- "Thank you for organizing this event with NEERS. We should do more in the future. The funding made this possible and increased knowledge and collaboration in the region."
- "Thank you for this important, well-organized, and enjoyable workshop."
- "This was a great crash course in what is happening currently in the field of salt marsh conservation in New England. I especially benefited from hearing about what other scientists and managers are doing to address how we can deal with the effects of climate change on marshes. Great job and thanks for organizing this. Very timely and incredibly important!"
- "Very well-organized workshop, which was highly informative and engaging."
- "Well done!"
- "Good job to all involved."

Conclusions and Next Steps

Based on the post-workshop evaluation data and personal communications with presenters and attendees, the planning team highlights the following outcomes from the grant proposal as at least partially realized:

- Increased knowledge of regional salt marsh condition status and trends
- Increased awareness of opportunities for partnership and collaboration
- Stronger connections between research, management, and restoration sectors
- A network for more robust information sharing

- Increased awareness of NERRs as unique and suitable sites suitable for long-term salt marsh research and "test beds" for management strategies

We conclude that the remaining outcome, "the implementation of new, and/or the alteration of existing, management strategies based on the information gained during the workshop," positively benefited but requires more research and evaluation. The symposium emphasized the complexity of salt marshes under shifting conditions and potential regime shifts that will require research and adaptation of management strategies, which we will evaluate approximately six- to twelve-months post-workshop. To facilitate the continuation of these efforts, a webpage will be open to workshop attendees and other interested parties featuring all associated materials (e.g., agenda, presentations, abstracts, break-out group notes, attendee list, etc.) and a workshop proceedings document to serve as a forum for communication and discourse.

The NERRS will continue to adapt future workshop content based on the feedback received during and after the event. Areas of interest indicated by participants include:

- Documenting post-storm and king tide conditions through monitoring water levels and the deposition and erosion of sediment
- Applying the Unvegetated-Vegetated Marsh Ratio (UVVR) technique to more marshes
- Furthering the understanding of the effects of boat wakes, changing currents, and other hydrologic processes on salt marsh edge erosion and slumping
- Researching and monitoring ecotones (transitions between mudflats and low marsh, low marsh and high marsh, and high marsh and upland were suggested) that may be caused by sea level rise
- Monitoring vegetation changes caused by invasive species such as exotic crabs and other influential groups or species (e.g., *Geukensia*, *Melampus*)

From a "bigger picture" perspective, participants expressed support for increasing regional collaboration among practitioners, the prioritization of marsh research, conservation, and adaptation efforts, and better public communication and engagement around marsh protection.

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Appendices

Appendix A: Workshop Agenda

8:45 am Registration and refreshments

9:30 am Welcome and overview Jennifer West, Narragansett Bay NERR

Salt marsh sustainability in New England: progress and remaining challenges Cathy Wigand, EPA

How are coastal marshes faring in New England?

Coastal wetland loss in Rhode Island: 1850s-present Beth Watson, Drexel University

Marsh impairment and future considerations: a Massachusetts overview Marc Carullo, MA Office of Coastal Zone Management

Maine: state of the State's salt marshes Susan Adamowicz, USFWS

Prospects and uncertainties for tidal marshes in New Hampshire Dave Burdick, UNH

Long Island Sound tidal marshes in the Anthropocene Scott Warren

Break

How are we building coastal marsh resilience throughout the region?

No management is active management: a regional evaluation of salt marsh conservation and restoration opportunities in a changing climate Rachel Stevens, Great Bay NERR

A soils/landscape perspective to salt marsh migration Mark Stolt, URI

Upland vegetation removal as a potential strategy for facilitating salt marsh migration Kenny Raposa, Narragansett Bay NERR

Increasing salt marsh surface elevations as an adaptation strategy- will it work in New England? Caitlin Chaffee, RI Coastal Resources Management Council

Ditch remediation pilot studies in National Wildlife Refuges of the Northeast Dave Burdick, University of New Hampshire

Marsh response to shallow drainage or runnels Wenley Ferguson, Save The Bay

1:00 pm Lunch

What monitoring and assessment strategies are being used in the region?

Long-term tidal wetland changes at Barn Island, Stonington, CT Ron Rozsa, plant community ecologist

Overview of salt marsh losses on Cape Cod, with special emphasis on crab-driven vegetation losses and consequences Steve Smith, National Park Service

Multimetric indices for integrated assessments of salt marsh integrity Hilary Neckles, United States Geological Survey

Drone applications for estuarine monitoring and assessment Bob Hartzel, Comprehensive Environmental Inc.

Appropriate use of numerical models for simulating salt marsh geomorphic evolution Neil Ganju, United States Geological Survey

Break

Group discussion

Wrap-up

4:30 pm Adjourn

Appendix B: Presentation Abstracts & Associated Q&A/Comments

I. How are coastal marshes faring in New England?

Salt marsh sustainability in New England: progress and remaining challenges

Dr. Cathleen Wigand, US EPA, NHEERL, ORD, Atlantic Ecology Division

Natural resource managers, conservationists, and scientists described marsh loss and degradation in many New England coastal systems at the 2014 "Effects of Sea Level Rise on Rhode Island's Salt Marshes" workshop, organized by the Narragansett Bay NERR, Save The Bay, RI CRMC, and US EPA. Workshop participants described how marsh loss and changes in vegetation and accretion patterns correlated with sea level rise and anthropogenic stressors. They agreed that partnerships throughout the New England region were needed to facilitate a better understanding of coastal marsh vulnerability, resilience, and sustainability. Development of climate adaptation and restoration methods to build coastal resilience were discussed, and an adaptive management framework incorporating reference systems was identified for implementation. I discuss the progress made in assessing, monitoring, and restoring coastal marshes in New England. I highlight the direction of the science including research addressing the underlying processes and dynamic feedbacks to sustain coastal marshes and communities. This progress has influenced the evolution of the adaptive management framework, with new emphasis on incorporating a social-ecological systems approach when defining restoration goals and selecting adaptation methods. Remaining challenges for social and ecosystem scientists are development of predictive, dynamic models to forecast coastal marsh resilience to sea level rise, storm surges, and multiple stressors, and the incorporation of socio-economic parameters into models and indicators of coastal resilience. Using ongoing restoration efforts, I describe the process for successfully building partnerships and selecting climate adaptation actions.

Q: Were costs related to removing dredged materials included in the restoration costs? (suggests that they should not be included since dredge removal would be a cost anyway.) **A:** This will be covered in more detail in a talk later today (by Caitlin Chaffee).

Q: Why was there a big spike in news reporting around sea level rise in 2008/2009? **A:** Maybe because there was a change in administration. Al Gore also got the Nobel Prize that year, and there was an economic stimulus that happened. Ultimately, we are not sure, and this would be a good socio-political thesis topic. There was the largest spike in sea level rise that year as well, so there could be a connection between the science and the news.

Coastal wetland loss in Rhode Island: 1850s-present

Dr. Elizabeth Watson, Drexel University and the Academy of Natural Sciences

Worldwide, coastal wetlands are recognized as transition zones that are critical for buffering the coast from the effects of climate change, and they are also one of the habitats most vulnerable to the effects of accelerated sea level rise. Recent research has shown that coastal wetlands in the U.S. Northeast are disappearing at an alarming rate. These wetlands largely are not being lost to coastal development, but to fragmentation and drowning. This presentation will discuss processes and rates of coastal marsh drowning in Rhode Island over the past four decades, within the context of late 19th and 20th century changes analyzed using historic maps, and present evidence that sea level rise is chiefly to blame. These results highlight the inability of current remote sensing monitoring programs (C-CAP and NWI) to identify coastal wetland drowning. Furthermore, these results demonstrate the need for an improved coastal remote sensing monitoring program as well as publicly-available on-the-ground monitoring data to guide and inform coastal climate adaptation projects.

Q: I recently read that accretion is increasing with tidal inundation; have you seen this? **A:** I think that if the amount of inundation increases, there is increased opportunity for sediment deposition. But it

can be decoupled from the elevation trend in the marsh. Some of the long-term surface elevation table (SET) data suggests that elevation is not tracking sea level rise.

From notecards:

Q: What percentage of the 1972-2011 marsh loss is due to development vs. physical processes described (erosion, ponding, etc.)? **A:** Qualitatively, none of the marsh loss was due to development. I did not see any instances of coastal development encroaching upon the marshes at which I looked. From site visits, I can tell you that marsh in a few places is getting mowed or has a semi-permanent path over it for coastal access (e.g., pallets), but none of the sites at which I looked were marsh in the 1970s but parking lots today. Some of the decline in tidal marsh was due to conversion to *Phragmites australis*. Because I couldn't tell the difference between tidal and non-tidal *Phragmites australis*, I excluded it from the analysis and didn't include it as native tidal marsh. This was an important contributor at only a couple of sites (Sepowet and the Palmer River), but these are some of the larger areas of marsh. **Comment** *(Ron Rozsa)*: I think the question here is not about marsh loss but vegetation loss. A natural marsh, especially the basin areas, support extensive areas of salt pannes/ponds, and these are critical marsh habitats; so, the restoration of salt pannes/pools to a ditched marsh should not be characterized as vegetation loss. Long-term studies at Barn Island reveal this: post ditching, the basin vegetation contracts and *Spartina patens* becomes dominant in the basins. Post circa 1960s, the basin vegetation begins to expand (moves upslope; marsh change is controlled by elevation) in response to sea level rise and shorter-term metonic cycle sea level accelerations and decelerations. This is the stage of basin expansion. From the 2017 elevation survey, the natural marsh profile of levee and basin topography is preserved. The backslope of the levee which supports *Spartina patens* is a wide band of the uppermost basin vegetation in 1976- the forb community. By 2017, all of the forb community is replaced by short-form *Spartina alterniflora*, but in the basin, there are alternating bands of stunted *Spartina alterniflora* and salt pannes/pools. This critical and natural habitat of salt pannes/and pools are restored; this is not marsh loss. The next stage for Palmer Neck may be the waffle marsh- a megapool with vegetation confined to the edges of ditches and creeks. (This, however, did not occur at Sassafras Marsh which reverted to the pre-ditching habitat without the waffle phase). In Plum Island, it has been observed that as ditches aggrade, creeks grow, and in some places they incise across levees, drain the pools, and are colonized rapidly by tall *Spartina alterniflora* with sedimentation rates 2 to 3 times that of sea level rise. This could be a phase that allows the marsh to return to the natural marsh with levee and basin topography. Meanwhile, the natural marshes with levee and basin topography have remain unchanged for at least a century. **Comment** *(Scott Warren)*: After passage of tidal wetland protection legislation in New England in the late 1960s and early 1970s, marsh loss due to filling and dredging for commercial development pretty much ended. In CT, loss rates in the decade before 1969 were over 200 acres yr^{-1} (principally fill for residential and commercial building and dredging for marina development). Since passage and implementation of CT's "Tidal Wetlands Protection Act," losses have averaged about ½ acre yr^{-1}, generally permitted for transportation infrastructure projects and often requiring some sort of compensation or mitigation.

Marsh impairment and future considerations: a Massachusetts overview

Marc Carullo, Massachusetts Office of Coastal Zone Management

Massachusetts' approximately 1,500 miles of shoreline includes over 18,000 hectares of tidal wetlands, including both micro- and mesotidal conditions and two biogeographic provinces (Virginian and Arcadian). Evidence suggests that while losses from filling have stabilized since the implementation of the Massachusetts Wetland Protection Act, significant future challenges and threats remain. Research and anecdotal evidence from the Great Marsh (northeastern MA) and Cape Cod suggests that drivers of marsh stress have caused excessive ponding, severe edge erosion, high marsh vegetation dieback, and overall marsh loss or impairment in a number of salt marsh complexes. Marsh areas perched high in the local tidal frame have experienced excessive ponding, possibly caused by a combination of legacy ditching effects, including subsidence and hydrologic impairment, and sea level rise. Edge erosion and creek

widening, possibly driven by one or more stressors such as sea level rise, nutrient loading, and crab herbivory and burrowing, have significantly reduced the areal extent of marshes in numerous microtidal estuaries in Buzzards Bay and Vineyard/Nantucket Sound. Anecdotal evidence of increased erosion of fringing marsh suggests potential sea level rise and storm impacts. Tracts of salt marsh in the Great Marsh, Barnstable Great Marsh (Cape Cod), and elsewhere along the coast suggest that some areas may be more resilient than others, but the tipping points of marshes are largely unknown. Various research, monitoring, and inventory projects being conducted by federal agencies, academic and NGO institutions, and the state have raised the stakes for resource managers to develop sound tools, frameworks, and policies for increasing marsh resilience in the Commonwealth. CZM and partners are coming together to develop a blueprint for marsh resilience that aims to provide tools, strategies, and guidance on managing marshes at this critical juncture and beyond.

Q: You talked about a citizen science network manual; can you tell us more about that? **A:** CZM and partners developed it around 2000 or so as a tool for folks to use. The restoration community did make use of that too, to do pre- and post-restoration monitoring. There has been less funding for monitoring over years. We think people are using it, but there is not a comprehensive way to know if it is being used.

Maine: state of the state's malt marshes

Dr. Susan Adamowicz, US Fish and Wildlife Service, Rachel Carson National Wildlife Refuge

While known for its rocky shoreline, Maine also hosts thousands of acres of tidal marsh. Much of that acreage is held in Scarborough Marsh itself, though a slightly larger number of acres is held by the Rachel Carson National Wildlife Refuge in its 11 divisions across 50 miles of coastline. With tides ranging from 9 to over 20 feet in height, the state's salt marshes experience a meso- to macro-tide range. Salinities range from euryhaline to oligohaline. Though there are a few large salt marsh systems (Scarborough, Webhannet, Brave Boat Harbor), many of the sites are relatively small fringing marshes. Maine's salt marshes are definitely experiencing change/stress on multiple fronts. Fiddler crabs (*Uca* spp.) were first documented southern Maine in 2016. Though there have not been documented cases of *Sesarma*, *Carcinus maenas* may be having a significant effect on marsh edge stability. Certainly we have lost the sloping zone of *Spartina alterniflora* along many channels and now have unstable straight-sided banks, or collapsing banks with crevasses on the marsh platform. Large sediment deposits noted in Massachusetts in 2018 also occurred in southern Maine. We also await assessment of sediment deposition from Winter Storm Reily and the Nor'easter that followed a week later. With contributions from many state colleagues, we hope to present a brief synopsis of our marshes "by the numbers."

Comment: Let's discourage the use of the word "spoils" when talking about dredged materials, as it has such a negative connotation.

Prospects and uncertainties for tidal marshes in New Hampshire

Dr. David Burdick, Jackson Estuarine Laboratory, University of New Hampshire

(Moore, G., Peter, C., & Payne, A., Jackson Estuarine Laboratory, University of New Hampshire; Ballestero, T., Environmental Research Group, Department of Civil and Environmental Engineering, University of New Hampshire; Vincent, R., MIT Sea Grant College Program)

In New Hampshire as the rest of New England, tidal marshes are responding to climate change. Warmer climate allows northern limits of plants like *Iva frutescens* and *Hibiscus moscheutos* to extend northward. The rate of marsh building is chasing increased sea levels, but some marshes cannot keep up, leading to dramatic changes. Some of these high marshes are transitioning gradually to low marsh, but others exhibit hummock formation and dieback before cordgrass can colonize. Low marsh can drown as well, with significant and rapid loss of elevation (marsh collapse) seen in particularly vulnerable marshes. Although NH has been a leader in restoring tidal flow, a recent examination of culverts installed to restore tidal hydrology shows partial restrictions often remain and these may put upstream marshes in jeopardy. Loss of historic drainage paths combined with rising sea levels may lead to vegetation loss

following tidal restoration. Since marshes require regular tidal flooding and ample sediment supply to build in elevation, the longer we wait to restore the tides to restricted marshes, the less likely marshes will be able to recover. Replacement of drowned marsh via migration onto uplands is a great concept, but marshes have built into large flat meadows over millennia, shores are generally much steeper, especially in NH and many shorelines have been (or will be) walled off with barriers. To hedge against widespread marsh loss in the region, it would be prudent to consider new and combined approaches, including artificial sediment nourishment and re-engineering new and existing shoreline barriers into living shorelines with new marshes that grade gently into uplands.

Q: This is the first time I've ever seen boulders in a salt marsh; why did you choose to use them? **A:** There was no high marsh, so we put boulders where we thought ice would be based on wind direction.

Q: In DE bay and CA, I know that where there is a tidal restriction and subsidence when you re-introduce the marsh, it does not come back- it's open water. **A:** We will need to watch for that using water level monitoring. Partially opening restrictions is one way to deal with that.

Long Island Sound tidal marshes in the Anthropocene

Dr. R. Scott Warren, Connecticut College Temple Professor Emeritus of Botany
(Shimon Anisfeld, Yale University, New Haven, CT)

For the last 350 years, Long Island Sound tidal marshes have been on the receiving end of multiple human activities that have affected both community structure and a range of ecological functions. There were direct losses from fill and dredge, and more subtle impacts from tidal restrictions due to transportation corridors and tidal gates. Extensive ditching for mosquito control in the 1930s continues to alter vegetation patterns and ecological functions. Nutrient loading may be accelerating low marsh loss and is unquestionably degrading estuarine water quality. Accelerating relative sea level rise (RSLR) is potentially the most problematic anthropogenic factor affecting tidal marsh systems throughout the Sound. The high marsh community is likely to be the most threatened by RSLR. High marsh accretion rates along the Sound have generally increased over the last century, though not enough to keep up with RSLR, leading to a regional elevation deficit and increased hydroperiods. However, some sites with greater sediment availability have fared better, with accretion rates exceeding 4 mm/yr. *S. patens*-dominated sites sitting higher in the tide range have thus far remained relatively stable in their vegetation cover; systems with less elevation capital, however, show a decline in high marsh graminoids and an increase in forbs, stunted *Spartina alterniflora*, bare peat, and open water, all reflecting increasing hydroperiods. Loss of high marsh habitat both through erosion and conversion to low marsh will lead to the loss of ecological function and presents a significant management challenge for individuals and institutions with stewardship responsibilities for the Sound's tidal wetlands.

Q: For the Jarvis site, what is the source of mineral soils? **A:** I suspect it is mobilization as a result of a recently re-opened tidal restriction, but I do not know. There is 4-5 times more total suspended solids at this site than other places in Long Island Sound.

Q: A lot of people study sparrows. *Melampus* may be more important to the marsh; how much research is being done on organisms that are closer to the plants? **A:** There is a new paper out on *Melampus*; the other high marsh invertebrates are being ignored.

II. <u>How are we building coastal marsh resilience in the region?</u>

No management is active management: a regional evaluation of salt marsh conservation and restoration opportunities in a changing climate

Rachel Stevens, Great Bay National Estuarine Research Reserve and NH Fish and Game Department

Traditional conservation and restoration strategies need to evolve to account for changing sea levels in the face of climate change. To assess what future conditions might look like, the Sea Level Affecting Marshes Model was run for coastal New Hampshire under multiple time and sea level rise scenarios. From this, supplemental "decision support" mapping layers were developed to help identify the most

strategic restoration opportunities that will likely be sustained for the longest duration and maximize coastal resilience. An assessment of current salt marsh condition and adaptation potential, identifying areas of resilient salt marsh and pathways for migration, allows us to consider the relative benefit of restoration verses land protection when trying to maximize coastal resilience in the face of unprecedented change. A synthesis of statewide results and highlights at the community level will be presented.

Q: When you look at migration pathways, how much of it is privately owned where there are houses? Are there provisions for buying them or invoking eminent domain? **A:** In SLAMM you can either flood developed lands or protect them; we flooded them, so I am not sure of the percentage on that. I am working on the natural environment, others in the room are more involved with the community perspective.

Q: Did you define migration pathways? Is it slope? **A:** I showed you two- one was SLAMM results by 2100 with 6.2 feet of sea level rise. The other was within a pre-existing NOAA model- we are looking at the one-meter vertical buffer which is working for us nationally.

A soils/landscape perspective to salt marsh migration

Dr. Mark H. Stolt, Laboratory of Pedology and Soil-Environmental Science, University of Rhode Island

Migration of New England's coastal marshes is a function of a range of factors and influences. In this study, we examined soil properties of five salt marsh settings in southern New England: back barrier, tidal river, tidal creek, cove, and open water. Our overall goal was to develop an understanding of the spatial relationships among soil properties relative to marsh setting and geographic location on the marsh. Within this context, we recorded the thickness of organic soil materials (peat) across the marsh and used these data to estimate the slope of the landscape over which the marsh was migrating as a result of sea level rise. Over 50 marshes were sampled and described along transects at a minimum of three transect points (directly adjacent to tidal water, within the marsh interior, and at the marsh-upland interface). We found that peat thickness, soil halinity, and the presence of porewater sulfide were the most important soil variables for understanding the distribution of soils across the marsh landscape. Tidal rivers had the thickest peat (average thickness >150 cm), followed by marshes in tidal creeks (130 cm), coves (120 cm), open water (60 cm), and back barriers (32 cm). In general, peat thickness decreased from the marsh area adjacent to the open water to the marsh/upland interface for the tidal river, tidal creek, and cove marshes. At the barrier marshes, peat thickness was similar regardless of the location of the marsh. Peat thickness data suggest that marshes have migrated over landscapes with slopes of 0 to 3.8% (mean =1.5%). We also used a restored marsh to examine marsh migration relative to rapid sea level rise. In this case, we measured the length that the marsh vegetation had advanced as the result of an increase in tidal flow into the restored marsh. Over 14 years the marsh vegetation advanced more than 60 feet from the original marsh boundary. This advance occurred on slopes as great as 2.9%.

Q: If you do not have the before data on a marsh, how can you assess it later? **A:** If you look at the soils, you can tell where it started. It is obvious where the marsh was before a culvert replacement, then you can look at present day vegetation and soils to tell.

Upland vegetation removal as a potential strategy for facilitating salt marsh migration

Dr. Kenneth B. Raposa, Narragansett Bay National Estuarine Research Reserve

(Robin LJ Weber & Daisy Durant, Narragansett Bay National Estuarine Research Reserve)

Research has linked sea level rise and crab impacts to the degradation of southern New England salt marshes. In response, adaptation projects aimed at building resilience are now underway in many marshes, but these projects are not expected to be applied extensively across the region due to financial and logistical limitations. As an alternative, researchers and managers are also focusing on ways to aid salt marsh migration to ensure continued marsh persistence. In the absence of built structures, marshes will ideally migrate landward with rising sea levels, but new research shows that some types of buffer

vegetation (e.g., native forest and *Phragmites australis*) can inhibit migration of marsh species. We are therefore conducting a field experiment to determine if the removal of three distinct types of upland buffer vegetation will facilitate landward marsh migration. Our project is a before-after-control-impact experiment on Prudence Island, RI that includes the removal of ~0.2 ha tracts each of upland shrubland, red-maple forest, and *P. australis*. We will document ecological and physical changes in vegetation removal and control areas with annual monitoring of marsh plant distribution and abundance; marsh elevation; light levels; porewater chemistry; water table depth; and edaphic conditions. We are also monitoring bird use to investigate possible trade-offs in habitat value when removing existing coastal habitats to make way for marshes. This ongoing project is designed to inform future management decisions regarding the potential for, and facilitation of, salt marsh migration in response to sea level rise.

Q: Are the controls in the bird survey far away enough? **A:** There are clearly birds going back and forth. I tried my best; it is a first attempt to do this.

Q: What kind of maple? **A:** Red maple

Q: What kind of vegetation removal? **A:** all aboveground, no chemicals or herbicides. Simple and consistent among the three areas.

Q: Do you think the reason it did not migrate was because of the shrub root structure? **A:** It could be a lot of things; the slope is different, the vegetation was so thick. I think the vegetative cover there played a big role.

Increasing salt marsh surface elevations as an adaptation strategy- will it work in New England?

Caitlin Chaffee, RI Coastal Resources Management Council

Increasing marsh surface elevations through the application of sediment has proven a successful method for improving marsh resilience in locations such as Louisiana, however the applicability and effectiveness of the technique in the New England region has remained uncertain. The practice had been largely untested in New England as of 2016, when three thin-layer sediment deposition projects were implemented in Rhode Island. Monitoring is now underway at these sites to evaluate the effectiveness of this technique in building marsh resilience to sea level rise. Information will be presented on the Ninigret marsh enhancement project in Charlestown, RI, including design and permitting considerations, monitoring plan design, initial results and lessons learned. The project will be discussed within the broader context of marsh resilience planning and management in Rhode Island—a multi-tiered effort involving several partner organizations.

Ditch remediation pilot studies in National Wildlife Refuges of the Northeast

Dr. David Burdick, Jackson Estuarine Laboratory, University of New Hampshire
(Susan Adamowicz, Rachel Carson NWR, USFWS; Gregg Moore, Chris Peter, & Devin Batchelder, Jackson Estuarine Laboratory, University of New Hampshire; Geoff Wilson, Northeast Wetland Restoration)

We have begun to pilot new approaches to reducing the presence and effects of past ditching. Ditches drain the marsh, as intended, but also result in substantial subsidence and carbon loss, which was unintended. In New England, ditching ranges from light to severe with ditches every 10 linear meters. Our measurements suggest that dense ditching can reduce marsh elevation by 15 cm. By also destroying marsh capital, dense ditching makes these marshes more vulnerable to conversion or loss with sea level rise. Complete restoration to pre-settlement times is unlikely to be achieved – locating and re-excavating original tidal creeks would be difficult. Early attempts to reduce marsh drainage involved "ditch plugging" and led to excessive impounding and vegetation loss behind the plugs. Another approach to reduce negative impacts from ditching is called "ditch remediation." This technique involves harvesting the "salt hay" from the marsh platform, tamping it into pre-identified ditches, and securing with biodegradable twine. We began piloting this effort at Rachel Carson NWR and Parker River NWR in 2010 and show some early results. In 2014 at Parker River NWR, the treatment was applied to every other ditch for two successive years at six sites. Monitoring has shown steady declines in ditch depth, leading to

recolonization by *Spartina alterniflora* after two years in some of the shallower ditches. Long-term monitoring will be required to determine if sediment accumulations reduce excessive drainage and allow rebuilding of elevation capital of the marsh bordering these artificial drainage paths. We also show pilot use of coir logs at Wertheim National Wildlife Refuge (NY) where there is not enough suitable vegetation.

Marsh response to shallow drainage or runnels

Wenley Ferguson, Save The Bay

(Watson, E., Drexel University)

Coastal wetlands in southern New England are not keeping pace with sea level rise and are experiencing an increase in interior ponding and die off areas and transitioning from vegetated to bare or open water areas. Installation of shallow channels, or runnels, is an adaptive management technique that is being used in New England marshes including Rhode Island, New Hampshire, and the Massachusetts section of the Narragansett Bay watershed. Runnels connect marsh dieback and shallow impounded water areas to existing tidal channels or ditches. By facilitating drainage, formerly impounded water areas can revegetate with early colonizing species such as *Salicornia* and eventually *Spartina alterniflora* and high marsh species dependent upon the marsh elevation. These hydrologic alterations can increase exchange of tidal waters and drainage of groundwater. Runnels can be relatively simple to install with low ground pressure equipment or by hand. Due to their shallow dimensions, runnels need to be maintained to prevent clogging from vegetation or sediment. In this presentation, data will be presented including the effect on the vegetation community, groundwater table and porewater salinities. Additionally, lessons learned from where this marsh adaptation technique has been implemented will be shared.

Q: Do trampling deer create runnels in the long-term? **A:** Yes- we use their trails.

Q: Is there a sweet spot regarding drainage? **A:** It's very shallow- ~16 cm decrease in elevation. We don't want to excavate so much that the marsh would subside, and we don't want new openings, so we install sills at the edges of runnels to deal with sheet flow.

III. <u>What monitoring and assessment strategies are we using in the region?</u>

Long-term tidal wetland changes at Barn Island, Stonington, CT

Ron Rozsa, plant community ecologist

Many wetland scientists point to sea level rise as a primary driver of biophysical changes in tidal wetlands. A careful examination of changes over eight decades reveals that the Barn Island wetlands are responding to the drastic alteration of tidal hydrology by the construction of mosquito ditches. Ditching depresses the height of high water to the extent that the once wide and continuous levees shrink over eight decades. This causes a shift of the dominant levee grass from *Spartina patens* to *Juncus gerardii*. In 1947 Dr. Frank Egler describes a dieback of the *Juncus* belt along the upland border and this dieback returns in 1963, 1983 and 2008. In 1976 and 2017, the *Juncus* belt has been replaced by forbs everywhere except for the one small natural marsh with levee and basin topography. Here the *Juncus* belt remains intact and therefore the dieback is the result of the altered hydrology from ditching and the tidal range fluctuations of the lunar nodal cycle. In 1976, the plant communities at several locations are mapped. Discovered in 2016 are Dr. Niering's field notes describing four new transects on the Palmer Neck section. These transects were resurveyed in 2017 and 1976-2017 data set allow for a detailed description of vegetation change in the last 40 years. Not all changes are slow as evident at and adjacent to the 2008 dieback at Brucker Marsh. In several locations, the marsh is reverting to the equilibrium levee and basin topography.

Q: Regarding work done at Barn Island in 2017- is the forb panne still there? **A:** I worked there for some years; *Juncus* is still there, and the rest is stunted cordgrass. Downstream it transitions, including *Spartina patens*. In the southern marsh, *S. patens* is coming back on the levee. In the north, forbs are switching to *S. patens*.

Overview of salt marsh losses on Cape Cod, with special emphasis on crab-driven vegetation losses and consequences

Dr. Stephen Smith, National Park Service, Cape Cod National Seashore

Research over the last 10+ years has revealed that salt marsh plants on Cape Cod are being consumed and eventually killed from intense, continuous grazing by a species of nocturnal, herbivorous crab—*Sesarma reticulatum Say* (Purple Marsh Crab). Losses within the low-marsh zone, dominated by smooth cordgrass (*Spartina alterniflora*), have been particularly severe, however, vegetation losses have also occurred in the high marsh, which is comprised of mainly saltmeadow cordgrass (*Spartina patens*). In contrast to the low marsh, high marsh losses consistently occur along the seaward-most edge of this zone, suggesting a link with flooding frequency and, therefore, sea level rise. Plants growing there also seem to have a much-reduced capacity to recover from *Sesarma* grazing. Throughout marshes, the creation of open dieback areas also seems to have facilitated invasions of mud fiddler crabs (*Uca pugnax*). Manipulative field experiments indicate that these crabs may be attracted to open, unvegetated habitats with softer substrates. This is important since these crabs contribute to elevated suspended sediment loads in the water column through bioturbation (burrowing and feeding) and this leads to erosion and elevation lowering. The loss of vegetation through *S. reticulatum* herbivory has resulted in a cascading series of events, with substantial consequences for vegetation recovery and overall marsh resilience.

Q: Why is the purple crab moving north? **A:** Climate change perhaps, but we don't have great monitoring data. Expect further movement north like fiddlers.

Q: Is there this much destruction in the south? **A:** No- the numbers may not be so high further south (perhaps from more predation).

Multimetric indices for integrated assessments of salt marsh integrity

Dr. Hilary A. Neckles, USGS Patuxent Wildlife Research Center

Tools for assessing and communicating salt marsh condition are essential to guide decisions aimed at maintaining, enhancing, or restoring ecosystem integrity and services. Ecosystem monitoring is recognized as a critical component of environmental decision-making, and integration of monitoring data into a multimetric index (MMI) offers a way to detect changes in ecosystem condition and report on overall system health. Ultimately, the usefulness of the index depends both on how well it reflects conservation goals and its sensitivity to change. The U.S. Department of the Interior protects extensive salt marsh acreage within northeastern National Wildlife Refuges and National Parks, and MMIs have been developed for salt marsh assessments to meet specific conservation mandates. The National Wildlife Refuge MMI is based on a structured decision-making framework to optimize management decisions. Monitoring variables were selected to target management objectives, and linear value modeling was used to aggregate multiple attributes into a single performance score representing total management benefit. The National Park MMI was generated using an algorithmic approach for selecting the combination of metrics most strongly correlated with human disturbance. In each case, the MMI provides an efficient, transparent approach to incorporate monitoring data into conservation practice.

Q: USFWS used vertical elevation change as a metric for marsh area? **A:** It's a crude measurement, not really an area.

Q: Did you weigh any of the metrics you used to calculate MMI? **A:** No, but they can be weighted. In a management context, if you value one more than another, you can apply different weights.

Q: How do you ensure that all management goals are incorporated in an MMI? **A:** It was an initial stakeholder process some 10 years ago and is an adaptive process.

Drone applications for estuarine monitoring and assessment

Bob Hartzel, CLM, CPESC, Principal, Comprehensive Environmental Inc.

The use of unmanned aerial systems (UAS, also known as drones) in environmental science and engineering is expanding rapidly as the accuracy of these tools increases and costs go down. In just a few

hours, drones can provide high-resolution imagery for estuarine areas that would take days or weeks to assess on foot. This presentation will provide an overview of how drones can be put to work for estuarine investigations, including: Ecological assessments and mapping (salt marsh vegetation communities, seagrass beds, invasive species, etc.); Infrastructure inspections, including stormwater infrastructure and culverts; Shoreline/coastal erosion assessments and mapping; Shoreline structure inventories (docks/piers, Chapter 91 inventories, etc.); Topographic survey to support BMP designs; and High-resolution imagery (photo-mosaic and video) to document baseline conditions for climate resilience planning.

Q: What is your crash rate? **A:** They can handle more than you think- up to a 20 mph gust. Showing off, one landed on a truck, not the target!

Q: Did you using ground control points for the ortho images? **A:** If you want actual elevations, go ahead of time and put in ground control targets- the drone can interpolate between points.

Q: Have you used MAR on drones for stress environments? **A:** Any vegetation with color signature change works well.

Comment: We are getting better with digital elevation models.

Appropriate use of numerical models for simulating salt marsh geomorphic evolution

Dr. Neil K. Ganju, U.S. Geological Survey, Woods Hole Coastal and Marine Science Center

Salt marshes respond to numerous forces, including sea level rise, sediment transport, and biogeochemical feedbacks. Identifying future states of salt marshes is a priority for coastal managers, and numerical models are used to predict future distribution under sea level rise scenarios. However, numerical model development for salt marshes has evolved rapidly, and in many cases these models neglect sediment transport processes, robust quantification of uncertainty, and proper skill assessment. In contrast, nearshore and estuarine physical scientists have developed numerical models to predict estuarine geomorphic response to sea level rise, tidal processes, and sediment transport, with limited success, despite adhering to comparatively rigorous assessment. The shortcomings, sources of uncertainty, and assessment standards of geomorphic models are well documented within the estuarine modeling community; however, the uncertainty surrounding salt marsh biogeomorphic processes likely results in relatively greater uncertainty. Nonetheless, we recognize the value of deterministic numerical models. They can be used to explore complex feedbacks between hydrodynamics, waves, sediment transport, and vegetation to develop a mechanistic understanding of what determines salt marsh geomorphic evolution. For example, we can investigate the fate of laterally eroded marsh sediments and examine the implications for landward migration of the seaward edge. With this application we aim to develop an increased understanding of coastal resilience through targeted scenarios (e.g., do living shorelines hamper sediment transport from the mudflat to the marsh levee and decrease vertical accretion?)

Q: Is SLAMM (and other models) useful or not? **A:** All models are wrong, some are useful. There are few robust calibrations of models (if you want to make decisions on what to manage). I imagine that SLAMM is useful for long-term low to high marsh, but not sure if it's better than a bathtub model. Regarding the Marsh Equilibrium Model (MEM)- it all goes back to a 2002 paper with parameters but no justification. It might work at the basin scale.

Q: How does your UVVR measure marsh loss over time? How can we use it for interventions? **A:** There is a stable one at .1, it used to be at .4, on its way to water. If you lose the ability to trap sediment, the marsh is on its way out.

From notecards:

Q: what kind of model resolution is necessary to adequately (and efficiently) resolve marsh sediment dynamics? **Comment** *(Scott Warren)*: This depends, very much, on the scales, both temporal and spatial, of interests: tidal cycle, annual, decadal, century, millennial/square meters, hectares, system wide…

General questions and comments from notecards:
Q: Knowing that coal combustion residue (coal ash) has lots of "bad stuff" (As, Se, V, Hg, etc.), could it be used for thin layer placement (TLP)? **Comment** *(Scott Warren)*: I sure would hope not. The anaerobic nature of salt marsh peats might well help immobilize some of the heavy metals, but this would probably take a while (years until the fly ash was buried/incorporated into the peat), meanwhile a lot of nasty stuff could be moving into the estuary. **Comment** *(Mark Stolt)*: Why would you want to do this? There seems to be plenty of calls for dredging, as long as the dredged materials are safe of contaminants and sulfides, this may be a good use of the materials.

Q: Do we have any examples (data or observations) of marsh gain possibly through migration? **Comment** *(Rachel Stevens)*: We have a couple of small-scale examples in Great Bay, which pretty much reflect our SLAMM modeling. **Comment** *(Mark Stolt)*: Yes, I showed several examples. Almost all marshes that are not fringe marshes and aren't adjacent to slopes greater than 4% are migrating. The question is how fast. **Comment** *(Ron Rozsa)*: Yes- there is a discrete cycle of marsh migration which seems to coincide with the metonic cycle. As a result of ditching, the upland border of *Juncus* dies back approximately every 18 years. The *Juncus* peat washes away, exposing scattered blocks of freshwater peat from the *Panicum* belt. So the *Juncus* belt forms over the freshwater peat every 18 years. Following the last dieback event which began in 2005, in 2018 there is one location at Barn Island (over gently sloping outwash sands) where there is 15 meters of new tidal marsh. There have been very rapid changes at this location since 2005 with increased rates of sea level rise (~14 mm/yr). However, it is predicted that this will contract over the next 10 years as the tidal range contracts during the drier phase of the metonic cycle. At the end of 18 years there will be net landward migration, but it is suspected that at this location, the width of the new marsh will be less than 15 meters. Most of New England is dominated by glacial till and the elevation is steeper and the migration is less than in the sandy outwash areas. For more about this cycle: http://www.sound.uconn.edu/lissm/barn_island/marshmigration.html

Q: Are marshes keeping up with sea level rise? **Comment** *(Scott Warren)*: Some, but most do not seem to be able to maintain elevation in the face of current relative sea level rise rates. **Comment** *(Mark Stolt)*: Some are; which ones is the big question. **Comment** *(Kenny Raposa)*: Most are not in RI. See Raposa et al. 2016 (Elevation change and the vulnerability of Rhode Island (USA) salt marshes to sea-level rise. Regional Environmental Change). In this paper, we calculated net elevation change at a whole suite of SETs around the State and found that most are not keeping up with either recent or long-term rates of sea level rise.

Q: If you know elevation relative to mean high water (MHW), would all your questions be answered? **Comment** *(Rachel Stevens)*: In some parts of our (NH) system, but we need more than MHW. Tidal range, barriers to migration, episodic flooding events, etc. all factor in. **Comment** *(Scott Warren)*: Marsh elevations relative to a REAL tidal datum would be most helpful. NAVD88 and the equivalent are nice to have, but I really want to know just how frequently and for how long any point on the marsh is flooded by the tides. Knowing actual on-site MHW, therefore, would be nifty; it would allow elevations to be converted to flooding frequency, which would allow meaningful comparisons among sites with different tide ranges. But it sure would NOT answer all the questions out there. **Comment** *(Ron Rozsa)*: Absolutely- especially for the natural marsh. But why would a marsh track an average sea level rise rate of ~4 mm/yr. when the metonic cycle creates much faster or slower rates depending on the stage of the metonic cycle? For example, in the 1990s, the New London tide gauge sea level rise rate was 14 mm/yr. So since sea level rise rates change over shorter intervals, why would anyone expect marshes to keep pace with an 18-year average sea level rise rate? In 2015, Warren reported that the natural Mamacoke Marsh was tracking sea level rise whereas in the past it did not always. No one is critically examining

sedimentation accumulation rates versus the stage of the metonic cycle and shorter-term sea level rise rates. We know that ditching in marshes increases the frequency of basin flooding, but this likely translates into a decreased hydroperiod to the point that the fines in the flood waters are not deposited in the ditched marsh basins (LeMay 2007, Plum Island). I do not believe there is a sediment deficit but that the hydrology of the natural marsh creates a 'sediment' deficit through the reduction of the hydroperiod. From the Barn Island data, we know that if you have a contour map of the ditched marsh, one can predict future and past vegetation change. There are no studies of sedimentation rates across the elevation gradient to know how sedimentation rates are affected by elevation. The other complication revealed by the 2017 elevation survey is that the characteristics of the tide change as one moves up creek and we see, as expected, that elevations of the marsh and communities decrease upstream. There are also vegetation subtypes not recognized in the literature. For example, *S. patens* at the upland edge grows at a higher elevation than *S. patens* on the levee. The levees are drier and better drained, so this grass can grow at lower elevations (Warren and Niering, 1993). It would be great to replicate LeMay's sediment studies at the ditched and unditched marshes of Barnstable, MA.

Q: What about monitoring the evolution of the intertidal mud flats in relation to salt marshes? **Comment** *(Ron Rozsa)*: In Western Long Island Sound, analysis of low marsh habitat versus intertidal flats reveals that low marsh is gradually converted to intertidal flats over a period of three or more decades. We refer to this as subsidence and it occurs on the north and south shores of Long Island Sound. The cause of this conversion, which may be natural, is unknown. Here is the link to the 2003 workshop report on the subject of wetland loss due to subsidence: http://longislandsoundstudy.net/wp-content/uploads/2010/01/habitat_rest_wkshp_rpt03.pdf. **Comment** *(Scott Warren)*: It's been done; see slides 10 and 11 in my presentation. Also see Tiner, R.W., K. McGuckin, and J. Herman, 2013. Changes in Connecticut Wetlands: 1990 to 2010. Prepared for the State of Connecticut, Department of Energy and Environmental Protection, Hartford, CT. U.S. Fish and Wildlife Service, Northeast Region, Hadley, MA. 30 pp.

Q: How does the change in soil type on the upward edge of salt marshes (forest edge) impact the ability of marsh plants to migrate? What about peat vs. woodland soil types? **Comment** *(Mark Stolt)*: We would like to investigate this. Do you have any funding? **Comment** *(Scott Warren)*: Here, again, I'd get in contact with the salt marsh sharp tail sparrow group with their "marsh into upland" transects; they have data. I can only speculate based on a few sites I've been following for the last decade or so. On the latter basis: salt kills upland plants and more brackish forbs and grasses take initial advantage of the newly open space; a forest edge canopy vs. open field may have more impact than soil "type." **Comment** *(Ron Rozsa)*: In many places in the northeast, but not everywhere, the upland border of the salt marsh supports a freshwater non-tidal marsh called the *Panicum* belt (*Panicum-Baccharis* community). The lower slope of this community, underlain by freshwater peat, is replaced by tidal marsh approximately every 18 years, mostly resulting from the short-term acceleration of sea level rise from the metonic cycle. There are four documented marsh migration events (http://www.sound.uconn.edu/lissm/barn_island/marshmigration.html). The extent of the *Panicum-Baccharis* community is decreasing as it is replaced by the pre-colonial forested wetland dominated by *Nyssa sylvatica*. At Barn Island there are places where the forested wetland is being replaced by *Baccharis* (it may be that sea level rise raises the freshwater table and the vadose zone which floods the roots of trees and causes the tree to die). In time, *Panicum* may return to these unforested areas and thus the marsh migration of the *Panicum* belt as described above will occur in the future. During the last metonic cycle at Barn Island, *Juncus* became the dominant understory plant. The understory is tidal and therefore this is marsh migration- whether or not the trees are live. More observations are needed to study the nature of marsh migration into these forested wetlands. At Hammonasset State Park, a field marsh to create parking near Meigs Point in the last 20 years has seen rapid marsh migration onto manmade fills.

In over 30 years of marsh restoration in CT, provision of light and tides is all that tidal marsh plants require. Soil type will not affect tidal marshes' ability to migrate landward; elevation controls the amount.

Q: How do you differentiate between sea level rise impacts and impacts from changes in sediment deposition and drainage from upland areas? **Comment** *(Scott Warren)*: This is a site-specific question, I'd argue. Vegetation response integrates relative sea level rise/sedimentation/drainage. **Comment** *(Ron Rozsa)*: The key question may be how does one differentiate between the role of sea level rise (and the metonic cycle) upon marsh change versus that of grid ditching which radically alters flooding frequency and reduces hydroperiod. Ditching is a primary driver of marsh change in the ditched marsh; meanwhile the natural marshes remain unchanged for decades or centuries. I suspect that the so-called claim of sediment deficits as a result of changes to the upland (damming) are unfounded and that the perceived sediment deficit on the ditched marsh is a result of a reduction of the hydroperiod. There are few sediment/geological studies like LeMay 2007 on Plum Island where it was demonstrated that the fines in the floodwaters are not deposited on the ditched marsh. In a natural marsh with levee and basin topography, the average marsh elevations are 10cm higher than the ditched marsh. Tidal waters must overtop the levee first, and then any water that enters the basins remains there, for there are no creeks to drain the water back to the sea. This creates the longest hydroperiod and any sediment that reaches the basin stays in the basin. This is nature's most efficient sediment trapping machine. There is probably ample sediment supply in the creeks but almost no studies to that affect. More investigations like LeMay's are needed to help us understand sediment budgets and processes.

Q: Regarding natural sediment deposition from 2018 storms (Great Marsh, MA mentioned by Dave Burdick)- are any other areas being monitored? **Comment** *(Mark Stolt)*: Yes, I know of at least three that Amber Hardy talked about at the NEERS conference. **Comment** *(Scott Warren)*: Mamacoke Marsh in the Connecticut College Arboretum and the Barn Island system (that I know of for sure). Virtually any systematic SET array is "monitoring" storm deposition at some level or another. **Comment** *(Ron Rozsa)*: Peat cores at Barn Island along bayfronts show that there was a distinct sediment layer deposited by the 1938 hurricane, with another probably from Hurricane Carol in 1954. These deposits are typically found near tidal creeks but are not seen throughout the high marsh. The hydroperiod from surge is too short to deposit much sediment away from the creeks. The ditched marsh, the dominant marsh in New England, has been an eight-decade distraction for wetland scientists. I doubt that storm events are a significant driver in marsh health (see other comments regarding ditching versus natural marshes previously described).

Comments:

- Interest in learning more about The Nature Conservancy's work on buyout of properties.
- Interest in research documenting that marshes are not moving into uplands.
- Publish records of salt marsh/sea level rise research in literature vs. news, popular media, and similar topics.
- Snails aren't getting much attention and may be more important for the habitat; there's a new paper on *Melampus*, but other invertebrates are being ignored.
- Costs for dredging shouldn't be including in costs for TLP restoration (because it must happen anyway).
- What we are doing in marshes today is what we have done to beaches over the last 100 years. TLP=beach nourishment. Living shorelines=seawalls. We know how that's gone for beaches, we are setting ourselves up for the same issues down the line in marshes. The issue, once again, is the sediment budget. Nourishment and any kind of shoreline project disrupts natural sediment transport, which naturally contributes resilience when left alone.

Appendix C: Speaker Biographies

Dr. Susan Adamowicz is the Region 5 Salt Marsh LMRD Biologist for the Northeast Region of the US Fish and Wildlife Service. She is stationed at Rachel Carson NWR in Wells, ME but also has responsibilities at Parker River NWR (Newburyport, MA) and throughout the region. With over 25 years coastal work experience, she now focuses on innovative salt marsh restoration techniques, coastal resilience and the legacy effects of prior human alterations. A native Rhode Islander, Adamowicz still enjoys Del's Lemonade and swimming at Gooseberry Beach. Adamowicz currently serves as President-Elect of NEERS.

Dr. David Burdick is Research Associate Professor of Coastal Ecology and Restoration in the Department of Natural Resources at the University of New Hampshire, where he has taught wetlands courses over the past twenty years. His study of coastal science concentrates on coastal ecosystems by assessing human impacts and planning, implementing and assessing habitat restoration at the Jackson Estuarine Laboratory, where he serves as Interim Director. In 2012 he was awarded the Susan Snow-Cotter Visionary Award from the Gulf of Maine Council for the Marine Environment. He recently published a book with Charles Roman to translate and extend lessons learned from tidal restoration of salt marshes in the Northeast US and Canada. Outreach products include Dock Design with the Environment in Mind (to protect eelgrass), an Eelgrass Site Selection Model, and two habitat restoration atlases for coastal New Hampshire. Recent projects include: shoreline rehabilitation in NH and Maine, planning for sea level rise in Portsmouth NH, and measuring responses of salt marshes to rising sea level.

Marc Carullo is a GIS/environmental analyst with the Massachusetts Office of Coastal Zone Management, directing or supporting a variety of projects involving wetland monitoring and assessment, land cover/land use analysis, coastal and ocean planning, and project review. He is the project lead on CZM's effort to model the potential effects of sea level rise on coastal wetlands for enhanced planning, management, and policy development. Marc sits on the Northeast Ocean Council's Marsh Migration Steering Committee and participates in regional and national biological assessment of wetlands work groups. Marc has previously worked for the USFWS and NPS in GIS development and biological monitoring capacities.

Caitlin Chaffee has been a policy analyst with the Rhode Island Coastal Resources Management Council for over 11 years. In addition to developing policy on coastal habitats and stormwater management, she manages the Rhode Island Coastal and Estuarine Habitat Restoration Trust Fund and chairs the Fund's technical advisory committee. She works with federal, state and local partners to design and implement coastal habitat restoration projects. Chaffee received her master's degree in environmental science and management from the University of Rhode Island.

Wenley Ferguson is Save The Bay's Restoration Coordinator. She has worked at Save The Bay since 1990 on a variety of habitat and water quality assessment and restoration projects throughout Narragansett Bay and its watershed. Projects have included salt marsh, anadromous fish, and coastal buffer restoration projects and restoration monitoring. Wenley works with local, state and federal partners on the identification, design and implementation of salt marsh restoration and adaptation projects. Additionally, she works with municipal partners on stormwater infiltration and coastal adaptation projects.

Dr. Neil K. Ganju is a Research Oceanographer with the U.S. Geological Survey at the Woods Hole Coastal and Marine Science Center. His research spans the multiple disciplines that converge in estuarine systems. Research projects include numerical model development, field observations of hydrodynamics and water quality, wetland and coastal vulnerability assessments, geomorphic change, and

eutrophication. Prior to joining the USGS in Woods Hole in 2008, he worked for the USGS at the California Water Science Center, on the San Francisco Bay Sediment Transport Project. He studied civil engineering at the University of Michigan (BSCE), the University of Florida (MSCE), and the University of California-Davis (Ph.D.).

Bob Hartzel is a Principal with Comprehensive Environmental Inc. (CEI) and leads CEI's Ecological Services practice. Bob is a Certified Lake Manager, Certified Professional in Sediment and Erosion Control, and wetland scientist with over 25 years of experience in managing coastal, riverine, lake, and wetland restoration projects in New England.

Dr. Hilary A. Neckles has worked as a coastal research ecologist with USGS Patuxent Wildlife Research Center stationed in Maine for the past 20 years. Currently, she also serves as President of the Coastal and Estuarine Research Federation (CERF, 2017-2019). Previously she held a research position at USGS National Wetlands Research Center in Louisiana. Her recent research has emphasized developing integrative approaches for salt marsh, seagrass, and estuarine ecosystem monitoring and assessment at multiple scales. She received a B.S. in Wildlife from University of Massachusetts, a M.S. in Wildlife from University of Minnesota, and a Ph.D. in Marine Science from the Virginia Institute of Marine Science.

Dr. Kenneth B. Raposa has been the Research Coordinator at the Narragansett Bay NERR for over 18 years and has published 27 manuscripts in peer-reviewed scientific journals. He recently co-led and published a national-scale marsh resilience assessment, co-led the 2014 RI salt marshes and sea level rise workshop in RI, coordinated an *Estuaries and Coasts* thematic issue focused on salt marshes and sea level rise, and is currently involved in two large-scale sediment addition projects in southern Rhode Island. He has dedicated his recent research toward understanding marsh responses to sea level rise and experimentally evaluating multiple adaptation strategies for enhancing marsh resilience. This includes conducting a field experiment testing thin layer sediment placement as a tool to build marsh resilience at eight NERRS with a 500k grant from the NERR Science Collaborative, and experimentally testing ways to facilitate marsh migration with a grant from the RI Coastal Resources Management Council.

Ron Rozsa is a plant community ecologist retired from the Coastal Management Program of CT DEP. Ron developed the restoration policies contained in the CT Coastal Management Act and organized the tidal wetland restoration program. He conceived of the idea for a site plan review committee comprised of resource experts, scientists and managers to advise on marsh restoration projects and to help mosquito control implement Open Marsh Water Management. In 1994, Ron collaborated with the USFWS Coastal Program to develop the designation document to nominate the lower Connecticut River as a Wetland of International Importance. In retirement, he worked on three resource plans including an Assessment Report for the Barn Island Wildlife Management Area. Ron volunteers time to help the Wildlife Division of DEEP by creating a website about Barn Island as a sentinel monitoring site and compiling historic data for this location, including a series of conceptual modules about marsh migration, the natural marsh, the ditched marsh and the reverting marsh.

Dr. Stephen Smith is a Plant Ecologist at the Cape Cod National Seashore, with expertise in plant physiology and plant community ecology. Stephen received a B.S. degree from Florida State University and a M.S and Ph.D. from the University of Miami. After spending five years working on the restoration of the Florida Everglades, he assumed his current position with the National Park Service in 2002. Stephen's current activities are focused on understanding the dynamics of spatial and temporal variability within plant and animal communities in all of the different ecosystems within the Seashore.

Rachel Stevens is the Wildlife Ecologist for NH's Fish and Game Department and Stewardship Coordinator for Great Bay National Estuarine Research Reserve.

Dr. Mark H. Stolt is a Professor of Pedology and Soil Environmental Science at the University of Rhode Island. He teaches soil morphology, classification, genesis, mapping, conservation and land use to graduate and undergraduate students. He coached the URI soils team for the last 20 years; with six top 4 finishes at the national contest and the national championship in 2011. His research focuses on riparian, palustrine, coastal, and subaqueous soils and landscapes. Mark has been the major professor for 25 graduate students publishing over 75 research papers. He is the president of the Society of Soil Scientists of Southern New England, Chairman of the New England Hydric Soils Technical Committee, and Chairman of the Fundamental Changes to Soil Taxonomy Task Force.

Dr. R. Scott Warren, Connecticut College Temple Professor Emeritus of Botany, has been studying tidal marsh and estuarine ecosystems for over 45 years. His research has included vegetation dynamics, macroinvertebrates and fish, marsh restoration, and the impacts of sea level rise and nutrient enrichment. While much of his work has been within Long Island Sound, he has also participated in multi-investigator projects at South Slough, OR and Plum Island Sound, MA. His research has been funded by the National Science Foundation, Connecticut and Oregon Sea Grants, Army Corps of Engineers, The Nature Conservancy, Connecticut Department of Environmental Protection, and the U. S. Fish and Wildlife Service and appears in a number of journals including NATURE, ECOLOGY, ECOLOGICAL APPLICATIONS, ESTUARIES & COASTS, MARINE ECOLOGY PROGRESS SERIES, NATURE, and RESTORATION ECOLOGY. He has been an associate editor for WETLANDS and ESTUARIES & COASTS and served on numerous state and federal advisory committees and review panels and as president of both the New England Estuarine Research Society and the Northeast Chapter of the American Society of Plant Physiologists. In 2009 he received the William A. Niering Outstanding Educator Award from the Coastal and Estuarine Research Federation.

Dr. Elizabeth Watson is an Assistant Professor in the Department of Biodiversity, Earth & Environmental Sciences at Drexel University in Philadelphia, and the Wetland Section Leader at the Patrick Center for Environmental Research at the Academy of Natural Sciences, the oldest natural sciences institution in the western hemisphere. With colleagues from National Estuary Programs, she coordinates coastal wetland monitoring at 11 sites in the Mid-Atlantic. She received her PhD in physical geography from the University of California, Berkeley, and was a post-doctoral researcher at the University of California Davis (with the Hydrologic Sciences group, studying floodplains) and at CICESE, a research laboratory in Baja California (studying remote sensing of wetlands). Prior starting at Drexel in 2015, she worked for the U.S. Environmental Protection Agency in Narragansett, Rhode Island, and for the Elkhorn Slough National Estuarine Research Reserve, in coastal Monterey Bay, California.

Dr. Cathleen Wigand is a research ecologist with the US EPA in Narragansett, Rhode Island, beginning her position in 1998. She received her PhD from the University of Maryland and conducted postdoctoral research at the Cary Institute of Ecosystem Studies in Millbrook, New York, prior to beginning her career with the US EPA. Her research and management interests span three broad areas: (1) monitoring and assessment of wetland condition and vulnerability; (2) multiple stressor effects (e.g., eutrophication, climate change, sea level rise, land development) on the structure, function, and provision of ecosystem services (e.g., water quality maintenance, flood abatement, carbon sequestration, biodiversity); and (3) macrosystems science using integrative, ecological, and socioeconomic approaches across varying spatial and temporal scales to engage stakeholders and decision-makers, and provide the science to assess tradeoffs for different management, restoration, and/or climate adaptation actions.

Appendix D: Group Discussion Notes

Question 1: "Now that you have heard what is happening in all the states, what do you see as one or two of the most important things we should be doing together as a region?"

Main theme(s) of the conversation:

- Prioritize preservation of low-lying areas where we know marshes can migrate.
- Research the reason marshes in higher tidal ranges seem to be doing better. If there is a genetics connection, explore this further and consider propagating those plants in other vulnerable areas.
- Increase regional collaboration, share data and resources (e.g., equipment); perhaps start a dedicated mailing on who's doing what.
- Increase public awareness of the value of salt marshes. Implement hands-on activities to get people involved.
- Use consistent assessment methodologies [so we can share lessons learned, success/failures to inform future management (without repeat of pilot efforts)]
- Figure out how to transfer knowledge among practitioners (including non-professionals)- NEERS, existing databases and forums.
- Increase the use of UAS to assess vegetation change and standardize methods using UAS or other technologies (LiDAR, etc.)
- More invertebrate monitoring in high marsh habitats.
- Map where marsh migration can occur and where retreat is happening.
- Continue to support SET funding and educate students.
- More sharing of status- research like this and the 2014 meeting.
- Standardized set of metrics across New England (like or expand Salt Marsh Integrity)
- Understand the physics of edge erosion- does this lead to sedimentation in the marsh or erosion out to sea?
- Communication, collaboration, continued innovation.
- The main impediment is money, not lack of interest.
- More citizen science, coordination across regions, and prioritization of projects.
- Connect science to human well-being.
- We need a mascot for the salt marsh!
- Develop a region-level strategic blueprint for marsh preservation.
- Regional databases to share marsh data.
- Develop a tool that defines a lexicon of indicators of marsh loss.
- Need to clarify permitting and make it easier for living shoreline projects.
- Which salt marsh sites should be prioritized across states?
- Need for constant public engagement. Don't do things in a vacuum.
- Need to study invertebrates, etc., not just grass and sparrows.
- Need to get the word out to the public more about salt marsh loss and the value of marshes.
- Prioritization of what can be restored/saved.
- Regional coordination.

Discussion related to this question:

- In NY and in other places, one of the problems is outdated regulations that put the same restrictions on marsh restoration as they do on marsh destruction.

- We need policy and community planning to be more forward-looking and focused on the long-term; there are communities that want to hold back the water rather than recognizing the dynamic nature of the system.
- There's public misperception and lack of recognition of the importance of episodic events.
- Some places have been trying to be proactive, but regulators can be the barrier; instead of getting funding to support our work, we must pay all the regulation fees, etc.
- There's the social side of it- showing the news and the number of papers. No one in this room learned more- it is society that needs to be engaged. Something is missing, especially post-Sandy. Regionwide and nationwide, we need to pursue this. It is key to all the changes we want to see.
- Social media, news releases to broader audiences, etc.
- Needs to start in early education; younger grades do not have as much science.
- Maybe move it into curriculum so we can teach students in the field. Different states have different standards.
- If we cannot get students into marshes, maybe we need to develop curriculum that gets the marshes into the classrooms.
- Can we petition to make sure this is part of our national education standards?
- It's interesting that the rates of loss were almost identical…. this is a public awareness piece. We need to engage the community in understanding our rate of loss.
- We should work with social scientists to understand what people value and connect to that.
- Consideration of species range expansion.
- Have divide between meso/Arcadico and micro/Virginico salt marsh work.
- Need to remember the "old" science (invertebrates!) and integrate with newer technological methods (drones, remote sensing)
- Losing information on soil science, biogeochemistry.
- Regional data infrastructure collection and sharing.
- Regulations and permit holders' data collection needs to be integrated into science as well as made more relevant to issues.
- Need to look more to the macro tidal range in Maine (and Canada?)
- Need infrastructure to hold and share regional data.
- TNC's Ray Konisky- Global Programme of Action (GPAC; Gulf of Maine) protocols and his UNH database may be a model for the data infrastructure.
- Are we collaborating in the region as much as we should/could/need to be?
- Find out more about the MA program (rapid assessment, decision-support tools, marsh migration through land conservation, and statewide strategy) to inform/serve as a model for other states.
- We need young people to come into the workforce to do this work.
- The MA interior marsh data is not being used.
- Need to use the data that permit holders must collect as part of their permit.
- More use of UAS to assess regional loss and change and standardize with other technologies.
- More invertebrate monitoring in the high marsh.
- Map where high marsh migration can occur; get fine-scale topography and assess where retreat is happening (has been done in RI by CRMC)
- Is there a regional network that could support and integrate SET data?
- Tap into school systems and present this to students; get the curriculum to them.
- Keep up the organizational network and educate the public.
- Need to invest in science.
- Understand where living shorelines can be used to protect existing marsh.

- Regional coordination and prioritization across programs (e.g., Northeast Regional Ocean Council (NROC))
- Coordinate pilots of restoration efforts (no repeat of efforts to see how it works); report out at workshops.
- Share successes/failures.
- Consistent assessment methodologies; share lessons learned (use NEERS as a forum?)
- Erosion control to the detriment of marshes- how to increase marsh sedimentation without increasing sediment delivery to riverine areas?
- Large galvanization on the issue through engineering and management, but have skipped the opportunity to educate the wider public on best practices for marsh protection.
- Burdick, e.g., going after *Phragmites australis*; municipalities aren't focused on salt marsh.
- How to buy land for conservation?
- Change permitting structure.
- Inland hardscaping prevents migration; consider removal as a strategy.
- Internal federal communication: need to consider strategic use of dredged materials as a resource (test for contamination).
- Each marsh is unique.
- Culvert replacement is not a slam dunk.
- Regulation (nationwide permit) is a blunt tool.
- Conversation between research and permit/regulatory community.
- Need better interagency communication, particularly concerning essential fish habitat; "shared burden of proof"
- In NH there's a close connection with permitters; experimental projects need regulatory checkpoints to prevent harm.
- More use of suitable dredged material; it's a resource, not a waste product.
- Move hardened shoreline to expand migration pathways.
- Think about the bigger picture; before we do anything manipulative we need to understand how it would affect that specific marsh. Long Term Ecological Research (LTER) project convinced Parker River not to do living shoreline (as "do no harm"). It's all about the sediment for marshes to keep up with sea level rise; it's coming from tidal flats, not down from rivers; nature did it for us in one event, which wouldn't have happened if we had installed natural infrastructure. These are SITE-SPECIFIC systems.
- Great Bay is a sediment-heavy system; how do we work with natural process to keep this sediment on the marsh?
- Tidal restrictions vs. more accretion with more tidal flow is a challenging balance; when do you act when people like the status quo?
- Accretion of *S. patens* vs. *S. alterniflora*- are we just delaying it or there are more consequences down the line that we're not thinking about?
- CT is so impacted that there's no such thing as natural marsh; since it's so heavily impacted by humans already, if we have a chance to do anything we need to do it!
- Expand a strategic blueprint for tidal marshes to the regional level.
- Land and marsh protection, nutrient loading reduction.
- Some nutrient enrichment might be good (to improve plant growth?) Need more research on this topic.
- Regional database on sediment accretion rates; make SET information more widely available for modeling.

- Develop a catalogue of how sea level rise is impacting salt marshes which would allow others to identify issues before they get too bad.
- Want everyone speaking the same language; maybe have a regional terminology reference?
- Lexicon of marsh loss indicators.
- Need funding for long-term salt marsh research and monitoring.
- Need an inventory of and metric for tidal crossings so they may be evaluated.
- Is there a national regulatory issue here? New England states need to pull together and look at the big picture.
- How do you get Army Corps of Engineers dredged sediment?
- Create a 'ready to be implemented' database that matches dredge operations with local marshes that are ready to receive the material.
- What percentage of marshes are at the end of rivers? There is emphasis on removing dams, but how much would dam removal really help salt marshes?
- Which techniques would work at which marshes (what conditions require or would respond to thin layer deposition vs. natural shorelines vs. hardened edges, etc.)
- Currently, there is a different toolbox for each state; it would be good to get state regulators to adapt regulations so that there's one set of rules for New England.
- Demonstrate to regulators the natural processes in high vs. low marshes to provide more flexibility for restoration techniques.
- High resolution photos need to be available for all of our salt marshes.
- More collaboration/sharing and more detailed focus on specific issues in New England (like this and the 2014 workshop).
- Set of metrics for marsh loss.
- Not taking into account physics of edge erosion, only sediment source.
- Edge erosion could lead to marsh building or loss out to sea.
- MA is opportunistic re. restoration and is looking at things holistically. Seeing proposals and innovative pilot projects including living shorelines, hydromodeling of marshes, and thin layer placement (which is not permittable).
- Northeast Regional Ocean Council (NROC) Living Shorelines Regional Resilience Grants related to living shorelines- share information across states.
- Oyster restoration not allowed in MA because of water quality problems.
- How do invertebrates react to TLP?
- Are the functions (rather than just structure) of grasses the key?
- Not much in the public eye- will wait and wait, and then armor the shoreline. Need to get that out there and publicize.
- Prioritize at-risk marshes and what strategies can be done to restore them.
- What is "savable" and what is not and where should resources be placed.
- Infrastructure issues (e.g., culverts) and engineering solutions.
- National soil mapper added metrics. Support the Digital Coast Act to support high resolution data. Need additional tools to support continued collection of data for maps and big datasets.
- Expand inventory of crabs and other invertebrates to understand biological interactions.
- Further standardization of monitoring across districts.
- Further expansion of elevation measurements on a regular basis.

Suggestions for actions or next steps:

- Additional research and information on high marsh invertebrates.
- Regional database for map consistency (high resolution aerials, historic photos).

- Post/share results from TLP efforts.
- Best available sea level data in database (5 mm/yr. is an important #)
- Database and forum (e.g., CAKE)
- Transfer of knowledge to practitioners (land owners, land trusts); efforts exist but they really need a dedicated outreach person.
- Consistent geospatial metrics.
- All talk is about marsh loss; are there any marsh gains? (and identify the processes)
- Expand sentinel sites to identify marsh migration or loss, possibly using volunteers.
- Ways to change construction practices.
- Change how we message the threat- marshes aren't just changing, they could be lost- private landowners need to understand how the loss of marshes will impact them.
- Continue and increase collaboration between restoration practitioners, mosquito control, etc.
- More research needed on the impacts of coastal storms and sediment transport on salt marshes.
- Connect science to human health/wellbeing.
- Prioritization system for mapping strategies (on which salt marshes to focus for conservation); share that information across states.
- How are states addressing tide gates? Need for stormwater management for tide gates (bring in stormwater management folks)
- Need to figure out how to permit; get a group together to look at the ecology and the permitting process.
- Think about costs and long-term viability of projects/return on investment. Should be giving the coast more breathing room.
- Look at Netherlands & other European countries to see what they're doing.
- Restrictive regulations for living shoreline-type projects; can we change regulations for pilot projects?
- Don't do this in a vacuum- incorporate general public and stakeholders. We need really good stakeholder engagement.
- Come to a consensus on the restoration target (e.g., historic salt marsh extent? Future conditions?)
- Hoping that others understand that salt marshes are of value.
- Get out to the public more.
- Funding! Organize regional work, pool resources and money, hav a regional coordinator.
- Public, stakeholder, and interagency communication needs to improve.
- Use social scientists to improve communication outcomes.
- Connect with the public by talking about what they value (create a hook for engagement).
- Connect more with economic studies to communicate the value of wetlands to stakeholders.
- Make sure scientists are collecting the information that managers and the public needs.
- Need to ensure that financial support continues for long-term monitoring.
- Additional public benefit should be communicated (e.g., connect habitat with clam and oyster economies).
- What is actionable science and data? We need to ask the right questions before research is done to ensure the outputs and outcomes are what we desire.
- Better engage the National Estuary Programs (NEPs) as venues to support communication and outreach.
- Need to further connect end users with data (even at the federal level) and communicate with the public.
- How can we engage the public and empower them to act?
- Communicate the dire situation in our marshes to the public using existing communication avenues.
- Existing tide gates need further oversight because of the potential for mismanagement.

- Increase the use of visuals to capture coastal change and social media to drive support.
- Leverage citizen science to improve outreach.
- May be a crazy thought, but create genetically modified salt marsh hay to increase resilience? (general table consensus- probably not a good idea); investigate density of natural pools that maximize benefit [speaks to question of when/if we create drainage or not]; NOTE: no known studies, but studies needed.

Other topics that were mentioned during the discussion (parking lot issues):
- How to design stormwater control practices to not only hold sediment back from waterways, but to allow for a shortened residence time of sediment (let them filter through and return- cleaned- to estuaries)
- Connections to people (e.g., fisheries).
- Conflicts between wanting development and valuing systems.
- Coordinate citizen science actions.
- Road crossings banned in Greenland?
- In Canada there is a lot or rock, so you can armor more.
- In LA and GA, talk about the human benefits of marshes.
- In Maine you cannot restore mud flat- leave it protected habitat.
- "Living Shorelines in New England: State of the Practice" (TNC)

From notecards:
- Estuarine data are disparate across organizations and scales; the goal of the centralized data infrastructure is to bring them all together in one easily accessible and consistent database.
- Centralized data infrastructure for estuaries (features: data organized by estuary, standardized formats and schema, accessible to everyone; outputs: estuary data profiles and data gaps (spatial and temporal), landscape, site, plot)
- Do we have the data to calculate MMI? Can we do regional comparisons of estuaries?
- Look at changes in vegetation/biota and how that will play out in other marsh areas.
- Inventory of unditched marshes and better understanding of how they function to provide ideas on how to unplug ditches areas.
- Coordinated actions through citizen science programs, design a salt marsh mascot to teach local communities the importance of salt marshes, raise money for land purchases.
- Connect science to human well-being for general media.
- Be sure to say dredged "material" or "sediment" instead of "spoils"!
- Need "common" communication language and talking points as well as region-wide decision-support tools to promote marsh conservation, migration, etc.; research for our municipal governments.
- New England states need to get together and be consistent.
- Need regional prioritization of marshes (and areas within marshes) for interventions based on assessments.
- Need to prioritize what to monitor at the regional scale.
- Develop a region-level strategic blueprint for marsh preservation.
- Regional database to store marsh data across the region (e.g., SET data).
- Develop a tool that defines a lexicon of marsh loss indicators.
- Communication to the public and stakeholders on changing (and potential complete loss) of marsh.
- Continued and better collaboration and sharing of research and innovative management findings.
- Elevation of marsh units and adjacent lands.
- Groundwater levels.

- Rates of open water/vegetation.
- BIG priority for monitoring is marsh surface elevation and sediment accretion.
- Also, BIG need for SET data to be standardized and tied to local datums.

Question 2: "Do you know of important studies or projects that are building marsh resilience that were not highlighted but important for everyone to know about? Please share one or two and a contact person and organization."

- Hypsometry of Cape Cod Salt Marshes (Massachusetts, USA) and Predictions of Marsh Vegetation Changes in Response to Sea Level Rise *(Steve Smith)*
- Sapowet Point Restoration and Coastal Adaptation Project, Tiverton, RI; RI Department of Environmental Management (RIDEM) and Save The Bay *(Wenley Ferguson)*
- Longmeadow project, Warwick, RI; RIDEM and Save The Bay *(Wenley Ferguson)*
- Crab removal to decrease burrowing and dieback *(Megan Tyrrell)*
- Projects in North/South Rivers, MA: salt marsh sentinels (citizen science to document long-term change using docks as observation platforms); transects established in 2000 at six sites, vegetation monitoring along riverine estuary- conversion of freshwater tidal to salt marsh *(Sara Grady)*
- New England Ocean Science Education Collaborative (NEOSEC)- key network for science education and outreach; grant funded *(Mel Cote)*
- National Science Foundation (NSF) Coastal Science, Engineering and Education for Sustainability (SEES)-funded project on marsh resilience including three Long Term Ecological Research (LTER) sites (one being the Plum Island Ecosystem (PIE) LTER) *(Anne Giblin, Marine Biological Laboratory (MBL), lead PI for the PIE LTER and member of a broader LTER group)*
- Highly resilient coastal area modeling completed by the Maine Natural Areas Program; based on future marsh areas under a 1 meter sea level rise scenario, complexity of current and future shorelines, size of future marsh and landscape context *(Kristen Puryear, Puryear@maine.gov)*
- Runneling in CT since the early 2000s; looking more into small-scale TLP as part of an integrated marsh management program *(Roger Wolfe, Wetland Restoration/Mosquito Management Coordinator, CT DEEP Wetland Habitat and Mosquito Management Program; roger.wolfe@ct.gov)*
- Studies on methane emissions in degraded, restored, and healthy marshes *(Bev Johnson, Bates College)*
- The Salt Marsh Habitat & Avian Research Program (SHARP) *(Chris Elphick, UConn)*
- Dike removal in Wellfleet, MA to improve blue carbon storage *(Tonna-Marie Rogers and Jim Rassman, WBNERR)*
- Group in Maine working to create a rapid assessment protocol for tidal restrictions *(Slade Moore, CZM, smoore@bioconserve.net ; Bill Bennett USFWS, william_bennett@fws.gov, Shri Verrill, shri@mainesalmonrivers.org)*
- Tree girdling and removal of stumps (to reduce predation by raptors) for tidal marsh birds to facilitate migration *(Suzanne Paton, USFWS)*
- Little River Salt Marsh restoration project, Georgetown, ME *(Ruth Indrick; rindrick@kennebecestuary.org)*
- Experimental remediation (and analysis) of impounded marshes in the Great Marsh; funding-dependent (there are already some long-term transects) *(Dave Burdick, Susan Adamowicz)*
- Great Marsh, MA and Great Bay, NH natural and artificial sedimentation (TLP) study *(Gregg Moore)*
- Add boulders to created marshes (e.g., living shorelines) to block northwest winter winds from driving ice scour of the shoreline *(David Burdick)*
- Developing and applying a regional, standardized set of monitoring metrics and protocols to assess the effectiveness and impacts of living shoreline projects in New England *(Eric Roberts)*
- There needs to be a marsh resilience study/project on Rumney Marsh (there's the issue of the abandoned I95 embankment); removal of the embankment is needed to restore the hydrology to 444

acres of upstream wetlands which may not keep pace with sea level rise. EPA is gathering water level information to evaluate the embankment removal. (https://www3.epa.gov/region1/eco/rumneymarsh/rumney-marsh-restoration-areas.pdf) *(Ed Reiner)*

- Long Marsh tidal restoration project, Casco Bay *(Curtis Bohlen, Casco Bay Estuary Partnership (CBEP)).* Carried out by Maine DOT as mitigation for wetland impacts associated with a bridge replacement project. CBEP's principal role has been monitoring and research; several monitoring reports- the best sources of project details and data collected over the past five years- are available through their online documents library (e.g., https://www.cascobayestuary.org/wp-content/uploads/2018/01/MaineDOT-Long-Marsh-Report-Year-3.pdf, the 2016 annual monitoring report). The site has also been studied by students at both Bates College and the University of Southern Maine, looking at changes in vegetation, hydrology, and methane metabolism; one master's thesis and a couple of undergraduate honors thesis projects have come out of studying the site. The project consisted of replacing a severely undersized culvert under Long Reach Lane with a larger structure, thus increasing tidal exchange. Tidal range was increased, with changes to both high tide and low tide elevation benchmarks. More seawater enters the marsh during flood tides, inundating the marsh surface more deeply, and with saltier water than occurred before restoration. The marsh drains to a substantially lower elevation at low tides. While not a perfect mimic of hydrological changes anticipated under sea level rise, increases in tidal inundation did reveal possible mechanisms of wetland response to rising waters. Many of the responses seen at Long Marsh have reflected changes in water chemistry as seawater intruded into a long, narrow wetland complex. Inundation, per se, appears to have had smaller effects than altered water chemistry. Brackish water and freshwater species in the marsh died back quickly as salinity of the system increased. Recolonization of dieback areas by more salt-tolerant vegetation has been slow, but is beginning to occur now (in the fourth and fifth growing seasons after the project). The impact of the salinity change has continued (especially in the upstream/fresher portions of the marsh), possibly mediated by summer weather. Mortality of salt intolerant species continues, and appears to be more extensive during drought years. Hydrologic changes have also led to geomorphic adjustment in the historic tidal channel. A head cut took several years to migrate upstream (~ 200 meters from the new culvert), but then upstream migration accelerated, and the head cut has now migrated nearly a kilometer upstream to an historic ford that acts as a grade control, blocking further movement. Several changes following the project may increase resilience of the system to rising seas. First, opening the culvert increased the diurnal tidal range, meaning that a small change in tide elevation now has less impact on the period of inundation. That may make vegetation, and thus the structural integrity of the marsh, less vulnerable. Second, channel incision is likely to lead to secondary changes in ground and surface water hydrology (e.g., lateral channel incision) that will increase drainage; again, reducing the period of ponding or soil saturation following spring tides and protecting the vegetation from longer-term stress due to anoxic sediments. Countervailing those forces, however, has been the mortality of brackish water and freshwater vegetation, which has left significant portions of the marsh bare of vascular plants for several years. Unfortunately, sufficient monitoring to study the impact of the large-scale dieback of cattails on sediment processes was not in place. We don't know if portions of the marsh that were previously dominated by cattails lost elevation in the intervening years.
- TLP that did not work/lessons learned *(Steve Hale)*
- EPA-funded "Developing more effective CAPS metrics for assessing ecological integrity of salt marshes" *(Scott Jackson, UMass Amherst)*
- Use of TLP to save Stage Island (Dennis, MA); unfunded *(David Burdick)*
- Oyster Reefs as Natural Breakwaters Mitigate Shoreline Loss and Facilitate Fisheries (Scyphers et al., 2011)
- Parker River National Wildlife Refuge (NWR) ditch plug removal project *(Nancy Pau)*

- Jim Morris's studies on *S. alterniflora* and *S. patens* productivity with flooding (Morris et al. 2002 Responses of coastal wetlands to rising sea level. Ecology 83(10):2869–2877)
- Galilee salt marsh, Narragansett, RI
- Overestimation of marsh vulnerability to sea level rise (Kirwan et al., 2016)
- Tidmarsh Wildlife Sanctuary restoration (Mass Audubon)
- Salt marsh pool and tidal creek morphodynamics: Dynamic equilibrium of northern latitude salt marshes?
- Maine Decision Support Tool (ecological -> future habitat app; social -> community vulnerability app)
- Island restoration or creation using dredged sediments (e.g., Poplar Island in Chesapeake Bay)
- GMAC protocol (Neckles et al. 2002; http://www.gulfofmaine.org/2/wp-content/uploads/2014/12/GPAC-salt-marsh-monitoring-1999.pdf)
- RSET installation by Maine Coastal Program (2017) *(Matt Nixon; Claire Enterline, Claire.Enterline@maine.gov)*
- Sherman marsh, Damariscotta, ME (2006-present) *(Karen Wilson, University of Southern Maine, karen.wilson@maine.edu; Charles Hebson, Maine DOT)*
- "Marsh-berg" study.
- Open Marsh Water Management (OMWM) projects related to vegetation conversion (to short form *S. alterniflora*); pilot study at Parker River planned for 2019.
- MA CZM and Salem Sound (Coastwatch?) developed a handbook, although the data haven't yet been analyzed due to funding constraints.
- Webhannet tributary (Wells NERR).
- Padanaram marsh in Dartmouth, MA- a 14-year study assessing changes in the marsh floral and faunal communities (fiddler crabs, ribbed mussels) after a tidal reconnection (culvert replacement) and comparing them to a non-restricted control marsh.
- Utilizing breakwaters to stabilize shorelines.
- Marsh mitigation (e.g., living shorelines).
- Regrading of former agricultural fields to facilitate migration.
- Shellfish reefs; shell gabions backed by dredged material.
- TLP without planting (allowing natural vegetation to grow through the sediment).
- CT and NY are looking at the beneficial use of dredged materials in Long Island Sound, but there are many regulatory and policy barriers.

Question 3: "What should we prioritize regarding monitoring? Are there indicators of marsh health, resilience or adaptive capacity that we do not currently measure or analyze or existing indicators that could be further built out?"

Main theme(s) of the conversation:
- Take soil/sediment transport measurements more frequently and expand the use of existing mapping tools (e.g., USDA soil mapper).
- Support the Digital Coast Act.
- Further standardize monitoring protocols across bigger spatial scales/districts/states.
- Expand and improve elevation measurements.
- Elevation data.
- Local tide datums.
- High resolution mapping projects.
- Rapid assessment methodologies (e.g., those discussed in Hilary's talk).
- More use of drone technology.
- Get a better idea of the history of individual marshes by looking at paleoecology.

- Need to study things other than just the grasses (and maybe the sparrows), like the lowly *Melampus.*
- Need to get the word out to the public more about the values of marshes and their problems.
- Mudflats need to be included in salt marsh monitoring.
- Crab population should be closely monitored.
- UVVR using aerial photography.
- Need more public and stakeholder engagement and communication on the value of salt marshes.
- Interagency communication is important too.
- Need to learn how to talk to communities (beyond just presenting the data) to encourage them to value marshes for the long-term (Jen West does climate communications training).
- Need to connect more with economic valuation experts to help increase understanding and build support.
- With all the discussion about marsh migration, there is no talk of mudflat migration, which has an identifiable economic piece (e.g., *Mummichogs* (sp.) are an economic engine but are not publicly recognized by most people).
- NEERS as another venue for outreach.
- Need to visually capture change and show it.
- Citizen science data collection can help to reach people.
- Salt marsh sentinels on people's docks- homeowners measure transition points in vegetation over time (marsh transects).
- Need increased regional collaboration/consistency and a dedicated space for data sharing and comparability.
- Long-term monitoring is key, but finding money for it is challenging.
- Better identify manager needs and appropriate indicators to be sure we're answering the right questions.
- We need to think about what is salient and actionable. Ask: what is the problem, what is causing it, what do we need to do to fix it/is it fixable, how much will it cost, how long will take to happen?
- NEERS can tap into the Science Collaborative (wants engaged managers and decision-makers throughout the entire project).
- There are 130 existing tide gates in MA and more will be proposed.
- Need for adaptive monitoring (just like adaptive management).
- Need long-term monitoring (look at the protocols like GPAC).
- Prioritize UVVR and crab populations.
- Other indicators/parameters to monitor include mudflats and the shellfish population at the seaward edge of the salt marsh.

Discussion related to this question:

- Is Neil going to do assessment for just refuges? Kristin wants him to do Maine.
- Model a bunch of stuff and determine which is the best predictor.
- NERRS metrics are a little different place to place; Maine is trying to establish metrics for coast. Vegetation and hydrology might be important; Ralph Tiner's transects went WAY into the upland.
- If you know what the elevation is relative to MHW you would know if the marsh is keeping up with sea level rise.
- The storm surge associated with Nor'easters was astounding. RI has citizen scientists out measuring with GPS (which informs modeling) and taking photos of moon and king tides; very well received by those interested in what the high water line will really look like.
- Kennebunk hired a drone company to document the effects of the last Nor'easter; can help cross over to the social side.

- SMI indicators.
- NERRS sentinel sites.
- ME sentinel sites starting (vegetation and hydrology).
- Need to know the elevation of the marsh relative to MHW to determine if it's keeping up with sea level rise.
- Maine stands to lose 50% of its marsh.
- Coarse monitoring of storms (including storm surge) in New England (e.g., RI app "MyCoast"- photos taken at high tide/during storms (can fact check against SLAMM); helps tell the story to people who may need to retreat))
- Monitor to understand where to restore.
- Convince people where to invest.
- Need site-specific data on hard freezes and frosts (which affect plant material).
- Off-the-shelf development of sediment budgets (what data do you need?)
- Data sets need: 1) local rates of sea level rise; 2) impervious surfaces; and 3) min and max elevation of the marsh.
- Need indicators for the marsh catchment basin.
- Lack of information on crabs on Cape Cod.
- Do culvert repairs (openings) in phases vs. all at once so as to not overload the system.
- Need data on associated taxa (what lives there and what are the interactions); a more holistic approach.
- Look at new data on community will to deal with restoration and building resilience.
- Gradient along channel (i.e., slope over distance) as proxy for erosive force.
- Crab and/or burrow density.
- Sentinel sites.
- Monitor causative agents: porewater, sediment, crabs (since we know marshes are in trouble, focus on the mechanism of collapse).
- Predictive indices (such as MARS).
- Correlation between UVVR and sediment budget by measuring turbidity or TSS.
- In favor of the creation of a rapid assessment for marsh vulnerability and health.
- Utilize drones to see what habitat types, slopes, or soils migrate best.
- Crab presence and diversity.
- Invasive species.
- SET data.
- Sediment budget.
- More on sediment sources; it's very complicated in estuaries (e.g., multidirectional flow).
- Elevation.
- Ratio of open water to vegetation.
- Groundwater levels.
- Adjacent land use.
- Watch *Sesarma* more closely; use drones to see fiddler/*Sesarma* impact.
- Aerial photographs/outline vegetation for UVVR (high priority; examples by James Browne (NY))
- Include mudflats in monitoring of marsh and species identification (would add value to funding requests).
- Monitoring after large storms.
- Need to "get the data analyzed and out there" (capacity issue)
- Make data publicly available sooner.
- Volunteer/citizen marsh monitoring (e.g., EPA 1998) is effective but doesn't address climate impacts.

- High resolution bare earth elevations.
- Local tidal datums.
- Information on and consistency among hydrologically impaired methodologies.
- Biological parameters (e.g., invasive species (especially macroinvertebrates))
- Geomorphic traits are critical to understand.
- Local climate data included with marsh parameters.
- Weather station data at NERR sentinel sites.
- Consider the difference between weather and climate.
- Groundwater/saltwater intrusion into marshes.
- How can we improve SET methods?
- Soil chemistry parameters.
- Learn how to do predictive triage to prioritize marshes to protect/maintain.
- Very little sediment budget analysis work on marshes; need to get a handle on this.
- Look at the entire watershed- review soils from above to see what sediment is coming in, look at marsh soils to determine if they're becoming more sediment heavy (and if so, why and where is it from?)
- We should try to distinguish between internal movement of sediment and external inputs of sediment (we cannot count on external sediment supply to save marshes).
- How to take marsh response to aperiodic large storm systems into consideration (e.g., in some cases large storms cause a lot of erosion overnight).
- We don't know vegetation zones relative to elevation along a latitudinal gradient; we need this basic information.
- Indicators of marsh health depend on your management priority; we value high marsh at this point.
- Everyone is monitoring what we think is important related to management goals.
- In our biomonitoring plots we've started monitoring thatch and ribbed mussels in the high marsh as early sign of marsh conversion; we are finding that these are early detection indices of vegetation change.
- There's a lot of change in processes- how do we monitor them? Everything we know is changing, especially geomorphological and biochemical feedback loops which gets very complicated.
- Standardize and correlate SET data across longitudinal gradients and tie them to local tidal datums. It's a little crazy to implement high-cost marsh restorations without this local information; even better if we can tie the data together throughout the Northeast which would lead to much more informed management and the ability to answer a much broader suite of questions using the same amount of data.
- Vegetation seems to be a strong indicator of marsh resilience/status according to Ganju's talk; maybe we should put a priority on measuring this.
- Need to find a better way to gather information on in-ground biomass.
- Root density is an indicator of peat formation and marsh health; can you use acoustics to assess this?
- Need to establish baseline marsh assessments to look at change over time.
- Look at change every 1-5 years.
- Use aerial photographs to establish marsh baselines.
- Can you use UAVs to count stem density and identify species? If so we should consider using this approach.
- Develop a database of images showing various stages of marsh degradation for others to use to determine marsh health.
- Measure temperature of the water on marshes.
- Not monitoring sediments as well as we should.

- Should consider improving applicability of monitoring data.
- Really hard to assess resilience and adaptive capacity of marshes.
- Pretty poor predictive capacity of monitoring data so far.
- What should we monitor when our budgets are very limited?
- What to do with the results?
- Need more post-storm monitoring (e.g., ice effects on marshes).
- Comparing thin layer placement to natural storm deposition- relevant talk at the NEERS meeting.
- Adaptive monitoring (just like adaptive management).
- Sentinel site monitoring has gained some momentum.
- When you get really fine with MMI, it's only useful for a small area.
- Can we prioritize restoration sites?
- Modeling.

Suggestions for actions or next steps:
- More species -> biodiversity (invasives and range expansion); maybe none of them are good indicators.
- Sediment measurements (e.g., TSS) must be long-term; think ahead and deploy sediment traps, examine soil profiles.
- Ice.
- Soil chemistry and flooding depth.
- Cameras.
- Increase the visibility of how data is stored, managed, and collated (for comparisons among agencies, sites) to supplement available protocols and/or templates.
- Use post-storm monitoring to show the importance of salt marshes as buffers.
- Need more long-term monitoring.
- Involve the public more in monitoring?
- Need the data to make the next decision, but need to be adaptive as well.
- Re. migration- why can some marshes/soils withstand slope variation and some can't?

Other topics that were mentioned during the discussion (parking lot issues):
- What agencies can utilize drones? (EPA cannot) What metrics can we get from drones vs. field visits?
- Need to address the value of mudflats.
- While mudflats are expanding with the loss of salt marsh, we're losing mudflat to sea level rise (peat does not equal mudflat).
- Mudflats needed for shellfish.
- Think about marsh and mudflat together re. migration; they're part of the same system.
- The public doesn't like marshes.
- Study the effect of boat wake on salt marsh "slumping."

From notecards:
- Need marsh-specific data re. how hard frost/freeze influences the retention of sediment.
- Need a better way to assess in-ground biomass.
- Vegetation seems to be a strong indicator of marsh status according to Ganju's talk; maybe we should put a priority on measuring this?
- Marsh manipulation vs. natural processes in southern vs. northern New England.
- Urge caution with living shorelines; we have natural processes such as sediment addition from mudflats that living shorelines might have prevented.

- Need to look at long-term monitoring protocols.
- Currently need an adaptive approach, need to be more defined in terms of objectives and use of monitoring data.
- Freshwater inputs (rivers).
- Proximity to sediment supplies.

Appendix E: Attendee List

Last name	First name	Affiliation	State
Adamowicz	Susan	US Fish & Wildlife Service, Rachel Carson National Wildlife Refuge	ME
Allen	Sarah	Normandeau Associates, Inc.	NH
Aman	Jacob	Wells NERR	ME
Anderson	Nicholas	University of New Hampshire	NH
Babitch	Jaylyn	University of Louisiana at Lafayette	LA
Baker	Barney	Baker Design Consultants, Inc.	ME
Baker	Ellie	Horsley Witten Group, Inc.	NH
Balanoff	Jonathan	NH Coastal Program	NH
Balasubramanyam	Vidya	NOAA Coastal Management Fellow	NH
Barrett	Patrick	RI Department of Environmental Management Division of Marine Fisheries	RI
Barry	Aidan	University of Connecticut	CT
Benvenuti	Bri	US Fish & Wildlife Service, Rachel Carson National Wildlife Refuge	ME
Berounsky	Veronica	University of Rhode Island Graduate School of Oceanography	RI
Berry	Walter	US EPA	RI
Borrelli	Mark	UMass Boston	MA
Bowden	Alison	The Nature Conservancy	MA
Bowron	Tony	CBWES Inc. & Saint Mary's University	Nova Scotia
Bradley	Michael	University of Rhode Island	RI
Branco	Brett	Brooklyn College	NY
Brennan	Diana	Bristol County Mosquito Control Project	MA
Browne	James	Conservation & Waterways, Town of Hempstead	NY
Buchsbaum	Robert	Mass Audubon	MA
Bulseco-McKim	Ashley	Northeastern University	MA
Burbank	William (Bill)	Trustees for Sandwich Beaches	MA
Burdick	David	University of New Hampshire, Jackson Estuarine Laboratory	NH
Burn	Peter	Suffolk University, Biology Department	MA
Byergo	Laura	Greenland Conservation Commission	NH
Carullo	Marc	MA Office of Coastal Zone Management	MA
Cassia	Olivia	Salem State University	MA
Castagno	Katherine	MIT/WHOI Joint Program	MA
Chaffee	Caitlin	RI Coastal Resources Management Council	RI
Champlin	Denise	US EPA	RI
Choate	Richard	retired	N/A
Cicchetti	Giancarlo	US EPA	RI
Comeau	Christine	Narragansett Bay Commission	RI
Cote	Melville	US EPA Region I	MA

Last name	First name	Affiliation	State
Cox	Emily	US Coast Guard Academy	CT
Craig	Matthew	Casco Bay Estuary Partnership	ME
Cullina	Melissa	Coastal Maine Botanical Gardens	ME
de Lanerolle	Nimal	Suffolk County Community College	NY
Delpapa	Cindy	MA Division of Ecological Restoration	MA
Denoncour	Jeff	The Trustees of Reservations	MA
Diener	Jay	Seabrook-Hamptons Estuary Alliance	NH
Dombroski	Ian	US EPA Region I	MA
Donnelly	Grace M.	retired	RI
Dorman	Matthew	USDA NRCS	ME
Dowling	Tessa M.	University of New England	ME
Duff	Elizabeth	Mass Audubon	MA
Duffey	Sean	MA Office of Coastal Zone Management	MA
Eberhardt	Alyson	NH Sea Grant/UNH Cooperative Extension	NH
Elliott	James	University of Maine	ME
Enterline	Claire	Maine Coastal Program	ME
Erskine	Kristine	City University of New York, Graduate Center	NY
Evans	Tay	MA Division of Marine Fisheries	MA
Fahey	Curtis	Salem State University	MA
Feaga	Jim	Ducks Unlimited	PA
Ferguson	Wenley	Save The Bay	RI
Feurt	Christine	University of New England	ME
Feurt	Ward	Friends of Rachel Carson National Wildlife Refuge	ME
Fischella	Briana	University of Southern Maine	ME
Flickinger	Sarah	Narragansett Bay Commission	RI
Foertch	Jim	Millstone Environmental Lab	CT
Foley	Abigail	University of New Hampshire	NH
Forbrich	Inke	Marine Biological Laboratory	MA
Franz	David	City University of New York, Brooklyn College	NY
Furbeck	Michelle	Wells NERR	ME
Ganju	Neil	US Geological Survey	MA
Genest	Daniel	UMass Boston Graduate student	MA
Gettman	Al	RI Department of Environmental Management Mosquito Office	RI
Glode	Joanne	The Nature Conservancy	NH
Gottsegen	Claire	Wells NERR	ME
Grady	Sara	MassBays National Estuary Program	MA
Guertin	Daniel	Teacher	N/A
Gurdon	Christine	Buzzards Bay Coalition	MA
Hale	Stephen	US EPA	RI
Hardy	Amber	University of Rhode Island	RI
Hartzel	Bob	Comprehensive Environmental, Inc.	MA

Last name	First name	Affiliation	State
Helt	William	The Nature Conservancy	RI
Hirsch	Chris	Neponset River Watershed Association	MA
Hojnacki	Katlyn	US Fish & Wildlife Service, Parker River National Wildlife Refuge	MA
Hopping	Russ	The Trustees of Reservations	MA
Huguenin	Mike	Buzzards Bay Coalition/Mattapoisett Land Trust	MA
Hutchins	Eric	NOAA Restoration Center	MA
Indrick	Ruth	Kennebec Estuary Land Trust	ME
Jakuba	Rachel	Buzzards Bay Coalition	MA
Johnson	Beverly	Bates College	ME
Jupin	Johanna	University of Bordeaux	France
Kahl	Katie	UMass Amherst, Gloucester Marine Station	MA
Keer	Georgeann	MA Division of Ecological Restoration	MA
Kennedy	Cristina	MA Office of Coastal Zone Management	MA
Kinkade	Chris	NOAA Office for Coastal Management	NH
Kraeuter	John	University of New England	ME
Kriegel	Darron	AECOM Marine and Coastal Center	MA
Kutcher	Tom	Rhode Island Natural History Survey	RI
Labrie	Micheline	UMass Dartmouth	MA
Lamb	Annesia	City University of New York Graduate Center	NY
Lambert	Beth	MA Division of Ecological Restoration	MA
Latimer	James	US EPA	RI
Lavallee	Katherine	National Park Service	MA
Lawson	David	Norfolk County Mosquito Control District	MA
Lea	Peter	Bowdoin College	ME
Leduc	Elise	Woods Hole Group	MA
Leo	Wendy	MA Water Resources Authority	MA
Little	Michael	Freelancer	N/A
Logan	John	MA Division of Marine Fisheries	MA
Lucey	Kevin	NH Coastal Program	NH
Macfarlane	Sandy	Coastal Resource Specialists	MA
Maher	Nicole	The Nature Conservancy	NY
Mandeville	Caitlin	NH Sea Grant/UNH Cooperative Extension	NH
Maney	Ted	Salem State University	MA
Mangolds	Arnis	C-2i, Inc	MA
Mann	Sharon	University of Southern Maine	ME
Marsh	Michael	US EPA Region I	MA
Matso	Kalle	Piscataqua Region Estuaries Partnership	NH
Maxwell	Logan	University of New Hampshire	NH
McDermott	Sean	National Marine Fisheries Service	MA
Medley	Grace	University of Rhode Island Graduate School of Oceanography	RI
Memmolo	Jessie	Salem State University	MA

Last name	First name	Affiliation	State
Meyer	Christopher	Stony Brook University	NY
Mlsna	Ivy	US EPA Region I/Tufts University	MA
Moore	Gregg	University of New Hampshire	NH
Moore	Eliza	Narragansett Bay Commission	RI
Mora	Jordan	Waquoit Bay NERR	MA
Morgan	Pam	University of New England	ME
Morton	Ted (Walter)	Pew Charitable Trusts	DC
Neckles	Hilary	USGS Patuxent Wildlife Research Center	MD
Nuhn	Heather	The Nature Conservancy	RI
Nye	Tara	Horsley Witten Group, Inc	MA
O'Brien	Kate	US Fish & Wildlife Service, Rachel Carson National Wildlife Refuge	ME
Ooi	Sean Khan	University of Connecticut	CT
Pappal	Adrienne	MA Office of Coastal Zone Management	MA
Paton	Suzanne	US Fish & Wildlife Service	RI
Pau	Nancy	US Fish & Wildlife Service, Parker River National Wildlife Refuge	MA
Payne	Kimberly	Normandeau Associates, Inc.	ME
Payne	Andrew	University of New Hampshire	NH
Pelletier	Kayla	Salem State University	MA
Perry	Danielle	RI Coastal Resources Management Council	RI
Peter	Chris	Great Bay NERR/University of New Hampshire	NH
Phelan	Kelly	Town of Braintree	MA
Phioppen	Peter	MassBays National Estuary Program	MA
Potti	Pooja	UMass Dartmouth SMAST	MA
Potts-Santone	MarySusan	Northeastern University	MA
Price	Andrea	Louisiana State University	LA
Privott	Thomas	University of Rhode Island	RI
Puryear	Kristen	Maine Natural Areas Program	ME
Quintal	Sara N. da Silva	Buzzards Bay Coalition	MA
Raposa	Kenny	Narragansett Bay NERR	RI
Reiner	Edward	US EPA Region I	MA
Roberts	Eric	The Nature Conservancy	MA
Robinson	Deirdre	Salt Marsh Sparrow Research Initiative	RI
Roth	Rebecca	National Estuarine Research Reserve Association	NH
Rozsa	Ron	Plant ecologist	CT
Russell	Ellen	University of Massachusetts	MA
Schmidt	Courtney	Narragansett Bay Estuary Program	RI
Sewall	Laura	Bates College	ME
Short	Frederick	University of New Hampshire	NH
Simpson	Michael	Antioch University	NH

Last name	First name	Affiliation	State
Smith	Stephen	National Park Service	MA
Spencer	Larry	Plymouth State University, Department of Biology	MA
Stacey	Paul	Footprints In The Water LLC	CT
Steere	Linda	Applied Bio-Systems, Inc.	RI
Steeves	Tanner	RI Department of Environmental Management Division of Fish & Wildlife	RI
Stevens	Rachel	Great Bay NERR	NH
Stolt	Mark	University of Rhode Island	RI
Sullivan	Hillary	Woods Hole Research Center	MA
Taber	Tristan	University of Southern Maine	ME
Terry	John	Gulf of Maine Institute	ME
Thornber	Carol	University of Rhode Island	RI
Toomey	Jeff	Read Custom Soils	MA
Torio	Dante	University of New Hampshire	NH
Trueblood	Dwight	NOAA Office for Coastal Management	NH
Truslow	Danna	Truslow Resource Consulting LLC	NH
Tucker	Jane	Marine Biological Laboratory	MA
Turek	Jim	NOAA Restoration Center	RI
Tyrrell	Megan	Waquoit Bay NERR	MA
Vaudrey	Jamie	University of Connecticut, Department of Marine Sciences	CT
Verrill	Shri	Downeast Salmon Federation	ME
Vincent	Robert	MIT Sea Grant	MA
Wainright	Sam	US Coast Guard Academy	CT
Walsh	John	University of Rhode Island Coastal Resources Center	RI
Warren	Scott	Connecticut College, Botany Department	CT
Warren	Barbara	Salem Sound Coastwatch	MA
Watson	Elizabeth	Drexel University	PA
Weber	Robin	Narragansett Bay NERR	RI
West	Jennifer	Narragansett Bay NERR	RI
Wigand	Cathleen	US EPA	RI
Wilkins	Caitlyn	Salem State University	MA
Will	Anthony	Read Custom Soils	MA
Wilson	Geoff	Northeast Wetland Restoration	ME
Wolfe	Roger	CT Department of Energy & Environmental Protection	CT
Wood	Craig	ESS Group Inc.	RI
Yamalis	Harry	CT Department of Energy & Environmental Protection	CT
Young	Alan	Salem State University	MA
Zerilli	Tony	Weston & Sampson	MA
Zogg	Greg	University of New England	ME

Appendix F: Evaluation Results

Summary

Q1. Participating in this event was a good use of my time.

Answer Choices	Responses	
Strongly agree	66.67%	36
Agree	31.48%	17
Neutral	0.00%	0
Disagree	1.85%	1
Strongly disagree	0.00%	0
Prefer not to answer/not applicable	0.00%	0
Comments		11
	Answered	**54**
	Skipped	**0**

Q2. How much did this event increase your knowledge of the topic presented?

Answer Choices	Responses	
A great deal	24.07%	13
A lot	38.89%	21
Some	33.33%	18
A little	3.70%	2
Not at all	0.00%	0
Prefer not to answer/not applicable	0.00%	0
	Answered	**54**
	Skipped	**0**

Q3. If you chose 'A little' or 'Not at all' for question 2, why did you make this choice?

Answer Choices	Responses	
I already know a lot about this subject	80.00%	4
The presentation was too basic	40.00%	2
The presentation was too advanced	0.00%	0
The presentation was not effective	20.00%	1
Other (please specify)		3
	Answered	**5**
	Skipped	**49**

Q4. Did you learn something that you will apply in your work?

Answer Choices	Responses	
Yes	75.93%	41
No	3.70%	2
Maybe	18.52%	10
Prefer not to answer/not applicable	1.85%	1
Comments		7
	Answered	**54**
	Skipped	**0**

Q5. Are there any other issues/topics that you would like information/training on that might help you in your work?

Answered	**19**
Skipped	**35**

Q6. Any additional comments?

Answered	**22**
Skipped	**32**

Complete Results

Participating in this event was a good use of my time.	Comments	How much did this event increase your knowledge of the topic presented?	If you chose 'A little' or 'Not at all' for question 2, why did you make this choice?	Did you learn something that you will apply in your work?	Comments	Are there any other issues/topics that you would like information/training on that might help you in your work?	Any additional comments?
Strongly agree		A great deal		Yes		Maybe a training on science communication	As a region, we should think about big data on estuary conditions and what to do with it.
Strongly agree		A lot		Yes	In my mind the symposium had something for everyone, including researchers, practitioners, and decision makers. As a researcher I appreciated learning about aspects of marsh ecology that are outside my area of expertise, new assessment methodologies, and collaborative opportunities.		Congratulations and thank you for a great symposium! There are trade-offs between going broad vs deep into such a complex topic, and I think you achieved an appropriate and effective balance for a one-day symposium. As a speaker, I would have found more advance communication from the steering committee useful; e.g. it wasn't until quite late in the process that I learned I was actually on the agenda, and the objectives for the planning calls among the speakers weren't crystal clear to me. But these are minor issues, I know the organizers were out straight! Thanks again --
Strongly agree		A lot		Prefer not to answer/not applicable			Excellent job of time control. Still, there may have been too many speakers.

Strongly agree		A lot		Yes	Things that were new to me include the soil scientist presentation, the effectiveness of runnels, role of fiddler crabs in preventing seedling establishment,	Use of SLAMM model connected with MEM.	Great workshop, great speakers
Strongly agree	Great to see colleagues give an overview of their state, followed by novel research and restoration approaches	A great deal		Yes			Great workshop. Great presentations and the break-out discussions were worthwhile. It could have easily been a two-day event covering additional salt marsh topics.
Strongly agree	As an educator I was pleased with variety of information provided. I'll 7 548870deg so	A great deal		Yes		A crossover with the science/marine educators in the region	I found it difficult reading the bottom of the slides during the presentations.
Strongly agree	A really valuable workshop for understanding the latest marsh science and appreciating the urgency of marsh loss.	A great deal	Although I already had a great deal of knowledge on these topics, I felt the presentations were not very effective. Many of the speakers seemed to just ramble on and read their slides. Not much that was extremely groundbreaking.	Maybe			I think the structure with the NEERS conference was odd. I expected all the more salt marsh specific talks to be on Thursday and Friday and not Thursday/Saturday. I was also disappointed that many of the people that attended the Thursday workshop did not stay for the other days, with Saturday having particularly low attendance. In the future why do you hold it so the 3 days do not fall on a weekend.
Strongly agree	Wow -- this was a rock star of a workshop. Thanks for all the difficult	A lot		Yes			I would love more communicating science workshops as mentioned!

	work in getting it organized.						
Strongly agree		A lot		Yes	Learned a lot. Causes of marsh loss and possible restorations will certainly apply.	Seagrass	Nice job pulling off a great workshop!
Strongly agree		A lot		Yes		Current info on salvage and restoration	Nicely done - I really appreciated you trying to hold to the schedule. 15 min works well for most. Better, taller or more screens. Hard to see from the back.
Strongly agree		A great deal		Yes	Information provided should help agencies and organizations prioritize locations and types of restoration projects to protect and/or restore.	Strategizing how to protect/acquire uplands adjacent to drowning marshes seems like a priority, and enforcing proper tide gate maintenance and operation.	One of the best NEERS special symposia I've attended in 20 years of membership. Thanks to NERRS for co-sponsoring!
Strongly agree		A great deal		Yes			Opportunities exist for moving forward on some of the group suggestions. It would be nice to see some on-going momentum based on this workshop (as opposed to thinking ahead to what topics might be appropriate for the next workshop).

Strongly agree		A great deal	Great presentations! My work is in this field and I loved hearing about what everyone is doing.	Yes	Absolutely!	I loved all the marsh resilience and restoration work that was presented on. I'm interested in seeing how all these projects progress and continually learning about new projects within this field. Please hold this workshop again!!	Thank you for organizing this!! As someone who loves citizen science as a way to involve the public in restoration, I'm also wondering about the possibility of a workshop on this. Who funds this work? How to get funding? What are the best ways to reach out to the community? What are the success rates of this work? Do ecosystems have measurable responses to citizen science projects? Inquiring minds would love to know! :)
Strongly agree	What a wonderful event!!! I was able to get new material to help bolster my thesis work and am eternally grateful for the opportunity!	Some	I already know a lot about this subject	Yes		Please continue to follow up on these salt marsh workshops every few years.	Thank you for this important, well-organized, and enjoyable workshop.
Strongly agree		A lot		Yes			This was a great crash course in what is happening currently in the field of salt marsh conservation in New England. I especially benefited from hearing about what other scientists and managers are doing to address how we can deal with the effects of climate change on marshes. Great job and thanks for organizing this. Very timely and incredibly important!

Strongly agree	Well organized with timely, very important theme and specific topics.	Some		Yes	I want a drone! And the post-processing support team!!		Well done!
Strongly agree		Some		Yes			Would really like to see more people of color speakers (there are many of them in New England working on this topic, but largely invisible and unrepresented), fewer white male speakers.
Strongly agree		A lot		Yes			
Strongly agree	This workshop was packed with important information presented by top salt marsh scientists	A lot		Yes		Increased technical design work presented would be beneficial.	
Strongly agree		A lot		Yes		Let's include topics on soil microbiology which utilize the soils minerals and nutrients that make it possible for plants to uptake. It would be interesting to see what biota are in the marsh soils and their relationship with the plants.	
Strongly agree		A lot		Maybe			
Strongly agree		Some		Yes		Impacts to salt marsh habitat with the use of tide gates.	
Strongly agree	Learning about regional salt marsh research in one day was a benefit	A great deal		Yes			

Strongly agree		A lot		Yes		More time spent on some of the technical development would be great. Too much is too brief and an overview to really offer much guidance. It has more of the idea / drawing board quality to it which is good, but getting into the nitty-gritty of some of the technical specifications and development decisions would be great.	
Strongly agree		A lot		Yes		I'd love to see a workshop on connections between things we currently view as separate -- like oyster beds and eelgrass; eelgrass and salt marshes; salt marshes and watersheds.	
Strongly agree		A lot		Maybe			
Strongly agree		A lot		Maybe			
Strongly agree		A great deal		Yes		techniques & technologies, particularly with respect to field work.	

Strongly agree		Some		Yes	I am trained in genetics and am working on eDNA studies. This conference was very helpful in providing a crucial ecology perspective to my work; science is all about collaboration these days and the organizers of this event did a great job taking experts from different disciplines to offer their experiences and opinions.		
Strongly agree	I am a seasonal research assistant in the NERR system and started in March 2018. I was very glad to attend this workshop - I learned a lot about salt marsh ecology and management practices. My colleague who has been a research assistant in the NERR system thought that a lot of the talks were introductory level, which was helpful to someone like me but review for someone with her experience.	A great deal		Yes			
Strongly agree		A lot		Yes			
Strongly agree		Some		Yes		salt marsh geomorphology.	
Strongly agree		A great deal		Yes			
Strongly agree		A lot		Maybe			
Strongly agree		A great deal		Yes			
Strongly agree		Some		Yes			
Disagree		Some		No			

Agree		Some		Yes		standardizing marsh monitoring methods and a data mgmt and analysis workshop to get everyone on the same page and able to compare findings	Great job organizing the symposium, it was extremely informative
Agree		A great deal		Maybe			Really nice workshop. I enjoyed the presentations + format. My only critique would be that the venue (long level room) isn't ideal for viewing the speaker (at least for those of us towards the back).
Agree		Some	An amazing about of information was conveyed and there was still time for dialogue. This was a plus not a minus	Yes			Thank you for organizing this event with NEERS. We should do more in the future. The funding made this possible and increased knowledge and collaboration in the region
Agree		Some	I already know a lot about this subject; the presentation was too basic	Yes			Very well-organized workshop, which was highly informative and engaging
Agree		A little		Maybe		Restoration techniques - stabilization - upland erosion control measures.	Wish I could have attended Friday sessions as well. Good job to all involved.
Agree		A little	I already know a lot about this subject	Yes			
Agree		Some	I already know a lot about this subject; the presentation was too basic	Yes			
Agree		A lot		Yes			
Agree		Some		Yes			

Agree	the meeting was very well run and kept on schedule! Kudos to you for that. The presentations were all interesting and the round table discussions were insightful. I give credit to the last speaker of the day, Mr. Ganju was most entertaining- a fun way to end the day.	A lot		Maybe			
Agree		Some		Yes			
Agree		Some		Yes		water quality trends in NE	
Agree		A lot		Maybe			
Agree		Some		Yes			
Agree	A couple presenters were unprepared. One morning presenter in particular.	Some		Yes			
Agree		A lot		Maybe			
Agree		Some		No		Instead of just looking at marshes it might be more informative to focus on the estuary including the importance of the marsh systems to processes/structure of the estuary.	