RESILIENT Coastal Wetlands and Communities

EPA

Workshop Proceedings

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Resilient Coastal Wetlands and Communities:

Workshop Proceedings

Center for Public Health and Environmental Assessment
Office of Research and Development
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Washington, DC 20460

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QUALITY ASSURANCE SUMMARY AND DISCLAIMER

This work was conducted under the U.S. Environmental Protection Agency's Quality Assurance (QA) program for environmental information, with an approved Quality Assurance Project Plan, L-HEEAD-0031309-QP-1-7. Independent QA audits were not deemed necessary; the product was reviewed by QA, two internal technical reviewers, and two external peer reviewers.

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ACRONYMS AND ABBREVIATIONS

ADT	Adaptation Design Tool
BMP	Best Management Practice
CBP	Chesapeake Bay Program
CERAP	Coastal Ecological Restoration & Adaptation Plan
DEIJ	Diversity, Equity, Inclusion, Justice
EJ	Environmental Justice
EPA ORD	Environmental Protection Agency Office of Research and Development
EPA ORISE Fellow	Oak Ridge Institute for Science and Education Fellow at EPA
FEMA	Federal Emergency Management Agency
HCS	Hazardous and Contaminated Sites
MarshRAM	Salt Marsh Rapid Assessment Method
MD DNR	Maryland Department of Natural Resources
NBEP	Narragansett Bay Estuarine Program
NBNERR	Narragansett Bay National Estuarine Research Reserve
NNBF	Natural and Nature-Based Features
NOAA	National Oceanic and Atmospheric Administration
PDE	Partnership for the Delaware Estuary
RAM	Rapid Assessment Method
RAMP	Restoration, Assessment, and Monitoring Program
RIDOH	Rhode Island Department of Health
RINHS	Rhode Island Natural History Survey
RWVF	Relative Wetland Vulnerability Framework
SESAME	Social-Ecological Systems, Adaptive Management, and Engagement Framework
SLAMM	Sea Level Affecting Marshes Model
SLR	Sea Level Rise
TMDL	Total Maximum Daily Load
Tt CES	Tetra Tech Center for Ecological Sciences
URI	University of Rhode Island
USGS	United States Geological Survey
VIMS	Virginia Institute of Marine Science
WATCH	Wetland Assessment Tool for Condition & Health

PREFACE

This report was prepared by the U.S. Environmental Protection Agency (USEPA) Office of Research and Development, as part of the Sustainable and Healthy Communities (SHC) research program, with support from Tetra Tech, Inc. The SHC research program is committed to helping communities build resilience in their socio-ecological systems to optimize health and well-being outcomes. This includes developing tools, methods, and frameworks to support healthy and resilient ecological and human communities. USEPA scientists collaborate closely with partners and stakeholders as they use the best available science to develop effective plans to increase communities' resilience to climate change, land use activities, and other rapidly changing environmental conditions.

Coastal wetlands are an important part of this equation. States and their constituent coastal communities recognize that wetlands are a critical environmental component of community resilience because of the beneficial ecosystem services they provide. One such service—the ability to protect adjacent upland areas by mitigating the impacts of storms and floods—is of growing interest and importance to communities facing extreme events of greater frequency and intensity, especially where man made buffers are too costly or less desirable for ecological or social reasons. Other ecosystem services, such as water purification, provision of fish and wildlife habitat, and carbon sequestration, are also of great value to community and regional stakeholders.

The *Resilient Coastal Wetlands and Communities* workshop (24-25 May 2022) brought together USEPA researchers along with a host of other partners and stakeholders virtually, for a cross-organizational and cross-regional exploration of three scientific themes: characterizing and measuring wetlands resilience; adapting management to support wetlands resilience; and linking wetlands resilience to the health and resilience of coastal communities, including those that are overburdened and underserved. The workshop focused on efforts in the Northeast and mid-Atlantic regions, but the tools, approaches, and lessons learned are relevant nationally. This workshop *Proceedings* synthesizes the results of the workshop presentations and interactive audience discussions. The aim is to generate new information and opportunities that will further advance our collective understanding of how to protect and boost the resilience of our coastal wetlands, and the communities that depend on them.

AUTHORS, CONTRIBUTORS, AND REVIEWERS

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EXECUTIVE SUMMARY

Introduction

In May 2022, the U.S. Environmental Protection Agency's Office of Research and Development hosted a two-day virtual workshop on resilient coastal wetlands and communities. The goal was to leverage knowledge and lessons learned from across regions and organizations to help standardize, improve, and advance methods to support resilience of coastal wetlands and communities. To this end, interactive online polls, open-ended questions, and chats were used to facilitate sharing of information, ideas, and lessons learned from diverse approaches to resilience. The over 100 participants on each day included a broad array of researchers, managers, and decision makers from across multiple regions (Mid-Atlantic and Northeast), organizations (federal, state, local, Tribal, non-governmental, academic, and private), and specialties (wetlands resilience and community resilience). This Proceedings synthesizes the results of the workshop presentations and discussions and explores emerging insights and opportunities to further advance our ability to achieve resilient coastal wetlands and communities.

This document consists of two main sections. The first is a cross-organizational and cross-regional examination of three themes: defining and measuring wetlands resilience; adapting management to support wetlands resilience; and linking wetlands resilience to community resilience. The second section presents a synthesis of the workshop community's evaluation of where we stand with respect to existing strengths, challenges and gaps for improvement, and emerging principles.

Themes

What is wetland resilience?

- Resilience is determined by the combination of sensitivity and adaptive capacity of the system when exposed to climate and other environmental stressors.
- From an ecological perspective, this translates to the ability of a wetland to persist through a disturbance while maintaining valued functions or services.
- From a sociological perspective, this translates to the ability to effectively engage with partners (e.g., federal, state, Tribes, local, non-governmental, academic, and private) and stakeholders (e.g., local governments, communities, individuals, other) to implement best management practices that preserve services.
- Highest ranked indicators of long-term resilience included: increased acreage of unfragmented habitat, increased elevation capital, decreased erosion rates, increased ecological diversity, and increased natural hydrology.

How do we manage for resilience under changing environmental conditions?

- A variety of vulnerability assessment, condition assessment, and impact diagnosis tools are available to help inform decisions on how to select and design interventions for different sites.
- Participants reported a strong focus on site selection and marsh migration, with an emphasis on linking evaluation of the problems at sites with design of appropriate interventions.

- Socio-ecological frameworks are available to facilitate robust partner and stakeholder engagement in marsh management that includes consideration of marsh values for human health and resilience.
- Analyzing trade-offs among social and ecological costs and benefits is essential in decision making for management adaptations to increase coupled wetland and community resilience.

How can resilient wetlands boost the health and resilience of coastal communities?

- Participants affirmed the importance, challenges, and benefits of partner and stakeholder engagement when seeking to link resilience of wetlands to benefits for communities.
- The main connection perceived between wetlands and community resilience is ecosystem services (e.g., flood protection, wave attenuation, water quality, water storage, aesthetics).
- Wetlands contribute to community well-being and human health via interactions that influence the social determinants of health directly, or indirectly by ameliorating climate change impacts.
- The combined resilience of connected wetland and human communities will best be measured by the quality, persistence, and sustainability of both through time, using indicators of ecosystem service functions, property values, cultural values, and mental health outcomes.

Synthesis

Strengths

An overarching strength of the resilience management community is that the participants self-report a moderate-to-high level of both focus and experience in five cross-cutting areas.

- Translating scientific information for decisions is an area of rich exchange and sharing among participants on a variety of tools, information resources, and initiatives.
- Working with partners and stakeholders, hand-in-hand with addressing barriers and opportunities for successful implementation, builds a shared understanding of local environmental problems and co-production of solutions, leading to greater community support for resilience activities.
- Dealing with uncertainty is often handled implicitly in research and project methodologies, and while always a challenge, is an area in which participants are well-experienced.
- Capacity building efforts are focused on boosting expertise and resources that enable resilience management and build community support for inclusive and sustainable goals and projects.

Challenges and Gaps

The workshop participants were asked to evaluate five different categories of challenges and gaps and identify what would be needed to make improvements.

- Decision support tools represent a strong area of development, but a remaining challenge is how to better contextualize how various tools complement or align with each in each situation.
- Capacity building improvements are needed to increase dedicated staffing and funding for resilience work, education of community members, and outreach and training to empower environmental justice leaders and champions.

- Closing technical research gaps has made good strides, yet more work is needed on the specifics of management tactics, monitoring to demonstrate effectiveness, how to blend wetland restoration with improving community health, and understanding unintended consequences.
- Overcoming barriers to implementation is seen as a challenge, with gaining partner and stakeholder buy-in, funding, and permitting essential in the context of specific projects, tools, and programs.
- Political will is seen as the area needing the most work, including building relationships with local governments so that a better understanding can help remove barriers to implementation.

Emerging Principles

The participants brainstormed what fundamental advancements are needed to move forward as a community of practice, and these can be represented by the following principles.

- Coordination among groups should be greatly expanded and improved through more widespread and intentional use of cooperative frameworks and information-sharing platforms.
- Communication, for both coordination and partner and stakeholder outreach, requires expertise and priority investment to more extensively share failures and associated lessons learned, better document and share what actually does and does not work, and publicize and celebrate successes.
- Planning horizons for shorter and longer time frames will be key for deciding when/how to shift from shorter- to longer-term objectives, for more robust decisions on allocation of resources.
- Standardizing approaches--such as monitoring performance metrics, methods for determining ecosystem service benefits, permitting practices, and assessment frameworks—must be balanced with the recognition that data and applications may have to remain site-specific.
- Environmental justice (EJ), along with related concepts of diversity, equity, and inclusion, is a burgeoning area of study and priority action that is widely recognized across organizations but still has many needs for improvement, especially in implementing EJ actions.

With these Proceedings, the authors hope that the ideas gleaned from the workshop community can be used to collectively drive continued improvements in effective implementation of strategies to achieve resilient and sustainable coastal wetlands that in turn support healthy and thriving coastal communities.

1 Introduction

In May 2022, the U.S. Environmental Protection Agency's Office of Research and Development (EPA ORD) hosted a two-day, interactive virtual workshop to explore evolving concepts of climate change vulnerability, socioecological impacts, and priority adaptation practices to manage for resilient coastal wetlands. The goal of the workshop was to leverage knowledge and lessons learned from across regions and organizations to help standardize, improve, and advance methods to support resilient coastal wetlands and communities. In developing the workshop, emphasis was placed on interactions among participants to explore commonalities and differences in methods, areas of success, opportunities for improvements, and other insights gained from varied approaches applied across regions, organizations, and practitioners. Participation was achieved using Mentimeter[1] as well as the video and chat features of Microsoft Teams[2].

Two parallel lines of related research within EPA ORD on approaches to resilience and wetland management formed the backbone for this workshop:

1) a 'Mid-Atlantic' research team led by Dr. Jordan West working with Tetra Tech, the Partnership for the Delaware Estuary (PDE), and other EPA Region 3 partners to connect information from EPA's Relative Wetland Vulnerabilities Framework and other EPA tools[3] with PDE decision tools to inform more effective program and project adaptations; and

2) a 'Northeast' research team led by Dr. Cathy Wigand working with partners in EPA Region 1 to analyze wetland adaptation efforts and identify areas of success, opportunities for improvements, and methods to maximize social and ecological co-benefits for restored wetlands.

The scope and richness of the workshop were further enhanced by participation of regional partners in panel presentations and discussions focused on their own Mid-Atlantic- and Northeast-based research and management practices related to coastal and community resilience.

The workshop agenda may be found in Appendix A. The workshop was attended by a diversity of participants (146 on Day 1, 97 on Day 2) from six federal agencies; more than two dozen state, local, and Tribal agencies; 16 non-governmental organizations; more than a dozen academic institutions; and several private companies. The first day consisted of research presentations and interactive discussions on EPA ORD's Mid-Atlantic and Northeast research tracks. The second day consisted of two panels, each featuring presentations by four partner organizations. Presenters from the Mid-Atlantic region included representatives from the Virginia Institute of Marine Sciences, the National Oceanic and Atmospheric Administration/Chesapeake Bay Program, United States Geological Survey/Chesapeake Bay Program, Maryland Department of Natural Resources, and the Partnership for the Delaware Estuary. Representatives from the Narragansett Bay Estuary Program, Narragansett Bay National Estuarine Research Reserve, Rhode Island Natural History Survey, and Rhode Island Department of Health

[1] https://www.mentimeter.com/

[2] https://www.microsoft.com/en-us/microsoft-teams/group-chat-software

[3] More descriptive information on and links to tools, methods, and other resources mentioned in this Proceedings can be found in Appendix D.

presented during the Northeast session. (Full details on workshop speakers and panel participants are found in Appendix B.)

Each day's presentations were followed by interactive discussions with the audience, and the workshop concluded with a brainstorming session on lessons learned and emerging insights from across regions and organizations on how to better standardize, improve, and support the advancement of our collective wetland resilience efforts. Detailed summaries of the interactive Mentimeter polls may be found in Appendix C and are referenced throughout this document.

Finally, Appendix D provides a full compilation of specific tools, publications, and information resources provided by the presenters. These are organized for easy reference according to the workshop session, region, organization, and presenter, with brief descriptions and links to associated web pages and publications. Additional resources shared by workshop participants are also included, along with the link to the workshop page that includes all the presentations.

2 Workshop Themes

Three questions were considered key to advancing the practice of wetlands adaptation and resilience-based management, and thus were presented as workshop themes:

- *What is wetland resilience?*

  This theme explores the concepts of resilience utilized by resource managers, restoration specialists, scientists, decision makers, and other practitioners in their approaches to wetlands management. As the essential starting point for discussing how to manage for resilient wetlands, this theme involves consideration of: how to define, characterize, measure, and monitor resilience; the relationship of resilience to vulnerability, threats, and impacts; and how to assess vulnerability and socioecological impacts in the context of resilience.

- *How do we manage for resilience under changing environmental conditions?*

  This theme covers the practical aspects of managing for resilient wetlands. Specific areas of interest with regard to management applications include: considering resilience when selecting priority sites; evaluation, prioritization, and design of interventions in the context of resilience; and socio-ecological trade-offs in decision making for resilience.

- *How can resilient wetlands boost the health and resilience of coastal communities?*

  This theme explores linkages between ecological and socioeconomic considerations, with a focus on areas that could be reflected in trade-off analyses during decision making, including: community resilience through wetland coastal protection; human health benefits of resilient wetlands; and the role of other wetland values and ecosystem services (e.g., fish and wildlife habitat) for human health and well-being.

In the sections that follow, workshop findings for each of the themes are explored based on material shared over the two days of the meeting. Summary information, examples, and key insights are drawn from across the presentations, panel discussions, and interactive participant feedback sessions.

2.1 What is wetland resilience?

The workshop began by asking participants to consider a conceptual model of resilience used by EPA ORD (Figure 1). This model is consistent with the climate change science community's widely accepted

conceptualization of the components of vulnerability and shows the relationship of those components to resilience according to resilience science specialists. Here, vulnerability is determined by the exposures of a system to climate change and other stressors that result in an impact based on the sensitivity of the system; but that impact may be mediated by the adaptive capacity of the system to resist, tolerate, or bounce back. System resilience is thus determined by the combination of sensitivity and adaptive capacity of the component communities, species, habitats, and interactions. In the context of wetlands management, the overall goal is to reduce vulnerabilities through management interventions that either reduce exposures or increase system resilience (by reducing wetland sensitivities and/or boosting wetland adaptive capacity). The sections that follow further explore concepts of wetlands resilience from the perspective of the workshop participants.

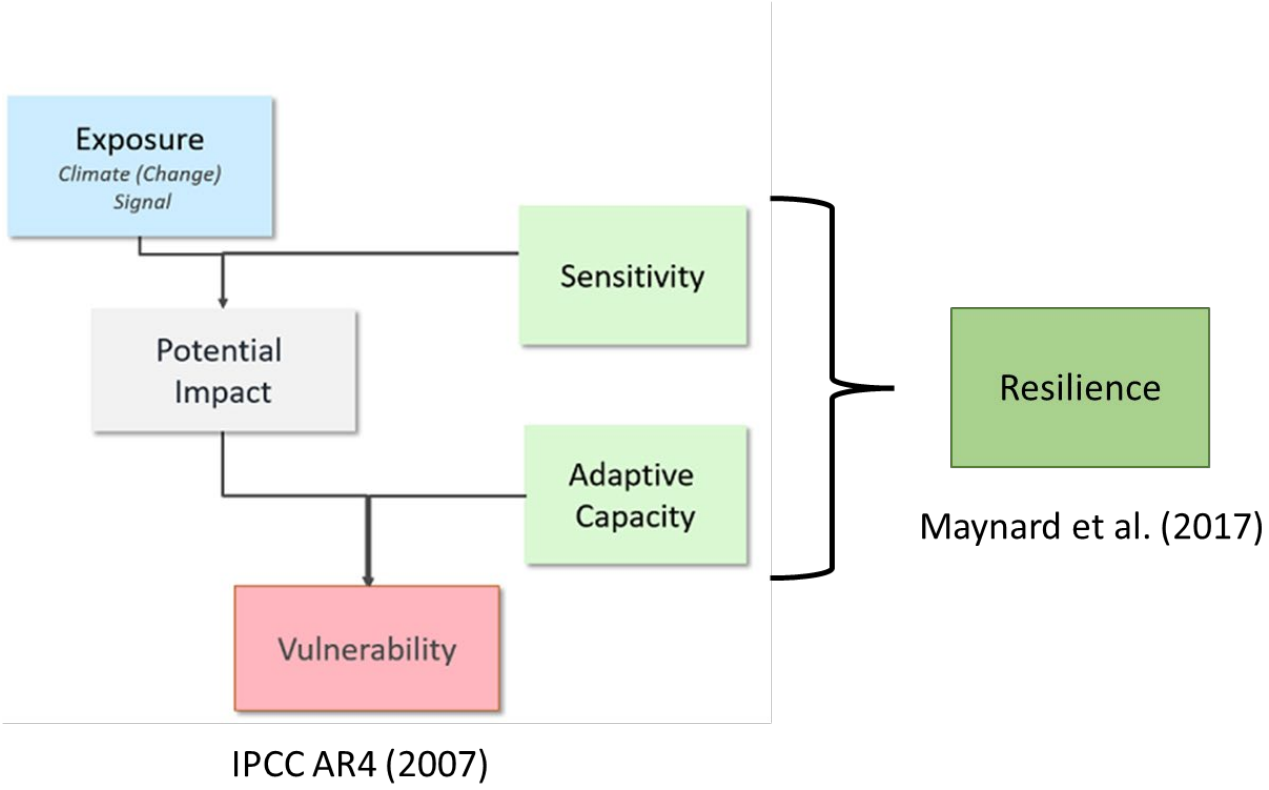

Figure 1. The physical and biological determinants of vulnerability and their relationship to resilience.[4]

2.1.1 How to Define, Characterize, and Measure Resilience

Workshop presentations were all related to coastal wetland resilience, with most presenters defining or characterizing resilience contextually by examining various aspects of the systems contributing to or affecting resistance and resilience. A common paradigm was the association of restoring wetlands or

[4] IPCC, 2007: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 976pp.

Maynard JA, Marshall PA, Parker B, Mcleod E, Ahmadia G, van Hooidonk R, Planes S, Williams GJ, Raymundo L, Beeden R, Tamelander J (2017) A Guide to Assessing Coral Reef Resilience for Decision Support. Nairobi, Kenya: UN Environment.

preserving them *for the long term* as a key aspect of managing for wetland resilience. In other words, wetlands persisting into the future represents wetland resilience. For example, Chaffee (NBNERR[5]) discussed two case studies of projects in Rhode Island that applied dredged sediments to degraded coastal marshes to increase elevation, restore the marshes, and increase resilience against sea-level rise over time. Reichert-Nguyen (NOAA/CBP) and Sullivan (USGS/CBP) presented the CBP's wetland and climate resiliency goals in the Chesapeake Bay Watershed Agreement[6]. The wetland goal is expressed as acres of wetland creation or re-establishment, or as functional enhancement of degraded wetlands, to be accomplished within a defined timeframe (by 2025). The climate resiliency goal aims to increase the resiliency of the Chesapeake Bay's living resources, habitats (including wetlands), public infrastructure, and communities to withstand adverse impacts from climate change.

Conn (MD DNR) presented Maryland's approach to building coastal resilience, which includes selecting priority areas to conserve wetlands. This is achieved using Sea Level Affecting Marshes Model (SLAMM) projections to identify areas of wetland loss and gain and where wetlands can migrate inland in response to sea level rise (SLR). This is combined with prioritization of coastal wetland areas that provide risk reduction benefits (e.g., flood protection) to residents, thereby making a link to the resilience of human communities. Climate resilience benefits are then, in part, characterized as areas where marshes can persist through migration in response to SLR. MD DNR's concept of promoting wetland resilience by enabling marsh migration is also captured in their establishment of coastal resiliency easements, which include delineation of wetland adaptation buffers to allow wetland migration. Mason (VIMS) asserted that tidal wetland resilience equals "future" marshes, that is, preserving or restoring marshes to maintain their services (e.g., water quality, habitat, erosion control, carbon flux, flood abatement, cultural, historic, recreation and aesthetics). As part of this process, thought needs to be given to how future marshes need to be preserved--whether to the same extent (acreage) as they currently exist, in the same locations, with the same distributions, of the same class, and/or providing the same services.

Another aspect of understanding resilience, from a practical point of view, is how resilience would be measured and monitored, or what would be considered an indicator of wetland resilience. To gather initial thoughts from workshop participants on this question, a poll asked them to rank the best among six categories of resilience indicators; results are shown in Figure 2. Consistent with the common paradigm among presenters, increased acreage of unfragmented habitat was most frequently ranked as the best indicator of wetland resilience. Nevertheless, four other potential indicators—increased elevation capital, decreased erosion rates, increased ecological diversity, and increased natural hydrology—also were highly ranked. All of these are related to 'healthy' wetland functioning and provide varying levels of resistance to stressors. Social benefits from wetlands were not as commonly perceived as an indicator of wetland resilience (Figure 2).

[5] For conciseness, organizational affiliations are abbreviated throughout the rest of this document; full names of all organizations are provided in the Abbreviations section on page i.

[6] https://www.chesapeakebay.net/what/what-guides-us/watershed-agreement

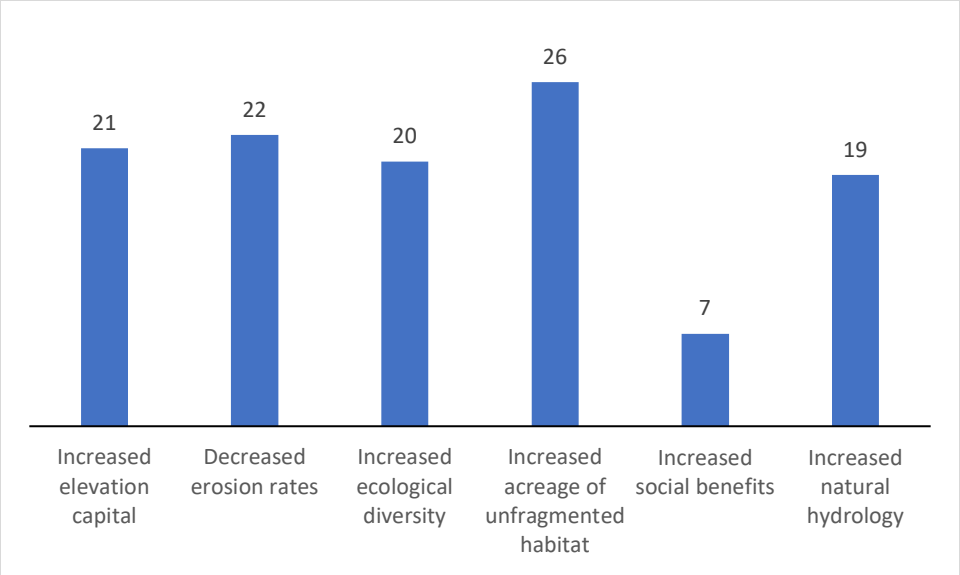

Figure 2. Participant inputs on the best indicators of a more resilient wetland.

The CBP is also working on climate-related indicators, and Reichert-Nguyen (NOAA/CBP) and Sullivan (USGS/CBP) presented an approach in which climate change indicators were grouped into those representing exposures, impacts, and resilience. Examples are shown in Table 1. SLR is an exposure (which CBP refers to as a *Physical Indicator* of climate change). Wetlands loss is an *Impact Indicator* of ecological/community threats (from SLR). A change in land use designation to allow for marsh migration is a *Climate Resilience Indicator* of preparedness (i.e., a potential response that would help mitigate marsh losses). In this application, the ability or intent to respond to or resist a threat was part of their definition of resilience.

Table 1. Examples of CBP climate change indicators representing exposure, impact, and resilience.

Exposure	Impact	Resilience
Physical Indicator	*Impact Indicator*	*Climate Resilience Indicator*
SLR	wetlands loss	change in land use designation to allow for marsh migration

In an open-ended poll, workshop participants were asked to submit statements about what resilience means to them. The most common ecologically oriented responses involved the ability (of a wetland) to persist through a disturbance. A variety of terms were used in addition to 'persist', including recover, adapt, survive, resist, absorb, withstand, retain, deal with, maintain and strengthen, bounce back, rebound, return to a stable state, come back, and respond positively. Other terms used in addition to 'disturbance' were stressors, adverse impacts, extreme events, significant change over time and space, weather challenges, and droughts or storms. In some cases, the concept was elaborated to include persisting within certain parameters, or while maintaining a certain ecosystem expression, retaining ecosystem functions, or continuing to provide ecosystem services.

Some participants also provided responses that reflect human socio-economic aspects of resilience, ranging from engagement with partners and stakeholders, to implementation of best management practices (BMPs), to some of the ecosystem services that wetlands typically provide (such as flood protection). A more complete tabulation of participant inputs on the question "What does resilience mean to you?" can be found in Appendix C.1.

2.1.2 The Relationship of Resilience to Vulnerability, Threats, and Impacts

Workshop presentations and participant inputs suggested that coastal wetland problems can be understood through a framework of vulnerabilities, threats, and impacts. This framework helps define and clarify the actions needed to achieve resilience. Various talks addressed vulnerability assessment (e.g., Hamilton (Tt CES), West (EPA ORD)), condition assessment (e.g., Kutcher (RINHS), Chaffee (NBNERR)), diagnosis of threats and impacts (Haaf (PDE), Moody (PDE)), and combinations of these (e.g., Conn (MD DNR), Mason (VIMS)). The presenters discussed ways in which resilience management programs can use results from these types of analyses to help inform decisions on restoration and climate adaptation priorities of where to work (i.e., site selection for wetland restoration and protection efforts), what to do in response (i.e., what restoration or protection techniques to apply), and how to design interventions to be effective.

Several presenters discussed methods or tools for evaluating or comparing wetland vulnerabilities, or for diagnosing wetland threats and impacts. Hamilton (Tt CES) presented the Relative Wetlands Vulnerability Framework (RWVF), which uses structured steps to: select and evaluate parameters of exposure and response (as a combination of sensitivity and adaptive capacity); and integrate these into a visualization of relative vulnerability that can be compared among sites and regions to support setting priorities, selecting sites, and designing interventions. West (EPA ORD) used results from the RWVF for a set of wetlands in Delaware Bay to explore how the results could support management decisions when linked appropriately to management goals. She discussed the types of trade-offs that might be considered depending on whether management objectives focused on preserving stable sites or restoring vulnerable sites; explored how details of vulnerability assessment outputs could inform tactic selection, particularly at finer spatial scales; and showed the potential for long-term assessment results to reveal tipping points (e.g., from relatively stable marsh in the short term to high marsh losses in the long term) that may be important to consider when making management decisions. Jen Stamp (Tt CES) offered a framework to aid in making selections among the many tools that are available to support decision making in the form of a conceptual model (Figure 3) that would help define the ecological and management contexts in which the tool would be applied. The model development supports a comparison among several EPA and PDE decision support and assessment tools, organizing components that represent key system drivers, internal marsh processes and responses, stressors (including both conventional and climate change components), and ecosystem services, with options for inclusion of socio-economic factors as well. By organizing system components so that they reflect relationships among climate exposures, other stressors, wetland condition factors, and wetland response metrics, it is possible to map the components and pathways that each tool covers. A user can use this to ask whether a tool covers the components that are important to them and are needed in the context of the decisions they need to make. The conceptual model also can be used to compare tools by showing how they complement or align with each other.

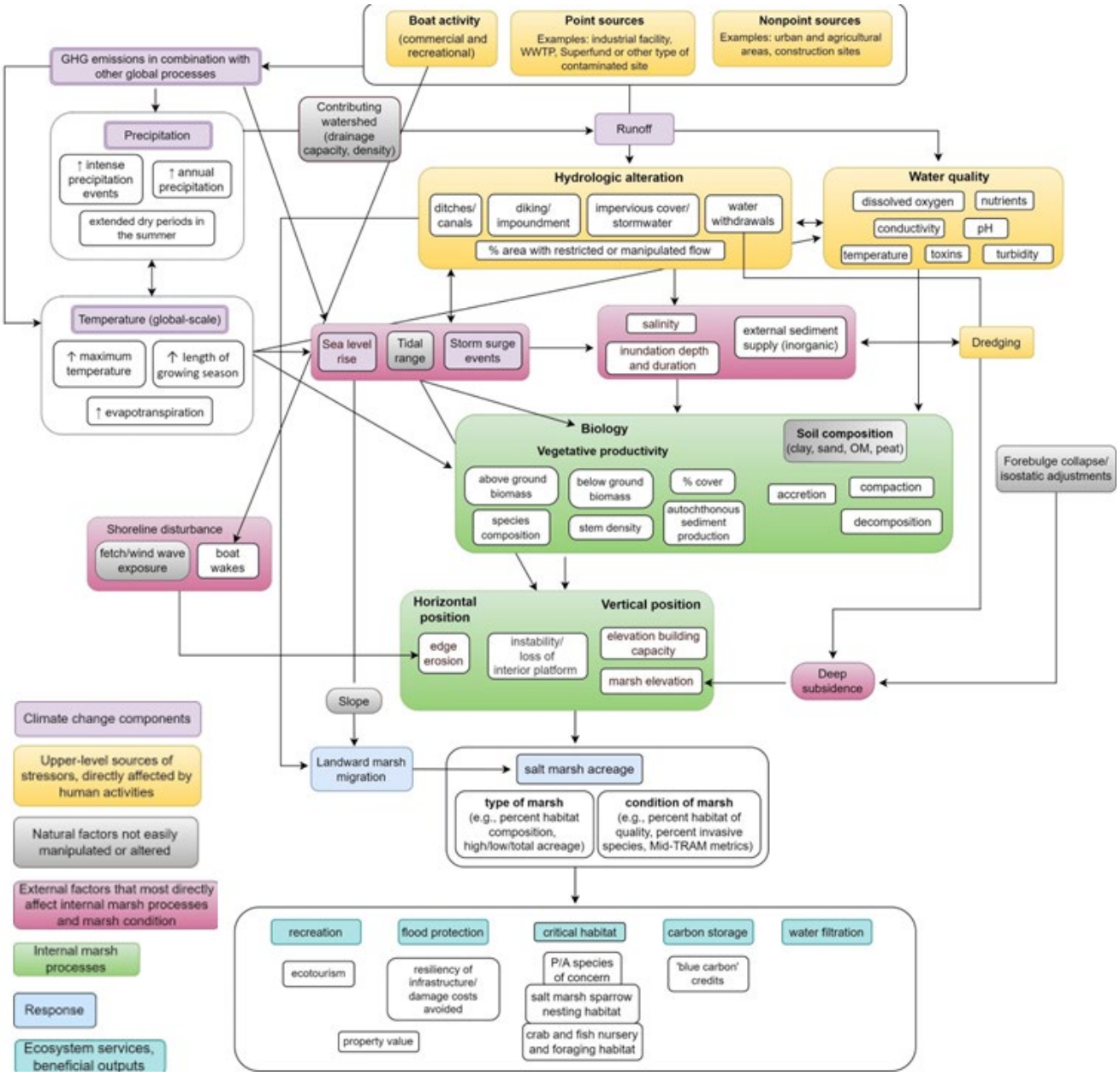

Figure 3. Conceptual diagram of key factors driving a coastal salt marsh system, calling out factors that sustain a marsh and potentially contribute to resilience, that are potentially impacted by anthropogenic stressors, or that can be influenced by management.

From a different point of view, Burman (EPA ORISE Fellow) considered the future vulnerabilities of wetland and adjacent upland areas (including human communities) related to the presence of hazardous and contaminated sites (HCSs) within coastal marsh migration pathways. As wetlands are submerged and migrate landward with SLR, contaminants within the migration pathway can be exposed to tidal waters and released into the environment. The severity of risk would be, in part, related to the type of contaminant and its expected level of effect on human health and aquatic life, a factor that can be incorporated into an assessment. Her work suggests that the overlap of projected marsh migration

and HCSs is an additional factor that should be considered to inform both hazard remediation and conservation planning, including determination of overall vulnerability and priority setting. For example, a heavily polluted marsh site might be considered a poor candidate for restoration if contaminated sediments would be re-suspended in the process. Many hazard remediation, marsh restoration, and coastal resilience projects have significant costs and efforts associated with them, so it is important to consider the intersections of coastal resilience priorities and identify project sites that can accomplish multiple objectives.

2.2 How Do We Manage for Resilience Under Changing Environmental Conditions?

There was a mix of technical and practical information shared during the workshop on how resilience figures into on-the-ground wetlands management work performed by different practitioners and regional groups. Input from participants was sought on how much time they spend on five different aspects of resilience-related management activities, as well as how they believe resilience should figure into their work. The five types of activities were: site selection, working with marsh migration, identifying and evaluating strategies, designing adaptive interventions, and social-economic considerations. Averaged over all participants, the distribution of effort among the activities was fairly even; working with marsh migration received the highest ranking while designing adaptative interventions received the lowest (Figure 4). The responses were, similarly, very strong that resilience should be the main driver of all decision-making activities (see Appendix C.2 for further details). A common perspective was that considering resilience reflects a long-term perspective and should provide for longer-term success for adaptation projects. The sections that follow further explore these concepts from the perspective of the workshop participants.

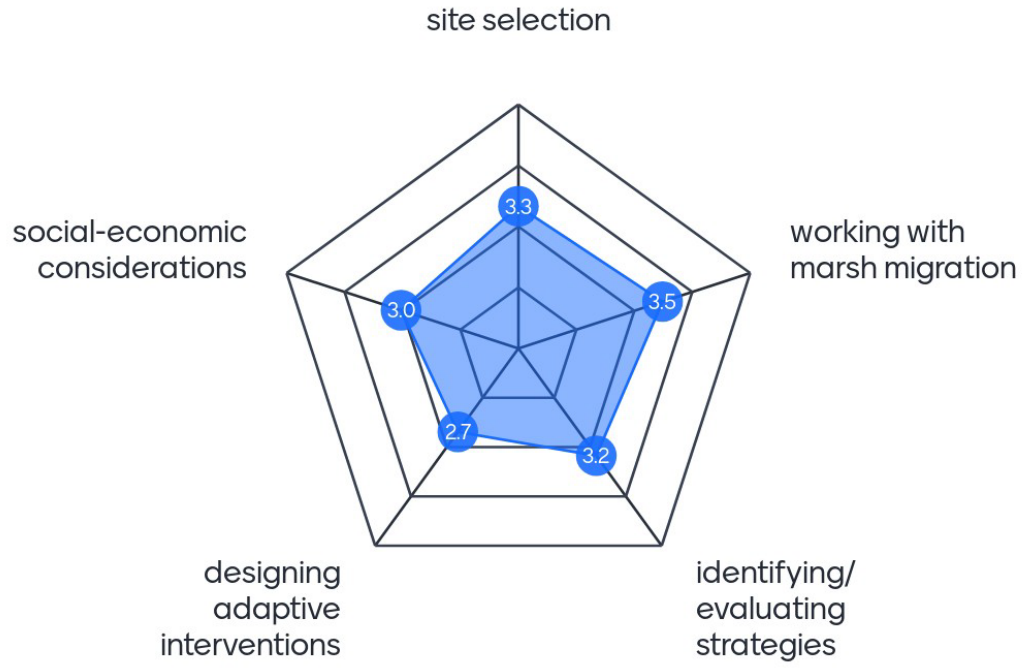

Figure 4. Participant inputs on how much time they spend considering resilience in the context of five different aspects of management. Ratings were scaled from 1 (least) to 5 (most); the numbers represent the weighted average across 40 respondents.

2.2.1 Site Selection & Working with Marsh Migration

Workshop participants indicated that they focus strongly on resilience in the context of site selection and working with marsh migration (Figure 4). Workshop presentations from several regions/groups promoted use of comparative vulnerability and/or condition assessments (Hamilton (Tt CES), West (EPA ORD), Kutcher (RINHS)), diagnosis of threats and impacts (Haaf (PDE), Moody (PDE)), or a combination of vulnerability based on marsh loss rates with other factors such as migration potential, co-benefits of coastal community risk reduction, and/or ecosystem services (Conn (MD DNR), Mason (VIMS)) as a basis for site selection and spatial analysis for working with marsh migration.

Outputs for several metrics contributing to components of vulnerability were shown from application of EPA's RWVF (Hamilton (Tt CES)), which provide a basis for making both between- and within-site comparisons in support of selecting priority sites. Further exploration of management applications of these RWVF results by West (EPA ORD) started with an overarching management question of whether restoration efforts should focus on the most vulnerable sites or on stable locations. From this initial decision point, site-specific results were used to set up example site comparisons to illustrate trade-offs managers might face in setting site priorities. Comparisons among components of vulnerability contributed to understanding not only where marsh changes were occurring (or projected to occur), but also why they might be occurring. Such information can inform what interventions might be considered to reduce and reverse losses, or conversely, preserve stability and boost gains. Additional consideration of information on tipping points (e.g., a change from a stable marsh site in the short term to one losing marsh in the long term) might influence short-term site prioritization decisions.

Kutcher (RINHS) outlined a Salt Marsh Rapid Assessment Method (MarshRAM) that assembles and scores a wide variety of marsh status and condition information, including an index of marsh integrity, disturbance, elevation, functions and services, migration potential and area, and several other factors, which can then be compared as a basis for making site-level priority decisions. A color-coded output matrix of sites by Rapid Assessment Method (RAM) metrics supported a readily justifiable prioritization of sites for restoration, conservation, and management. PDE's Wetlands Assessment Tool for Condition and Health (WATCH) (Haaf (PDE), Moody (PDE)) helps a user organize data and evaluate six attributes that are fundamental for salt marsh function within an interactive spreadsheet model. It uses the inputs of information on the current state of each attribute, user-defined acceptable ranges/bounds, information on trajectories of change in the attributes, and time frames of management interest to flag system deficiencies that can then be used to recognize priority locations in need of management interventions. At a larger scale, areas of concern identified by stakeholders/other interested parties and proposed or active restoration sites are mapped with state-identified issues of concern (e.g., wetland degradation, coastal flooding, underserved communities) in the Coastal Ecological Restoration & Adaptation Plan (CERAP), which allows users to identify sites that align with a variety of goals for intervention prioritization (Moody (PDE)).

The Maryland DNR (Conn) uses SLAMM to identify areas available for marsh migration and prioritizes these areas using criteria that include large contiguous wetland areas, wetland diversity, new wetland areas, presence of breeding marsh-dependent birds, future wetland areas by year 2100, existing non-wetland hydric soils, and Maryland's Green and Blue Infrastructure Assessments. They define low, medium, and high-priority Wetland Adaptation Areas, with medium- and high-priority areas becoming conservation priorities. They also use a model called GreenPrint[7] to identify Targeted Ecological Areas to

[7] https://geodata.md.gov/greenprint/

prioritize the most ecologically valuable land parcels for acquisition and investment in protection/restoration.

VIMS (Mason) has been working with the state of Virginia to use an assessment of co-benefits to prioritize sites. They map existing natural and nature-based features (NNBFs) in coastal Virginia, identify NNBFs that occur between buildings/other infrastructure and the pathway of inundation from SLR and storms, and estimate the flood mitigation benefits of the NNBFs based on how many buildings are protected and whether any of the infrastructure is critical to the community. Co-benefits considered include Federal Emergency Management Agency (FEMA) Community Rating System credit and water quality/total maximum daily load credit potential. In addition, Virginia developed a biophysical Shoreline Management Model to rank shoreline sites for application of living shoreline projects, which uses criteria of fetch, marsh or beach presence, existing structures, nearshore bathymetry, land use, and proximal infrastructure.

Workshop participants applauded these approaches and agreed that resilience is important to consider in site selection and related planning activities, such as setting restoration targets and identifying areas for preservation, restoration, or other adaptation approaches.

2.2.2 Identifying Strategies & Designing Interventions

Workshop participants also indicated that they focus on resilience as part of identifying strategies and designing interventions (Figure 4). Management planning typically links evaluation of the problem(s) at a site with selection of appropriate actions to address that problem, and there were several presentations that referenced tools and approaches that touched on this. PDE's WATCH tool (Haaf, Moody) is explicitly designed to diagnose deficiencies in marsh condition based on evaluation of six marsh attributes (vertical or horizontal position, elevation, hydrology, soil condition, and the biological community). WATCH outputs can be used to help select appropriate interventions to address the identified problems. Similarly, the outputs of the RWVF (Hamilton, West) provide insights into factors contributing to marsh vulnerabilities, which can inform potential management interventions. Hamilton (Tt CES) and West (EPA ORD) discussed two examples from the Delaware Bay case study. One site was projected to lose high proportions of high marsh due to SLR. Based on site information that was gathered during the vulnerability assessment, the high marsh area had a relatively low elevation (0.405 ± 0.26m), which suggests that thin-layer placement could be an effective tactic. The other site was a moderately vulnerable site with a high starting acreage of marsh and a relatively low marsh loss response to SLR but had a high storm surge vulnerability, which suggests it could be protected with a tactic such as a living shoreline.

A more detailed and site-specific design of an intervention, once it is selected for a particular site, can be achieved using EPA's Adaptation Design Tool (ADT) (Haaf). This tool leads practitioners through a series of steps to incorporate climate-smart considerations into the design of specific management tactics, and to brainstorm other potentially applicable interventions. Information on climate change vulnerabilities and other stressors from tools like WATCH and the RWVF are key inputs for using the ADT.

2.2.3 How to Assess Vulnerability and Socioecological Impacts in the Context of Resilience

The northeast EPA ORD research team presented study results on the roles of community and other partner/stakeholder engagement and other human dimensions for marsh resilience management. Mulvaney (EPA ORD) presented the 'SESAME' framework (Figure 5), which represents adaptive management with a strong element of partner/stakeholder engagement. The framework supports

collaborative development of human- and ecosystem-focused restoration and adaptation goals, consensus building, and the opportunity to revisit goals at multiple stages of planning and implementation. It also supports development of both ecological and social metrics for monitoring. An identified challenge is related to the duration of project planning, implementation, and monitoring, during which time consistent participation by the same partners/stakeholders and ongoing maintenance of responsibilities can become disrupted. Another challenge for increasing consideration of the social side of restoration is that there is, at present, limited capture of lessons learned from wetlands resilience efforts from a social perspective.

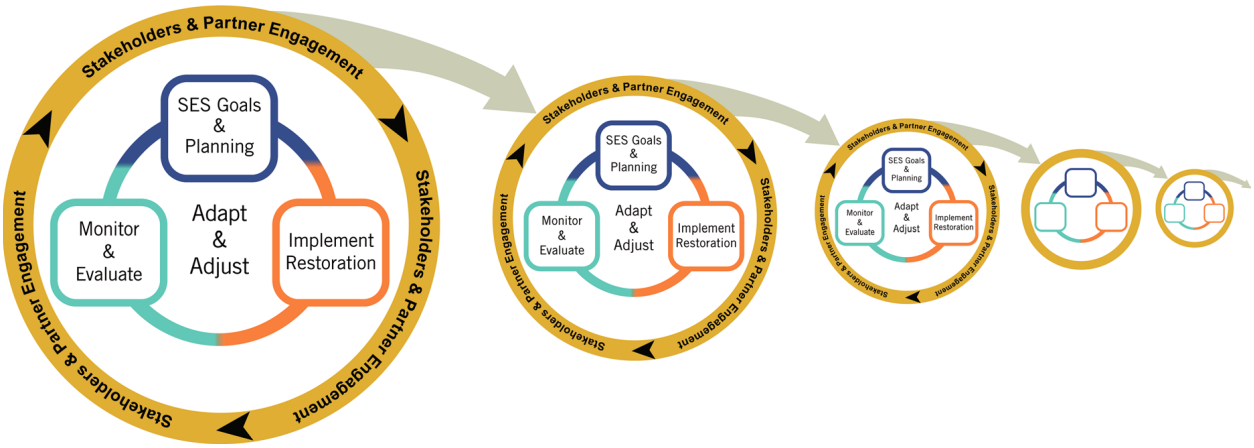

Figure 5. Social-Ecological Systems, Adaptive Management, and Engagement (SESAME) Framework for coastal restoration and climate adaptation (Mulvaney et al. 2022)[8].

Other socio-economic presentations covered methods for assessing values of marshes and their services in terms that would support assessment of potential restoration project benefits. Trandafir (URI) presented a modeling approach to estimate the monetary values of carbon sequestration and non-carbon ecosystem services. The approach uses SLAMM projections to estimate future marsh losses, which are then converted to monetary losses that would be prevented or reversed by management interventions. Such robust economic valuations can be used not only to help managers evaluate and select adaptation and restoration projects, but also to communicate the values of resilience management to the public. It should be noted, however, that while monetary valuations provide a useful means of estimating restoration benefits and communicating those values to the public, direct indicators of non-monetary values (e.g., ecosystem benefits such as reduced flood risk, recreational and aesthetic opportunities) also should be considered when evaluating salt marsh management options.

Reilly (EPA Region 1) presented a method for estimating blue carbon sequestration benefits that would accrue from avoiding the greenhouse gas (GhG) emissions (focusing on methane) that occur as wetlands degrade and are lost. The method utilizes information on marsh condition, risk of marsh losses, GhG emission rates, expected emissions with degradation, and causes of marsh degradation with a focus on salinity effects. These factors are used to estimate GhG emissions that could be avoided with conservation efforts. These are then related to the social costs of methane emissions. This provides an opportunity for states and local governments to work towards getting 'blue carbon' offset credits for coastal restoration efforts. Calabro (RIDOH) discussed climate change as an amplifier of community risk

[8] https://link.springer.com/article/10.1007/s11273-022-09891-3

to health, and the importance of considering community health when evaluating social impacts and vulnerabilities.

2.2.4 Social-Economic Considerations

Both process and technical information regarding trade-offs among social and ecological costs and benefits were presented. Regarding process, Schmidt (NBEP) spoke about the Restoration, Assessment, and Monitoring Program (RAMP), which seeks to integrate a wide range of partners and their monitoring and assessment efforts. This provides the benefits of standardized methods, increased capacity and efficiency of work across agencies, improved assessments, and greater ability (including funding resources) to preserve wetlands. This program, coordinated through the NBEP, provides the space and tools to increase emphasis on environmental justice (EJ) and balance priority wetland restoration activities with community resilience. The CBP (Reichert-Nguyen (NOAA/CBP) and Sullivan (USGS/CBP)) is also seeking to increase the focus on social factors in trade-off analyses that are used in decision making by developing and using partner/stakeholder resilience metrics for targeting marsh restoration projects and aligning partner/stakeholder organizational and geographic priorities with resilience research opportunities. There also is increasing consideration being given to using blue carbon offset crediting (i.e., economic incentives based on carbon sequestration services provided by wetlands) to establish values of and priorities for marsh restoration projects, as presented by Reilly (EPA Region 1).

On a project-specific scale, Mulvaney (EPA/ORD) presented how SESAME (Figure 3) was used in two different marsh restoration projects in Massachusetts and Rhode Island to collaboratively develop both ecological (restoring degraded marsh for resiliency) and social (channel dredging for economically important recreational navigation) goals in a single management project. Values were realized in terms of greater public engagement (including volunteer assistance in replanting new marsh platform), project support, municipal funding, and fundraising, as well as multiple benefits, both ecological and social. It was noted that the process used in the example was not quantitative, and that development of guidance is needed on how practitioners should approach identifying, comparing, and selecting between social and ecological restoration goals. In addition, challenges were encountered in collaborative project design and implementation, in part generated by having larger, more diverse groups of project participants. Examples included difficulty establishing project goals and objectives with a diverse team, balancing community objectives with technical requirements of permitting and funding, and shared project ownership and sharing of ongoing responsibilities.

2.3 How Can Resilient Wetlands Boost the Health and Resilience of Coastal Communities?

Workshop presentations and participant discussions provided insights into how resilience of wetlands can contribute to resilience of coastal communities. Throughout the workshop there was recognition of the key importance, challenges, and benefits of partner/stakeholder engagement when seeking to link resilience of wetlands to benefits for communities (Figure 6). In an open-ended poll, participants were asked, “What do you see as the biggest connection between wetlands resilience and community resilience, and how would you measure it?”. Responses emphasized ecosystem services (e.g., flood protection, wave attenuation, water quality, water storage, aesthetic beauty) as the main connection between resilience of wetlands and partner/stakeholder communities. Reponses also indicated that the combined resilience of connected wetland and human communities would best be measured by the quality, persistence, and sustainability of both through time, using indicators of, e.g., ecosystem service functions, property values, cultural values, and mental health outcomes (see Appendix C.3 for more

details). The sections that follow further explore the role of wetlands resilience for community resilience as presented and discussed by the workshop participants, focusing on flood protection services, other valued ecosystem services, and human health and well-being outcomes.

Figure 6. Word cloud of participant inputs describing the nature of partner/stakeholder engagement. Word size is based on frequency of word choice by participants.

2.3.1 Coastal Protection

The CBP considers the flood and erosion protection services provided by coastal wetlands to adjacent land areas as part of their site selection analysis (Reichert-Nguyen (NOAA/CBP) and Sullivan (USGS/CBP), Mason (VIMS)). This recognizes and makes linkages to the benefits to coastal communities from wetland resilience, in particular community benefits from protecting buildings and other infrastructure, as well as human-supported land uses (e.g., agriculture). Other organizations/regions address coastal protection by developing living shoreline projects that consider community resources, existing stewardship, need for community protection, and EJ as a basis for project siting and design (Moody (PDE), Mason (VIMS)). Maryland's coastal resiliency assessment identifies flood-vulnerable communities and shorelines prone to coastal flooding and erosion, and then maps protective coastal habitats to target protection and enhancement through management of natural coastal habitats that also provide risk reduction benefits to people (Conn (MD DNR)).

The work of Burman (EPA ORISE Fellow) offers a specific example of coastal protection provided by wetlands that is important to community health and resilience. For areas where hazardous and contaminated sites (HCS) occur within wetlands and in adjacent uplands along the path of wetland migration, progressive wetland losses threaten exposure of the HCS to flooding and release of contaminants. Thus, management actions that preserve and enhance these wetlands and increase wetland resilience also protect coastal communities by potentially decreasing the likelihood and/or severity of contaminant releases.

Based on workshop participant inputs, the wetland services of flood protection/mitigation and wave attenuation/coastal protection (from erosion) were perceived as a direct connection from wetland to community resilience. This is due to the perceived protections afforded by wetlands to water quality, houses and other infrastructure, and associated property values.

2.3.2 Human Health

In polls asking about how resilience figures into their work, various participants affirmed the importance of community health as a major target of their efforts, including mental health benefits, with special attention needed for increased research and funding to address social vulnerabilities around resilience and health. Calabro (RIDOH) presented information on community conditions that impact human health, including interactions with the natural environment that influence the social determinants of health directly, or indirectly by ameliorating climate change impacts. Other presenters (e.g., Conn (MD DNR), Reilly (EPA Region 1), Trandafir (URI)) recommended including the values of wetland services such as recreational activities (with their potential direct influences on human health/well-being), water quality, and carbon sequestration (with its indirect effects on human health through mitigation of climate change impacts) as decisions are made regarding managing for wetland resilience. This is an acknowledgement of the contributions of these services to community well-being and human health. It will be important to further explore and define the role of ecosystem services provided by resilient wetlands in protecting human health.

2.3.3 Other Wetland Values and Ecosystem Services

Other wetland services were examined in workshop presentations in relationship to community resilience. The state of Maryland sets conservation priorities to preserve the state's ecosystem services based on aquatic/terrestrial biodiversity, the green infrastructure network, water quality, and important fisheries, as well as climate resilience (Conn (MD DNR)). The CBP has identified a need for research on the impacts on fish of wetland habitat loss due to climate change—a recognition of this as a value to human communities (Reichert-Nguyen (NOAA/CBP) and Sullivan (USGS/CBP)). Similarly, water filtration is listed as a valued wetland service in the non-carbon valuation approach discussed by Trandafir (URI).

Based on workshop participant inputs, the value of wetlands as open space and for visual aesthetics provides mental health benefits to people and communities, thus contributing to community resilience. There also was mention of the human benefits from clean water, provision of critical habitats, and associated opportunities for eco-tourism.

3 Synthesis

In addition to exploring the latest research in the three themes above, a major goal of the workshop was to synthesize lessons learned from across the themes about how we can better standardize, improve, and advance methods to support resilient coastal wetlands and communities in the future. This section explores where we stand as a community of practice in terms of our strengths, challenges and gaps that remain, and emerging principles for furthering our collective capacity to achieve resilient coastal wetlands and communities.

3.1 Strengths

There were five key topics--representing cross-cutting activities that span all research themes--that presenters and participants were asked to think about throughout the workshop presentations and discussions:

A. **Capacity building** for improved management of wetland and coastal community resilience

B. **Working with partners/stakeholders** via human-centered design

C. **Translating scientific information for decision** making at all levels

D. **Barriers and opportunities** for successful implementation of management actions

E. **Dealing with uncertainty** associated with data and information limitations.

These topics are not mutually exclusive and have some overlapping elements but can help us evaluate our levels of strength as resilience researchers and practitioners in these important areas. An overarching strength of the resilience management community, represented by our workshop participants, is that the community self-reports a moderate-to-high level of both interest and experience in all five of the key topics identified (Figure 7). Each topic is discussed further below.

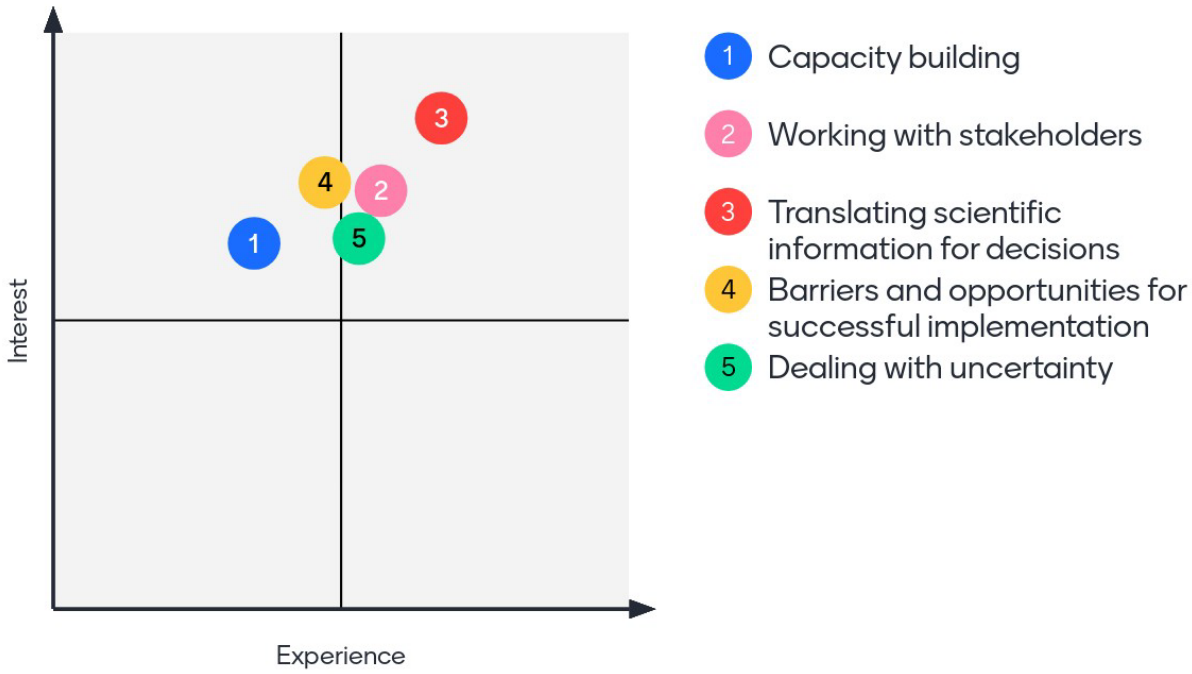

Figure 7. Participant inputs on their interest and experience with five key cross-cutting topics.

Translating scientific information for decisions was ranked highest for both interest and experience by the workshop community. Moody (PDE) presented several tools and approaches that help practitioners identify, gather, and summarize data and other information in a manner that facilitates management decision making at several levels (site alignment with management goals, site-specific issue diagnosis, and issue-specific tactic selection). Haaf (PDE) compared PDE's WATCH with EPA's RWVF and ADT in

terms of the terminology, attributes, metrics, and steps used in each, to explore how these tools could complement and be used in concert with each other. All three tools support evaluation and planning under present and future conditions and offer a systematic but flexible process with management-relevant outputs. Complementary tools can be used at all three levels of decision making, including large-scale site selection, within-site condition assessment, and tactic-specific climate-smart design. There was a rich exchange and sharing among participants of a variety of other tools, information resources, and initiatives (see Appendix D) that are further evidence of the workshop community's strengths in this area.

Working with partners/stakeholders tended to be discussed hand-in-hand with **barriers and opportunities for successful implementation;** here, interest was high and experience was moderately high. Mulvaney's (EPA ORD) presentation on the SESAME framework focused on the importance and value of integrating partner/stakeholder engagement and collaboration in an adaptive management context to overcome barriers and exploit opportunities for better wetland restoration and climate change adaptation. She acknowledged that the partner/stakeholder engagement and collaboration process is sometimes difficult, particularly the challenge of maintaining responsibilities during long-duration projects. From a technical perspective, Schmidt's (NBEP) presentation on RAMP represents a framework through which a large group of partnering agencies, NGOs, and others can increase their capacity for resilience management through collaboration, standardization of methods, and other aspects of cooperative work. Chaffee (NBNERR) presented some specific challenges associated with partner/stakeholder interactions in project planning and implementation, including potentially-difficult communication with contractors. While acknowledging such challenges, workshop participants saw benefits—and exciting opportunities for further improvement--of partner/stakeholder engagement, including development of a shared understanding of local environmental problems and co-production of solutions, leading to greater community support for resilience activities (see Appendix C.4 for more details).

Dealing with uncertainty was of high interest, with participants reporting a moderate degree of experience with the topic. With respect to design and implementation of a thin-layer sediment placement project, Chaffee (NBNERR) had summarized challenges of dealing with uncertainty in aspects of project design, water management, budget estimation and management, and construction bid solicitation. Unknowns contributing to these uncertainties, such as quality of the sediment and how transects were laid out for measurements, were informed to some extent by the experience gained from the Ninigret thin-layer placement case study. As per an adaptive management approach, this served to reduce some of the uncertainties encountered, to the benefit of future similar projects. Another approach is the use of scenarios. Uncertainties in projections of SLR were addressed in a valuation method (Trandafir (URI)) by presenting different SLR and mitigation scenarios and associated discounted economic values. For the workshop participants overall, the topic of dealing with uncertainty was handled implicitly in research and project methodologies rather than being a direct topic of study but was an area in which they felt fairly well-experienced.

Capacity building, while of high interest, was the one area where participants reported lower levels of experience (see next section on challenges and gaps). Capacity building can refer to various targets, from increasing the expertise and resources that enable practitioners to implement resilience management, to capacity building within partner/stakeholder, community, and volunteer scientist groups. As an area of high interest, capacity building was reflected in the talks of workshop presenters such as Conn (MD DNR), who reported on several MD DNR-sponsored mapping, modeling, and data compilation initiatives that produced a substantial set of technical resources that increase the capacity of practitioners to perform a range of resilience management tasks. Similarly, Mason (VIMS) presented

several technical support tools (mapping/GIS, modeling, and data compilation) developed in Virginia for the same purpose. PDE (Moody, Haaf) and EPA (West (EPA ORD), Hamilton (Tt CES), Haaf (PDE)) also have been in the forefront of tool and decision support development that expands the technical capacity of practitioners. Capacity building within partner/stakeholder and community groups was addressed in presentations on two pilot thin layer placement restoration projects conducted in Massachusetts and Rhode Island (Chaffee (NBNERR), Mulvaney (EPA ORD)) that were strongly focused on integrating partners/stakeholders in both the planning and implementation stages of these projects. In interactive discussions, presenters and participants collectively indicated that these activities have the benefit of getting 'buy-in' and community support while also encouraging community participation, leading to more inclusive and sustainable goals and projects.

In addition to the polled strengths above (Fig. 7), another strength is that the workshop community indicated that there has already been substantial thought and study on the topic of indicators of resilient wetlands, evidenced by the varied but confident opinions on this topic offered during the workshop. Figure 2 (see Section 2), which summarizes participants' opinions on the best among six categories of resilience indicators, shows that participants considered five of the six options as almost equally-good indicators, with increased acreage of unfragmented habitat ranking slightly highest. In further discussions, there was increasing input that elevation capital is key to marsh resilience, with elucidation of the roles and additional importance of marsh migration potential and community diversity. Social indicators, particularly reflecting flood protection benefits to human communities, were recognized as important; however, the disconnect between social benefits and other (ecological) indicators also was recognized, suggesting this as an area that needs further attention.

3.2 Challenges and Gaps

As discussed by the workshop participants, there remain diverse gaps and challenges for achieving resilient coastal wetlands and communities. Among five technical and socio-political areas upon which participants were polled, all were ranked medium-to-low in terms of achievement (Figure 8). Each area is discussed further below, including participant inputs on what is needed to improve as a community of practice on achieving resilient coastal wetlands and communities (Appendix C.5).

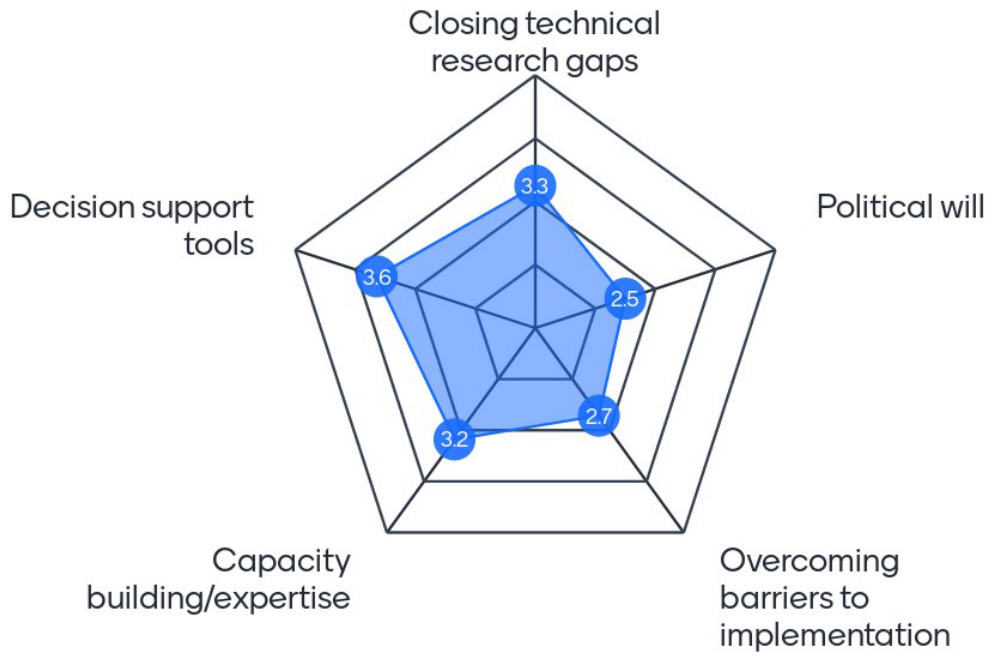

Figure 8. Participant inputs on where we stand on achieving resilient wetlands with respect to several factors (on a scale of 1-5 with 5 being the strongest).

Decision support tools ranked highest for their availability and support for achieving resilience**,** although there is still room for improvement. Despite strong work in this area, a remaining challenge is that, given the many tools and approaches available, there is a need to better contextualize how various tools complement or align with each other so practitioners can pick the best tools to use in each situation. As a possible approach for addressing the challenge of tool selection, Jen Stamp (Tt CES) presented a conceptual model (Figure 3) that provides context for defining the relationships among climate exposures, other stressors, wetland condition, and wetland response metrics (and with potential options for inclusion of socio-economic factors). Parameters included in the diagram then can be matched to parameters in example tools to help determine where a tool fits for evaluating wetland processes, thus supporting tool selection for application to different levels of decisions (e.g., site selection, problem diagnosis, tactic selection and design, etc.). There are certainly potential gaps in the draft conceptual model in terms of wetland processes and metrics included and the inter-relationships represented. An ongoing challenge is whether this approach can be usefully expanded for evaluation/selection of other resilience management support tools.

Capacity building is an area of growing strength, but more progress is needed. Some participants indicated that their agencies and partners need improvement in capacity building in areas such as dedicated staffing and funding for resilience work; education of community members in general, or specifically to cultivate citizen science capacity; and outreach and training to build capacity and empower DEIJ (diversity, equity, inclusion, and justice) leaders, mentors, and community champions. (see Appendix C.5 for more details).

Closing technical research gaps is an area where the community has made good strides, as indicated by much of the tool and decision support development, modeling, data compilation, and case study development that has been presented in this report. Examples were provided from the thin-layer

placement pilot projects presented by Chaffee (NBNERR), with a variety of lessons learned regarding types of elevation controls to use, approaches for sediment control during and after placement, and the need for and success of revegetation. More work is needed on specifics of some management tactics. In general, more case studies are needed to improve techniques/approaches, as well as related studies to improve specific information on restoration techniques. More effective and cost-efficient monitoring is needed to demonstrate effectiveness, share results, and establish long-term data sets. Gaps also were identified in knowledge of social vulnerability and how to blend wetland restoration with improving community health; understand unintended consequences of decisions; and demonstrate success through identification and monitoring of resilience indicators and reporting of results (see Appendix C.5 for more details).

Overcoming barriers to implementation is seen by practitioners as a challenge for resilience-based management. Workshop discussions were not focused specifically on identifying barriers, although gaining community acceptance/buy-in, funding, and permitting were identified in the context of specific projects, tool application processes, and programs. Based on workshop discussions, increasing inclusion of socio-economic efforts within management planning and project development and including greater partner/stakeholder engagement at multiple levels would contribute to progress on some of these fronts. Such progress will depend on increasing partner/stakeholder capacity to participate meaningfully in the process, increasing project support, and improving support for funding.

Political will was identified as the area of resilience management needing the most work. This includes building relationships with local governments so that a better understanding on their part can help remove barriers to implementation. Workshop participants asserted that more interaction is needed with regulators and permit writers to improve understanding of new restoration/adaptation techniques that bring results but may require alternative permitting considerations. It was also perceived that building better connections with funders is needed to help reduce funding barriers and streamline bureaucratic processes.

3.3 Emerging principles

More than half of the workshop participants were not sure that the information needed to manage for resilience is readily available or sufficient to assure success, while 30% were sure it is not (Figure 9). Drawing from participant inputs over the two days of the workshop, it is possible to identify some emerging principles and fundamental advancements needed to move forward and improve as a community of practice.

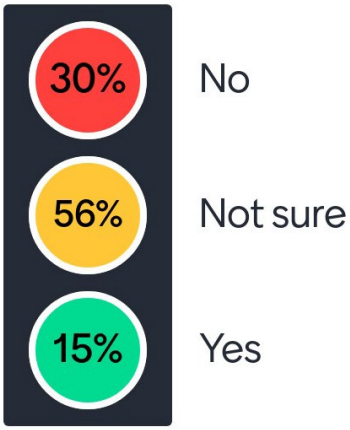

Figure 9. Participant inputs on whether information on managing for resilience is readily available and sufficient for success.

Coordination among groups could be greatly expanded and improved to facilitate collaborations and accelerate progress toward successful resilience management. Developing more regional collaborations would facilitate sharing of information and experience within and across states and regions. Coordination across organizations and regions to conduct site visits could be an effective, hands-on mechanism of sharing information and experience. Topical needs are to improve and coordinate more effectively on funding for restoration/adaptation, including developing connections among potential funders, reducing funding barriers, and streamlining bureaucratic processes. Increased sharing of experiences and lessons learned also would help practitioners understand the unintended consequences of decisions. Example mechanisms could include:

- Development of a mid-Atlantic (or beyond, including New England) program similar to the South Atlantic Salt Marsh Initiative (SASMI), or perhaps one patterned after RAMP.
- Development of a shared listserv and/or newsletter for work done on a regional basis.

Communication—in support of the coordination needs above but also for improved outreach to partners/stakeholders—is an area of expertise and investment that was highlighted throughout the workshop as a priority for expansion. Communications and interactions across the adaptation science and resilience management community could be used more extensively to share failures and associated lessons learned; better document and share what actually does and does not work; and publicize and celebrate successes. Specific ideas that were raised include:

- Developing "clearinghouses" of relevant information, so practitioners do not have to search multiple places for information and resources. This could include a clearinghouse or repository of information on available tools. A website with available resources might also be considered.
- Instituting regular meetings/communications via a Community of Practice (perhaps similar to the Salt Marsh RAMP working group).
- Investing in more widespread and improved public relations to advertise/communicate needs and successes with different groups of partners/stakeholders.
- Compiling summaries of successful case studies and lessons learned to share with officials and partners/stakeholders on current projects.

Planning horizons around shorter- and longer-term time frames represent an important emerging insight from the workshop. Participants reflected that, simultaneous with managing for shorter-term goals, it may be necessary in many cases to also engage in a longer-term planning perspective, one that places more emphasis than may have previously been made on longer-term success and sustainability of the overall system. In summary, the perspective was:

- The practice of resilience management would be improved by taking a longer-term perspective, improving the chances that restoration/protection work that is done is going to last.
- A longer time scale should take future conditions into account, including long-term projections of SLR and a changing landscape context, when prioritizing restoration/protection activities.
- Benefits of stronger partner/stakeholder engagement would include development of long-term solutions, and greater longevity of projects and project support.

Planning for when and how to shift from a shorter- to a longer-term set of objectives within and among wetland sites in a region could result in more robust decisions on the allocation of resources for adaptation. For example, wetland vulnerability results (and associated implications for decisions) can vary drastically depending on the time frame used for model projections. Using shorter-term (mid-century) SLR projections to estimate wetland vulnerability, as would be done to support the more traditional near-term management decision making, can yield very different results compared to longer-term (e.g., end of century) SLR projections. The differences can include threshold shifts of wetlands from stable or gaining, to abruptly undergoing major losses. These differences have the potential to drive very different decisions about objectives and actions in the near term versus in the longer term.

Standardizing approaches was a key objective for discussion at the workshop. The intent was to gain some insight into how much the practice of managing wetlands for resilience could be generalized, versus how much needs to be region- or location-specific. In summary:

- Aspects of wetlands resilience work that could be standardized include practices that are universally applicable and beneficial to compare across regions and applications, such as monitoring methods, metrics (e.g., of performance/success); methods for determining benefits and ecosystem services, permitting practices; and terminology. Also, standardization could be pursued in the form of a systematic process that steps through the critical elements required for rigorous resilience-based evaluation and planning.
- Aspects of wetlands resilience work that will likely need to be tailored include biological restoration and site-specific designs, and potentially decision tools, community needs, and other social connections. Also, addressing EJ needs must be tailored to place. Additional consideration of EJ is discussed in the next section.

Environmental justice (EJ), along with related concepts of diversity, equity, and inclusion, was identified as a burgeoning area of study and priority action across the workshop community. Most workshop participants reported that their organizations put a large or some emphasis on EJ (Figure 10), but most also recognized many needs for improvement, especially in implementing EJ actions. Other points of interest include how to better identify problems; integrate EJ into work plans; and build relationships and capacity with trusted community champions, leaders, and mentors.

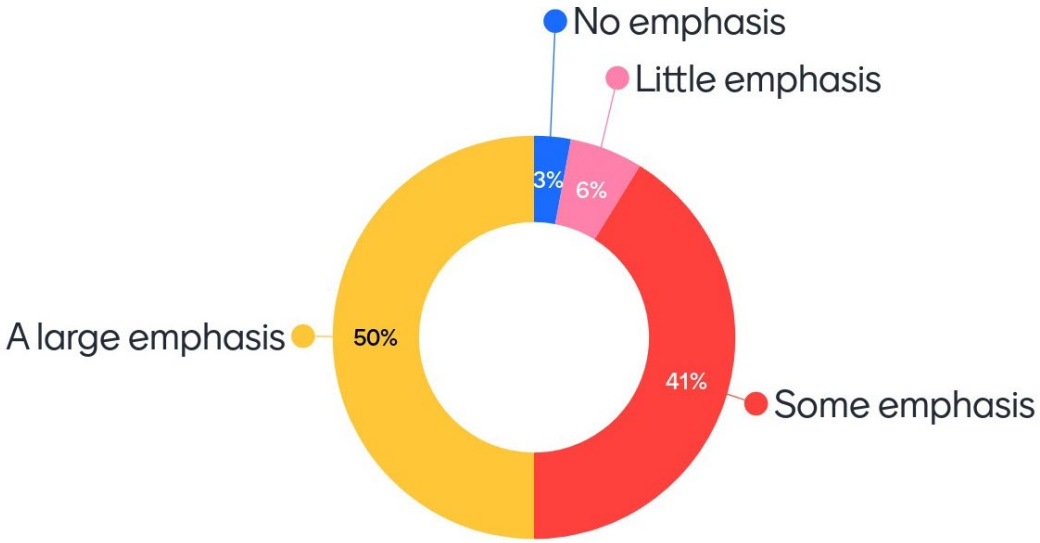

Figure 10. Participant inputs on how much emphasis their organizations put on environmental justice.

In terms of integrating (and making actionable) EJ within specific management activities, workshop participants consider it important to include prioritizing marshes for restoration based on benefits to historically overburdened and under-represented communities. This requires quantifying existing and potential users of the marsh and identifying the primary beneficiaries of restoration and protection for different marshes in the area.

Other key activities would be:

- Understanding the relative importance of marshes to underserved and native/Tribal communities, and that there is a connection between historically under-represented communities and recognizing Tribal uses/values.
- Having policies in place that assure "greening" of neighborhoods with natural features (wetlands) does not displace low-income housing.
- Assuring that vulnerable communities are recognized, as projects currently often go to the best-resourced communities.
- Building local capacity and supporting local leaders in EJ communities.
- Transferring power to Native, Tribal, and marginalized stakeholders when possible.

In conclusion, these results of the Resilient Coastal Wetlands and Communities Workshop have shown how new insights, innovative ideas, and emerging needs are revealed when diverse participants gather to explore commonalities and differences in methods, areas of success, and opportunities for improvements across regions, organizations, and areas of expertise. In addition to celebrating strengths and successes, participants were able to share challenges and areas for improvement. When asked what is needed to continue improving as a community of practice, many participants expressed a desire to hold regular gatherings such as this workshop, to achieve improved technology transfer and join forces in creating solutions to complex challenges. Only through expanded partnerships, collaborations, and information-sharing will it be possible to achieve our shared wetland protection and restoration goals, incorporate the benefits of local wetlands into decision-making activities for communities, and ensure that the benefits of environmental protection are shared by all.

Appendix A. Workshop Agenda

Resilient Coastal Wetlands and Communities: Multi-Regional Workshop
Online, May 24-25, 2022 @ 11am-4pm daily

GOAL: Leverage knowledge and lessons learned from across regions and organizations to help standardize, improve, and advance methods to support resilient coastal wetlands and communities.

OBJECTIVES: Share scientific perspectives and feedback on: 1) Coastal wetlands vulnerability and resilience; 2) Applications of resilience-based management; 3) Implications for coastal community resilience

AGENDA	
DAY 1— TUESDAY, MAY 24, 2022	
11:00-11:40 am	Welcome and Introduction • *Wayne Cascio, Director, Center for Public Health and Environmental Assessment, U.S. Environmental Protection Agency (EPA) Office of Research and Development (ORD)* • *Chris Frey, Deputy Assistant Administrator for Science Policy, U.S. EPA ORD*
11:40-1:05 pm	EPA Mid-Atlantic work: Wetland vulnerability assessment and links to management • Framework for wetland vulnerability assessments: Delaware Estuary case study, *Anna Hamilton, Tetra Tech, Inc.* • Interpreting vulnerability information for adaptive management of high marsh habitat*, Jordan West, U.S. EPA ORD* Considering coordinated use of multiple wetland assessment tools • A crosswalk of PDE and EPA tools for wetland assessment, *LeeAnn Haaf, Partnership for the Delaware Estuary* • Contextualizing multiple tools with a marsh conceptual diagram, *Jen Stamp, Tetra Tech, Inc.*
1:35-3:00 pm	EPA Northeast work: Social-ecological perspectives for resilient coastal wetlands • Open SESAME: A Social-Ecological Systems framework for collaborative Adaptive Management and Engagement in coastal restoration and climate adaptation*, Kate Mulvaney, U.S. EPA ORD* • Hazardous and contaminated sites within salt marsh migration corridors in Rhode Island, USA*, Erin Burman, U.S. EPA ORISE Fellow* Valuation of resilient coastal wetlands • Economic value of salt marshes under uncertainty of sea level rise: A case study of the Narragansett Bay*, Simona Trandafir, University of Rhode Island* • Fantastic wetlands and why to monitor them: Demonstrating the social and financial benefit potential of methane abatement through salt marsh restoration in Massachusetts, U.S.A.*, Adam Reilly, U.S. EPA Region 1*
3:00-3:45 pm	Interactive Discussion with Audience Participation

3:45-4:00 pm	Wrap Up

DAY 2— WEDNESDAY, MAY 25, 2022

11:00-11:30 am	Welcome Back and Day 1 Recap • *Tim Watkins, National Program Director (Acting), Sustainable and Healthy Communities Research Program, Office of Research and Development, U.S. Environmental Protection Agency*
11:30-12:55 pm	Partner Panel 1, Mid-Atlantic: Resilient coastal wetlands benefits, research, and partnerships • Coastal Wetlands Resilience: Co-benefits in restoration, protection and targeting*, Pam Mason, Virginia Institute of Marine Sciences* • Enhancing Partnership Support for Marsh Resilience Research and Restoration in Chesapeake Bay*, Julie Reichert-Nguyen and Breck Sullivan, Chesapeake Bay Program* Decision making and tools for implementing resilience interventions • The science to implementation pathway for resilient coastal ecosystems*, Christine Conn, Maryland Department of Natural Resources* • From Data to Decisions: Tools for Salt Marsh Restoration and Conservation*, Josh Moody, Partnership for the Delaware Estuary*
1:35-3:00 pm	Partner Panel 2, Northeast: Implementing salt marsh adaptation and restoration • Planning and implementing a salt marsh adaptation action*, Caitlin Chaffee, Narragansett Bay National Estuarine Research Reserve* • Assessing salt marsh condition to help guide restoration and conservation prioritization*, Tom Kutcher, Rhode Island Natural History Survey* Building resilient wetlands and communities • Salt marsh Restoration, Assessment, and Monitoring Program: Using a RAMP to move quickly and efficiently towards resiliency*, Courtney Schmidt, Narragansett Bay Estuary Program* • Building resilient communities with a focus on health equity*, Rachel Calabro, Rhode Island Department of Health*
3:00-3:40 pm	Cross-regional Interactive Discussion with Audience Participation
3:40-4:00 pm	Wrap Up and Next Steps

Appendix B. Workshop Presenters and Participants

EPA research teams and panels from the two focus regions included representatives from the following groups (with presenters shown in parentheses):

Mid-Atlantic:

- EPA wetland vulnerability and adaptation team (Jordan West/EPA ORD, Anna Hamilton/Tetra Tech, Jen Stamp/Tetra Tech)
- Partnership for the Delaware Estuary (LeeAnn Haaf/PDE, Josh Moody/PDE)
- Chesapeake Bay Program Resiliency Workgroup (Julie Reichert-Nguyen/NOAA/CBP, Breck Sullivan/USGS/CBP)
- Chesapeake Bay Program Wetlands Workgroup/Virginia Institute of Marine Sciences (Pamela Mason/VIMS)
- Maryland Department of Natural Resources (Christine Conn/MD DNR)

Northeast:

- EPA climate adaptation and resilient wetlands team (Cathleen Wigand/EPA ORD, Kate Mulvaney/EPA ORD, Erin E. Burman/ORISE Fellow at EPA, Adam Reilly/EPA Region 1, Simona Trandafir/University of RI partner)
- Narragansett Bay Estuary Program (Courtney Schmidt/NBEP)
- Narragansett Bay National Estuarine Research Reserve (Caitlin Chaffee/NBNERR)
- Rhode Island Natural History Survey (Tom Kutcher/RINHS)
- Rhode Island Department of Health (Rachel Calabro/RIDOH)

The workshop was facilitated by two EPA technical facilitators, Joseph Siegel (EPA Region 2) and Joan Johnson (EPA Region 3), and two Tetra Tech process facilitators, Adrianna Berk and Elizabeth Hiett. The workshop was attended on Day 1 by 146 participants (excluding the 22 hosts, facilitators, and presenters), and on Day 2 by 97 participants. From a participant survey taken at the beginning of Day 1, representation according to different categories of participant affiliations are shown below.

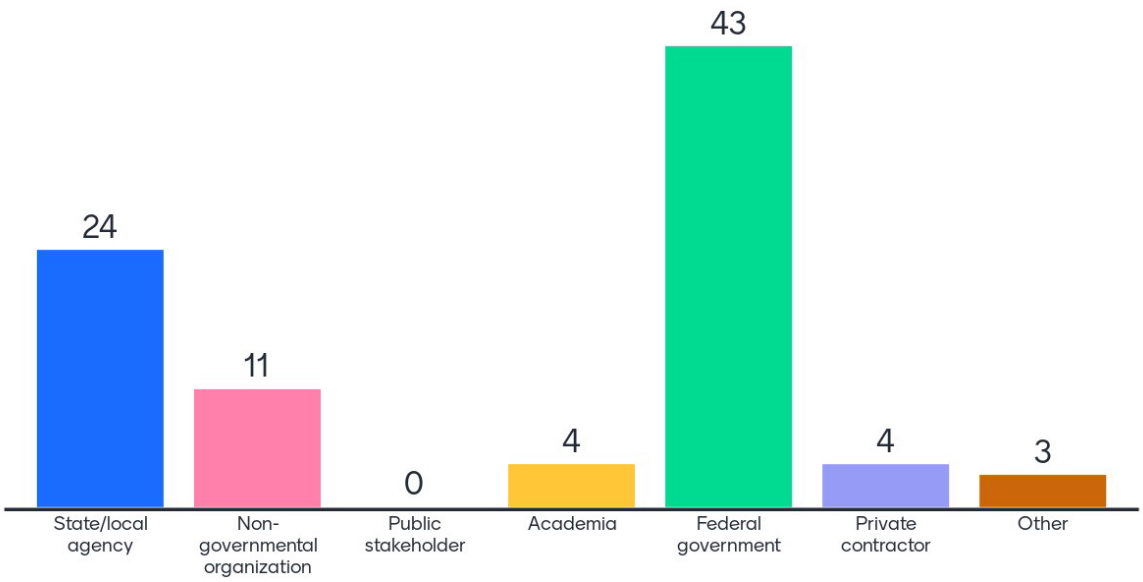

Figure B1. Distribution of workshop participant affiliations.

Based on registrations, participants came from:

- Federal agencies (e.g., EPA, NOAA, USGS, USFWS, NPS, the Navy)
- State, local, and tribal agencies (e.g., Maryland Dept. of the Environment, Maryland Dept. of Natural Resources (DNR), Rhode Island Dept. of Health, Washington DNR, West Virginia DNR, the Hampton Roads Planning District Commission, Washington DC Dept. of Energy and Environment, City of Norfolk, City of Hampton, Interstate Commission on the Potomac River Basin, Delaware Natural Resources and Environmental Control, Connecticut Dept. of Energy & Environmental Protection, Rhode Island Dept. of Environmental Management, Missouri Dept. of Natural Resources, the Georgia Dept. of Natural Resources, the South Carolina Dept. of Health and Environmental Control, the Mashpee Wampanoag Tribe, the NH Dept. of Environmental Services, New York State Dept. of Environmental Conservation, the North Carolina Dept. of Environmental Quality; Rhode Island Division of Statewide Planning; the Southern Ute Indian Tribe, Long Beach Township, Florida Dept. of Environmental Protection, Rhode Island Natural History Survey)
- Academia (e.g., Virginia Institute of Marine Science, Mass. Institute of Technology, Univ. of Rhode Island, Columbia Univ., Univ. of Maine, Univ. of Maryland Center for Environmental Science, Maryland Sea Grant College, Univ. of North Carolina Wilmington, Northeastern Univ., Univ. of New Hampshire, Cornell Univ., Univ. of Connecticut, the Stevens Institute of Technology, Louisiana State Univ., Ocean County College)
- Non-governmental organizations (e.g., Chesapeake Bay Program, Alliance for the Chesapeake Bay, the Chesapeake Bay Commission, The Nature Conservancy, the Audubon Society, Narragansett Bay Estuary Program, the Environmental Law Institute, Nantucket Conservation Foundation, Biohabitats, Ducks Unlimited, the Littoral Society, the James River Association, the Carolina Wetlands Association, South Carolina Coastal Conservation League, Save Barnegat Bay, the National Estuarine Research Reserve Association)
- Other private companies (e.g., Inter-Fluve, Mott MacDonald, Pare Corporation, Kimley-Horn, RK&K Civil Engineering).

Appendix C. Detailed Results of Mentimeter Polls and Questions

C.1. What does resilience mean to you?

Participants were asked about the meaning of resilience (Table C.1). Responses could generally be grouped into 'ecological' and 'socio-economic' categories.

- "Ecological" -- recover/rebound/adapt/persist
- "Socio-economic" – engagement, tools, BMPs

Table C1. Summary of participant inputs on the meaning of resilience.

Summary of most frequent, similar responses: What does resilience mean to you?
Ability to recover/bounce back/rebound/returning to a stable state/come back/respond positively from a disturbance/stressors/adverse impacts/extreme events/ significant change over time and space /weather challenges/droughts or storms
Ability to survive/persist/resist/absorb/withstand/retain/deal with/maintain and strengthen a disturbance/etc. (as above)
One of the above concepts (recovering, persisting, or sustaining after a disturbance, change, or impact) within certain parameters, or while maintaining certain ecosystem expression/retaining ecosystem functions/continuing to provide ecosystem services
Ability to adapt to disturbances/climate change/change; or simply adaptation, or adaptation and flexibility; or adaptation to ensure security
Sustainability or self-sustainability
Being prepared for climate change in a way that minimizes loss
Other responses:
The capacity of a system to absorb disturbance and reorganize in ways that retain essentially the same functions, structures, identities, and feedbacks
Applying foresight to preempt future climate-related challenges and disasters
Capacity to persist indefinitely
The ability of a system to return to equilibrium
Overcoming change and thrive/survive
Being better prepared for change to minimize negative effects
Keep on keeping on
Bouncing back, but not in the same way
Buying time
Being prepared
Safety
Community Engagement
Community wellness
Decreased flooding
Forethought in emergency planning, preparation and execution that is in sync with changing conditions
Being prepared for climate change in a way that minimizes loss
Taking out useless dams to provide better flow and less flooding

Community survival despite environmental or societal change
BMPs implemented
Needs-assessment
Auxiliary source of water supply
Retain native vegetation

There were myriad ways to express the concept of being able to recover from disturbance. The portion of the concept, "recovery', was most frequently expressed as rebounding, coming back, responding positively, or moving forward (after). However, the slightly different concepts of surviving, persisting, resisting, absorbing, withstanding, retaining, or maintaining and strengthening were also raised. The idea of 'avoiding and minimizing" also came up. In addition, some inputs included the idea of "preparing for" disturbances or change. The second portion of this concept was often referred to as 'disturbance', but other references were to change, stressors, adverse impacts, extreme events, weather, etc.

C.2. How does/should resilience figure into your research and decision making?

Participant responses to an open-ended question "How does or should consideration of resilience figure into your work or decision making?" are summarized in three broad categories below (Table C.2).

Table C.2. How does or should consideration of resilience figure into your work or decision making?

Responses - How does or should consideration of resilience figure into your work or decision making?
Approaches/General Considerations
Needs to be fully integrated into decision making, if not the primary driver
Integrated into all planning activities
It is integrated throughout management planning
One of the dominant drivers
It absolutely has to, with limited $ resources available and the overall geographical need
Resilience/restoration/adaptation projects are so resource intensive (money, time, people, attention) that they need to be considered for the long run, not short term
Need to shift to a longer-term perspective for resilience planning and management
It should form the foundation for every project in terms of unintended consequences
Success of restoration projects
Why do this work if it's not going to last?
Protection of our collective future
Good use of public funding
DEIJ to re-think the framework for decision-making
Aspects of Programs/Decisions
Site selection, design and planning horizons
Identifying priority areas for preservation
Prioritizing habitats to protect/restore
Setting restoration targets
The sites we select to work in, and the type of project we conduct are based heavily on resilience considerations

Considering resilience is very important to restoration and climate adaptation decisions
Understanding long-term sustainability
Manage for conservation of cultural and natural resources into the future
Have to focus on resilience improvement to the land behind the restoration as well as on the resilience of the restored habitat itself
Nature-based solutions perspective
Co-benefits to maximize partners and funding
Maximizing multiple benefits (carbon sequestration, flood mitigation, water quality improvement, habitat for fish and birds)
Better connection between habitat restoration and community benefits to coastal residents
Prioritize sacked ecosystem services
Tradeoffs become essential from the resilience perspective
Specific Applications/Targets
Future ecosystem services
Resilient fisheries management decision making
Community health
Protecting critical assets
Protect the built environment
Resilience is a critical point for restoration of wetlands to mitigate flooding
Regulating tidal marsh conservation for the future
Protects military missions
Protection of critical facilities
Adaptive management thresholds
Maintenance costs should be included for projects so that we still see the benefits after the project is over
Supports recreational fisheries
Restoring Rumney Marsh

Out of 41 responses, five indicated resilience should be the main driver of all decision-making activities. A few responses mentioned that resilience reflects a long-term perspective, and others that it assures longer-term success for resilience projects.

C.3. What do you see as the biggest connection between wetlands resilience and community resilience, and how would you measure it?

Participant inputs on connections between wetlands resilience and community resilience were most often related to the benefits (ecosystem services) provided to humans/communities by wetlands (Table C.3).

Table C.3. Participant inputs on the biggest connections between wetlands resilience and community resilience.

Responses - What do you see as the biggest connection between wetlands resilience and community resilience, and how would you measure it?
Flood protection
Time both exist together, measured in years
The biggest connection is the societal benefits that coastal wetlands provide.
Flood mitigation and measure by reduction of flooding incidents
The tidally flooded back yards of houses, measured by inches and frequency of flooding
People are the biggest connection. I would measure how people perceive the wetland, their community, and their perspective of having that wetland in their community
Wave attenuation
Property value - resilient wetlands providing protection to inland communities/development.
Open space, visual aesthetics, mental health
Measure through increased quantity and quality of public access spaces
Sustainability of BOTH wetlands and their adjacent communities
Marshes provide water storage, water quality improvement, and provision of commercial fisheries
To directly measure societal benefits will require better valuation methodologies and better K-12 education of habitat values. Kids are the future stewards and decision-makers.
Understanding by the community of all the "services" that wetlands provide, and their valuing those wetlands
Mitigation and wave attenuation of wetlands
Protected communities and healthy wetlands measured by reduced impacts to communities and wetland condition assessments
Flood protection, social and economic benefit
Open space
Under or not properly valued
Living sustainably to reduce environmental impacts
Clean water, critical habitats, eco-tourism
A resilience mindset
People protect what they love
Native American valuation which promoted respect and seventh generation valuation

C.4. What is the value gained from partner/stakeholder engagement in wetlands management for resilience?

Workshop participants associated partner/stakeholder engagement with concepts of collaboration, communication, inclusion, listening, partnering, cooperation, and need. Many other meaningful concepts (e.g., respect, trust, understanding) and modifiers (e.g., time-consuming/intensive, challenging) paint a more nuanced picture. In interactive discussions, participants were asked to elaborate on “What is the value gained from stakeholder engagement in wetlands management for resilience?” Perceived values emphasized ownership, buy-in, and community support, as well as capacity building (Table 4).

Table C.5. Participant inputs on the value gained from stakeholder engagement in wetlands management for resilience.

Responses - What is the value gained from stakeholder engagement in wetlands management for resilience?
Support
Buy-in by coastal residents
Ownership and stewardship
Reality based: ground-truthed community buy in for project goals
Behavior change toward nature-based strategies when understanding their value
Ownership and monitoring for maintenance
Understanding their needs and desires
Public support
Public support for funding
Funding
Community support
Understanding barriers to acceptance of strategies
To ensure projects are meeting community needs if possible
Ensuring that the work provides the info actually needed by the stakeholders
The stakeholders become protective of “their” projects
Can also gauge if stakeholders are willing to help maintain sites
Continued monitoring (low rigor) and maintenance, community support to move adjacent projects forward
Potential for longer-term and/or broader support for activities
Identifying stakeholders/benefactors
Longevity
Longevity
Long term solutions
Supports longevity of the project if you get buy in
Shared Understanding
You understand how the wetlands are used or perceived. This is high value to understanding how to manage the wetland
Understanding cultural relevance
Historical context and importance
Shared understanding of ecosystem services
Learn more about perception of the coastal residents. Including objections. Allows for a better conversation
Understanding objections to projects like dam removals, however, it’s not a democracy
Develop a level of understanding
Create sense of shared responsibility
Co-Production
Identifying potential roadblocks to implementation up front
Post-installation monitoring - community scientists
Community resilience
Measurement and long-term monitoring
Create a larger "tent"

Citizen science
Building volunteer capacity
Building capacity
Obtain all needs of the various stakeholders not just the ones who know who to talk to
Chance to learn from stakeholders and under-represented folks
Education/Outreach
Environmental literacy
Education
Increase capacity for community members to learn from their peers
Public education and outreach
Public understanding of the value of wetlands

C.5. What are the top things we need to do to improve as a community of practice on achieving resilient coastal wetlands and communities?

Participants were asked, "What are the top things we need to do to improve as a community of practice on achieving resilient coastal wetlands and communities?" Responses covered a range of factors, from working with communities and stakeholders, to working with regulators, changing the focus of how we currently work, sharing information (including successes and failures), and changing the way we communicate (Table C.4).

Table C.4. Participant inputs on the top things we need to do to improve as a community of practice on achieving resilient coastal wetlands and communities.

Responses - What are the top things we need to do to improve as a community of practice on achieving resilient coastal wetlands and communities?
Work with Community/Stakeholders/Build Capacity
Include communities in planning and decision making
Creating in-roads with the trusted members of a community
Working as a network for restoration projects instead of individual areas.
Build community buy-in/ownership
Be sensitive to the needs of the community, build capacity
Prioritize building relationships and thoughtfully identifying and engaging stakeholders
Build capacity for participation
Build community support
Educate, volunteer opportunities to collect scientific data, connect with stakeholders
Keep it simple! Less is more- people are overloaded with information. we need clearer and more concise (and consistent!) messaging
Focus on engagement and be willing to pay for it
Find, train, empower DEIJ leaders, mentors, champions
Work with Regulators
Work/Coordinate with regulators
Connect with permit writers for them to understand new techniques that bring results
Building relationships with local governments...to aid and not block projects
Other Aspects of Approach

More attention to social vulnerability and how to blend wetland restoration with improving community health
Dedicate staff resources to restoration planning and implementation
Remove barrier - literally and figuratively
Understand the unintended consequences of our decisions
Break down silos, and join forces to implement projects with multiple co-benefits
Groups coordinating and working together to make the most progress
Work together
Overcome social conventions and political momentum. Demonstrate accuracy of models and projections and demonstrate results so science is accepted rather than disparaged
Leverage current/past work/efforts- avoid duplication
Time scale vs sea level rise projections
Think long-term
Invest in adaptive management
Consider and estimate future conditions (SLR, landscape context, etc.) when prioritizing restoration, protection
Studies
Case studies
Conduct more heat island studies
Identify gaps in needed research or data
Share Successes and Failures
Acknowledge and share what doesn't work/what went wrong, in addition to just celebrating what does
Celebrate successes
Learn from previous failures
Share failures as much as we share successes
More/ better information sharing
Learn from failures
Assemble summaries of successful case studies to share with officials and stakeholders for current projects
Monitoring
Effective and cost-efficient monitoring
Continue to build out Coastal Wetlands Monitoring like the MAAWG is to freshwater wetlands
Allow greater flexibility with the WPDG to support long term data sets
Demonstrate the successes by monitoring and reporting results
Funding
Connect with funders
More funding for community health and restoration efforts.
Reduce funding barriers and streamline bureaucratic processes
Identify funding for project maintenance/monitoring/adaptive management
Other
Hold an annual workshop like this one
Continuing to communicate
Find common ground
Better public relations to advertise needs and successes

Appendix D. Relevant Information and Links Provided by Workshop Participants

All presentation slide decks are available on the Resilient Wetlands and Communities Workshop website found at https://resilience-workshop.tetratech.com/, or by request to Jordan West (west.jordan@epa.gov). Links to a variety of associated tools, publications, and other resources are provided here.

Links to tools, publications, other resources:

EPA Mid-Atlantic Team Resources:

Tool/Method/Approach; (presenter)	Description	Link or reference
SLAMM; (several presenters)	Sea-Level Affecting Marshes Model estimates projected wetland response to long-term SLR. Integrates numerous variables into the response metric (acreage change), including historic global SLR trends, global mean SLR projections, vertical land movement, elevation, slope, tide range, salt elevation (30-day inundation level), accretion, erosion and land use. Includes three protection scenarios that account for potential manmade restrictions on marsh migration: no protection, protection of dry developed land and protection of all dry land. Generates spatially-explicit projections of SLR-induced changes in marsh acreage for each site.	Lower Delaware Bay SLAMM Report: U.S. Environmental Protection Agency (EPA): 2019. Application of the Sea-Level Affecting Marshes Model (SLAMM) to the Lower Delaware Bay, with a Focus on Salt Marsh Habitat. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-18/385.
EPA's Relative Wetlands Vulnerability Framework (**RWVF**) (Anna Hamilton (Tt CES), Jordan West (EPA/ORD), LeeAnn Haaf (PDE)	A systematic process with five steps (classification, attributes, principal factors, metrics, relative vulnerability) that examines exposure and response components of vulnerability, generates vulnerability profiles that can be compared within and among sites to support site selection, and can be linked to evaluation of management tactics to support adaptation.	RWVF article. Wardrop, D.H., Hamilton, A.T., Nassry, M.Q., West, J.M. and Britson, A.J., 2019. Assessing the relative vulnerabilities of Mid-Atlantic freshwater wetlands to projected hydrologic changes. Ecosphere, 10(2), p.e02561.
		RWVF Application for Lower Delaware Bay: Stamp, J., Hamilton, A.T., Haaf, L., Liang, M. and J.M West. *In prep*. A management-relevant framework for assessing salt marsh vulnerabilities to sea level rise: Delaware Bay case study. PLOS ONE.

		Broader assessment adding storm surge and condition: Hamilton, A.T., Stamp, J., Haaf, L., Liang, M., and J.M. West. *In prep*. Salt marsh vulnerability to sea level rise and storm surge, influenced by marsh condition: Delaware Bay case study. PLOS ONE.
EPA's **Adaptation Design Tool** (ADT); (LeeAnn Haaf (PDE))	A structured approach that guides users through a series of steps to: 1) apply climate-smart design considerations to management tactics; 2) brainstorm additional adaptation activities that may be critically needed; and 3) identify and record insights on information gaps & research needs, and on synergies, conflicts & sequencing considerations among actions.	About the Adaptation Design Tool (ADT)
		Adaptation Design Tool (Coral Reef Pilot): West, J.M., Courtney, C.A., Hamilton, A.T., Parker, B.A., Gibbs, D.A., Bradley, P. and S.H. Julius. 2018. Adaptation design tool for climate-smart management of coral reefs and other natural resources. Environmental Management, DOI:
		Adaptation Design Tool (Chesapeake Bay Program Application): Chesapeake Bay Program 2018. Chesapeake Bay Program: Climate-Smart Framework and Decision-Support Tool. Johnson, Z. (ed), Hamilton, A., Hoffman, J., Herron, H., West, J., Julius, S. and D. Gibbs. CBP Climate Resiliency Workgroup, Chesapeake Bay Trust, Annapolis, MD. 43 pp.
		Adaptation Design Tool Online Training: Corals and Climate Adaptation Planning: Adaptation Design Tool Online Course. 2017. The Nature Conservancy, U.S. Environmental Protection Agency and National Oceanic and Atmospheric Administration.
PDE's Wetland Assessment Tool: Condition and Health (**WATCH**); (LeeAnn Haaf, Josh Moody (PDE))	A spreadsheet model to organize data, evaluate marsh health and diagnose deficiencies. Holistically evaluates 6 attributes fundamental for salt marsh function using scientifically defensible methods; guides the user through choosing metrics aligned with DE & NJ LS monitoring frameworks. User inputs	https://delawareestuary.org/science-and-research/tools/watch-tool/

	data regarding its current state, its acceptable range/bounds, (criteria), its trajectory, and a timeframe of interest. WATCH uses these inputs to diagnose attribute(s) deficiencies indicative of impaired functionality.	Partnership for the Delaware Estuary (PDE) Tools

EPA Northeast Team Resources:

Tool/Method/Approach; (presenter)	Description	Link or reference
SESAME; (Kate Mulvaney (EPA/ORD))	The Social-Ecological Systems, Adaptive Management, and Engagement (SESAME) framework provides reciprocal connections between the human and ecological components of restoration efforts and the resulting management and engagement needs. Incorporates stakeholder engagement through planning and implementation, reflecting aspects of collaborative adaptive management.	https://pubmed.ncbi.nlm.nih.gov/36643969/ Mulvaney, K. K., Ayvazian, S., Chaffee, C.,Wigand, C., Canfield, K., and Schoell, M., 2022. Open SESAME: a social-ecological systems framework for collaborative adaptive management and engagement in coastal restoration and climate adaptation. Wetl. Ecol. Manag. 52. doi:10.1007/s11273-022-09891-3.
SCoRR; (Erin Burman (EPA ORISE Fellow))	Sediment Bound Contaminant Resiliency and Response uses SLAMM to project marsh migration, areas of future marsh with SLR; identifies locations and types of hazardous and contaminated sites (HCSs) within marsh migration pathways; yields) contaminant hazard rankings: 4) hazardous effects on human/aquatic life; 3) slightly hazardous effects on human/aquatic life; 2) mild effects on human/aquatic life; and 1) little to no hazard risk to human/aquatic life. Overlays SLAMM projected current and future marsh areas with HCS points. Density and types of HCSs in marsh migration corridors can result in re-suspension of contaminated sediments; knowledge of these consequences can be used to identify priority marshes for conservation and/or restoration.	About USGS SCoRR Burman, E., Mulvaney, K., Merrill, N., Bradley, M., Wigand, C. 2023. Hazardous and contaminated sites within salt marsh migration corridors in Rhode Island, USA. Volume 331, 1 April 2023, 117218, https://doi.org/10.1016/j.jenvman.2023.117218 Reilly, T. J., Jones, D. K., Focazio , M. J., Aquino, K. C., Carbo, C. L., Kaufhold , E. E., . . . Schill , W. B. (2015). Strategy to evaluate persistent contaminant hazards resulting from sea level rise and storm derived disturbances Study design and methodology for station prioritization (2015 1188A). Retrieved from Reston, VA: Open-File Report 2015-1188-A

Blue Carbon (Adam Reilly (EPA Region 1))	Increasing marsh salinity and marsh degradation due to SLR increases release of stored methane. Estimation of GHGs emitted and how much emission would be avoided with restoration, and costs of not conserving marshes contribute to site selection/prioritization and justification for restoration (avoided cost as benefit). Also apply avoided methane emissions to carbon-equivalent crediting initiative (blue carbon offset crediting).	https://www.nature.com/articles/s41598-017-12138-4: Kroeger, K.D., Crooks, S., Moseman-Valtierra, S. and Tang, J., 2017. Restoring tides to reduce methane emissions in impounded wetlands: A new and potent Blue Carbon climate change intervention. Scientific reports, 7(1), p.11914.
Other methods/resources		Wetland Loss Patterns and Inundation-Productivity Relationships Prognosticate Widespread Salt Marsh Loss for Southern New England: Watson E.B., Wigand C., Davey E.W., Andrews H.M., Bishop J., Raposa K.B. (2017) Wetland loss patterns and inundation-productivity relationships prognosticate widespread salt marsh loss for Southern New England. *Estuaries and Coasts* 40:662-681.
		A Climate Change Adaptation Strategy for Management of Coastal Marsh Systems | Science Inventory | US EPA: Wigand C. et al. (2017) A climate change adaptation strategy for management of coastal marsh systems. *Estuaries and Coasts* 40:682-693.
		https://www.sciencedirect.com/science/article/pii/S0301479720308574 Perry, D.C., C. Chaffee, C. Wigand, and C. Thornber. 2020. Implementing adaptive management into a climate change adaptation strategy for a drowning New England salt marsh. Journal of environmental management, 270, p.110928.

Mid-Atlantic Partner Panel Resources:

Tool/Method/Approach (presenter)	Description	Link or reference
VIMS Center for Coastal Resources Management, **Nature Based Solutions**; (Pam Mason (VIMS))	Documents and evaluates natural & nature-based features (NNBFs), including coastal forests, wetlands, beaches, and living shorelines, for potential to provide multiple benefits for coastal communities, including storm protection, soaking up floodwaters, improving water quality, providing recreation areas and maintaining important habitats. NNBFs can be viewed in the AdaptVA Interactive Map. Criteria for ranking NNBFs include: • NNBF flooding mitigation services • How many buildings does the NNBF benefit? • Are there any critical community facilities the NNBF benefits? • Can the NNBF be used to take advantage of existing programmatic incentives?	Nature-Based Solutions | Virginia Institute of Marine Science (vims.edu)
VIMS Center for Coastal Resources Management **Shoreline Management Model (SMM)**; (Pam Mason (VIMS))	A geospatial data model run in ArcGIS that processes shoreline condition factors including: • Presence or absence of natural buffers – tidal marshes, beaches, riparian forests, submerged aquatic vegetation SAV • Bank height • Nearshore bathymetry • Wave exposure (fetch) • Existing defense structures and proximity of upland development • Other locally-based GIS data through decision flow charts to reach recommendations for shoreline stabilization, tidal shoreline erosion control, and living shoreline suitability. Model output viewed and analyzed with interactive map viewers.	Center for Coastal Resources Management
Chesapeake Bay **Marsh Resilience Targeting**; (Julie Reichert-Nguyen	A project report focused on two primary questions: 1. How do climate change and variability affect nutrient/sediment cycling in the watershed?; and 2. How do climate change and variability	A Systematic Review of Chesapeake Bay Climate Change Impacts and Uncertainty: Watershed Processes, Pollutant Delivery, and BMP Performance

(NOAA/CBP), Breck Sullivan (USGS/CBP))	affect BMP performance?, to support Chesapeake Bay nutrient/sediment TMDL attainment under climate change.	
	Website providing up-to-date CBP science needs determined by the Strategic Science and Research Framework (SSRF).	Chesapeake Bay Program Science Needs Database
Synthesis of Shoreline, Sea Level Rise, and Marsh Migration **Data for Wetland Restoration**; (Julie Reichert-Nguyen (NOAA/CBP), Breck Sullivan (USGS/CBP))	Project report that provides 1) a compilation of existing datasets and information related to marsh migration under sea level rise-driven inundation due to forecasted climate change, topography of bay shorelines, shoreline condition (e.g., erosion rates, hardening, existing natural resources), existing wetland area and potential migration corridors, and other relevant data from around the Chesapeake Bay and 2) a methodology that synthesizes the information in a format that can be used to assist with marsh conservation and restoration decisions under multiple sea level rise scenarios.	Synthesis of Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration
Maryland Targeting Tools (Christine Conn (MDNR))	A report summarizing the development of new criteria to target land acquisitions and conservation easements as a Maryland adaptation strategy. New land conservation strategies to address climate change impacts within Chesapeake bay focus on preserving the long-term survival of coastal wetlands that provide storm surge buffering to communities as well as critical habitat for aquatic and terrestrial species.	Coastal Land Conservation in Maryland: Targeting Tools and Techniques for Sea Level Rise Adaptation and Response
Maryland Coastal Resiliency Assessment; (Christine Conn (MDNR))	A landscape-level spatial analysis and modeling effort that identifies where natural habitats provide the greatest potential risk reduction for coastal communities. Includes considering co-benefits of community protection with habitat, water quality, and recreational benefits. Includes a Shoreline Hazard Index.	Coastal Resiliency Assessment (maryland.gov)
Natural Shorelines/Flood Risk, Maryland; (Christine Conn (MDNR))	A collaboration between The Nature Conservancy, George Mason University, and Maryland Department of Natural Resources, this website supports decisions about where Maryland and its natural resource partners should conserve, restore or enhance wetlands, submerged aquatic vegetation and shorelines to enhance community resilience by providing study results quantifying the wave attenuation and flood reduction benefits of salt marshes, submerged aquatic vegetation (SAV) and other natural and	Assessing Nature's Role in Resilience (conservationgateway.org), Ecosystem Services (maryland.gov),

	nature-based features (NNBF) along the shores of Maryland's Chesapeake and Atlantic Coastal bays. Wave attenuation benefits are being modeled by integrating hydrodynamic and habitat field data with updated SLAMM results into coupled local and regional hydrodynamic and wave models (ADCIRC + SWAN, XBeach).	
Maryland Coastal Atlas; (Christine Conn (MDNR))	A mapping tool that allows state and local decision-makers to visually analyze and explore coastal data layers to support project planning, including siting, identifying potential conflicts, helping communities identify areas vulnerable to sea level rise, flooding, and erosion, matching dredging areas with restoration areas, etc.	The Coastal Atlas (maryland.gov)
PDE **Living Shoreline Feasibility Model**; (Josh Moody (PDE))	Evaluates a suite of metrics to assess factors related to constructing and maintaining a living shoreline at a specific location. Guides collection of information on physical and ecological site characteristics, site access, and community resources, which is integrated into a summary of baseline existing conditions and information on team building, project design, and installation planning.	Partnership for the Delaware Estuary (PDE) Tools
Living Shoreline Storymap (Josh Moody (PDE))	Description of the Delaware Estuary Living Shoreline Initiative.	PDE Living Shoreline Storymap
Delaware **Living Shoreline Information** (Josh Moody (PDE))	Information and photo-documentation of living shorelines as a natural and effective way to protect Delaware's shorelines.	Delaware Living Shorelines Committee
Delaware Framework for **Living Shoreline Monitoring** (Josh Moody (PDE))	A goal-based framework for developing monitoring plans for living shoreline projects in Delaware; a step-wise procedure for selecting relevant metrics and appropriate methods to assess performance and adaptive management needs.	DE Monitoring Framework
MACWA (Josh Moody (PDE))	the Mid Atlantic Coastal Wetland Assessment (MACWA). MACWA supports a comprehensive assessment of coastal wetland condition across the Mid Atlantic region. MACWA is a 4-tier monitoring and assessment program; provides rigorous, comparable data across all tidal wetlands of the Mid Atlantic (the Delaware Estuary within Delaware, New Jersey, and Pennsylvania, as well as Barnegat Bay in New Jersey).	PDE Mid-Atlantic Coastal Wetland Assessment (MACWA) Program

New Jersey Framework for Coastal Restoration and **Living Shoreline Monitoring** (Josh Moody (PDE))	A framework for developing monitoring plans for coastal wetland restoration and living shoreline projects in New Jersey; recommended data collection and evaluation of project performance to facilitate adaptive management and improve future project designs.	NJ Monitoring Framework
NJ CERAP (Josh Moody (PDE))	The NJ Coastal Ecological Restoration and Adaptation Plan (CERAP) identifies areas for ecological projects that increase community resilience, ecosystem health, and/or carbon sequestration. Will result in an online mapping tool that meets decision-support needs of coastal stakeholders; will be iteratively developed with additional calls for project nominations in the future.	NJDEP Coastal Ecological Restoration and Adaptation Plan (CERAP)

Northeast Partner Panel Resources:

Tool/Method/Approach (presenter)	Description	Link or reference
Dredged sediment placement (**thin-layer placement**); (Caitlin Chaffee, (NBNERR))	Case studies using placement of dredged material for coastal wetland restoration, including particular consideration of public/stakeholder engagement throughout project planning and implementation, including: establishing project goals and objectives with a diverse team; balancing community objectives with permit and funding requirements; sharing project ownership; communication with consultants; and dealing with uncertainty in project design, water management, and budget and construction bid solicitation.	Implementing Adaptive Management into a Climate Change Adaptation Strategy for a Drowning New England Salt Marsh – ScienceDirect: Perry D.C., Chaffee C., Wigand C., Thornber C. 2020. Implementing adaptive management into a climate change adaptation strategy for a drowning New England salt marsh. *Journal of Environmental Management* 270:110928.
		Raposa, K. B., Bradley, M., Chaffee, C., Ernst, N., Ferguson, W., Kutcher, T. E., McKinney, R. A., Miller, K. M., Rasmussen, S., Tymkiw, E., and Wigand, C. 2022. Laying it on thick: Ecosystem effects of sediment placement on a microtidal Rhode Island salt marsh. Front. Env. Sci. https://doi.org/10.3389/fenvs.2022.939870.

		Vegetation Dynamics in Rhode Island Salt Marshes During a Period of Accelerating Sea Level Rise and Extreme Sea Level Events: Raposa K.B., Weber R.L.J., Ekberg M.C., Ferguson W. 2017. Vegetation dynamics in Rhode Island salt marshes during a period of accelerating sea level rise and extreme sea level events. *Estuaries and Coasts* 40:640-650.
		Raposa K.B., Wasson K., Woolfolk A., Endris C.A., Fountain M.C., Moore G., Tyrrell M., Swerida R., Lerberg S., Puckett B., Ferner M., Hollister J., Champlin L., Krause J.R., Haines D., Gray A.B., Watson E.B. *In review*. Evaluating thin-layer sediment placement as a tool for enhancing tidal marsh resilience: a coordinated experiment across eight U.S. National Estuarine Research Reserves. Submitted to *Estuaries and Coasts*.
Restoring hydrology/**runnels**; (Caitlin Chaffee (NBNERR))	Results of a workshop on the use and efficacy of runnels (shallow channels to drain standing water, recently used to restore marsh vegetation) for coastal wetland restoration; and results of a case study in which vegetation was restored at a degraded marsh within a few years of runnel construction. Runnel construction alone unlikely to improve long-term marsh resilience, but may "buy time" as a part of holistic climate plan that includes other management interventions.	https://link.springer.com/article/10.1007/s12237-021-01028-8 Besterman A.F., Jakuba R.W., Ferguson W., Grennan D., Costa J.E., Deegan L.A. 2022. Buying Time With Runnels: a Climate Adaptation Tool for Salt Marshes. *Estuaries and Coasts*. Correction to: Buying Time with Runnels: a Climate Adaptation Tool for Salt Marshes:
		Watson, E.B., Ferguson, W., Champlin, L.K., White, J., Ernst, N., Sylla, H., Wilburn, B. and Wigand. C. 2022. Runnels mitigate marsh drowning in microtidal salt marshes. Front. Env. Sci., (Conservation and Restoration Ecology section). DOI: https://doi.org/10.3389/fenvs.2022.987246

RAMP; (Courtney Schmidt (NBEP), Tom Kutcher (RINHS))	Salt Marsh Restoration, Assessment, and Monitoring Program (RAMP) formalizes a long-term collaboration among federal, state, local, non-profit, and academic groups, featuring a regional strategy, standardized methods, prioritization systems, and information exchange. It includes 3 tiers of assessment (landscape, rapid, and intensive). Developed resources include: the Rhode Island Coastal Wetland Restoration Strategy; and the Strategy for Developing a Salt Marsh Monitoring Program.	Salt Marsh Restoration Assessment and Monitoring Program — Narragansett Bay Estuary Program (nbep.org): Multiple agencies and organizations with different missions and mandates work efficiently and collaboratively towards the goal of preserving coastal wetland throughout Rhode Island. Point-of-contact Courtney Schmidt.
Salt Marsh Rapid Assessment Method (**MarshRAM**) (Tom Kutcher (RINHS))	The Salt Marsh Rapid Assessment Method 'MarshRAM' fills a need for broad, science-based information to guide management by documenting information characterizing salt marsh type, setting, ecological value, disturbance, integrity, and opportunity for landward migration at the site scale. Uses a Wetland Disturbance Index (a checklist that ranks the intensity of individual and cumulative human disturbances) and an Index of Marsh Integrity (IMI) (using a novel walking-transect approach to rapidly characterize site-wide vegetation-community composition) that also could be used as an index of marsh resilience.	A Rapid Method to Assess Salt Marsh Condition and Guide Management Decisions: Kutcher T.E., Raposa K.B., Roman C.T. 2022. A rapid method to assess salt marsh condition and guide management decisions. *Ecological Indicators* 138:108841.
The Rhode Island **Climate Change and Health Program**; (Rachel Calabro (RIDOH))	Recognizes climate change as a risk amplifier, with impacts on human health as well as on the environment. Vulnerable groups likely to suffer disproportionately. The RI Social Vulnerability Index includes 8 dimensions: the elderly, children, poverty, income, vehicle access, educational attainment, immigrant populations, and linguistic isolation. Integrates consideration of related environmental conditions and direct climate impacts on health (e.g., tree canopy cover and the average afternoon heat index). RIDOH Health Equity Measures include fifteen measures that look at determinants of health in five domains (e.g., community resilience, physical environment, etc.).	The Rhode Island Climate Change and Health Program: Building Knowledge and Community Resilience: Calabro, R. and Hoffman, C. 2021. The Rhode Island Climate Change and Health Program: Building Knowledge and Community Resilience. *RI Medical Journal*, Nov, pages 45-48.
Other related resources	Restoring a Degraded Marsh Using Thin Layer Sediment Placement: Short Term Effects on Soil Physical and Biogeochemical Properties: VanZomeren C.M., Berkowitz J.F., Piercy C.D., White J.R. (2018) Restoring a degraded	

	marsh using thin layer sediment placement: short term effects on soil physical and biogeochemical properties. *Ecological Engineering* 120:61-67.
	Evaluating Tidal Wetland Restoration Performance Using National Estuarine Research Reserve System Reference Sites and the Restoration Performance Index (RPI): Raposa K.B., Lerberg S., Cornu C., Fear J., Garfield N., Peter C., Weber R.L.J., Moore G., Burdick D., Dionne M. (2018) Evaluating tidal wetland restoration performance using National Estuarine Research Reserve System reference sites and the restoration performance index (RPI). *Estuaries and Coasts* 41(1):36-51.
	Guidance for Thin-Layer Sediment Placement as a Strategy to Enhance Tidal Marsh Resilience to Sea Level Rise: Raposa K., Wasson K., Nelson J., Fountain M., West J., Endris C., Woolfolk A. (2020) Guidance for thin-layer sediment placement as a strategy to enhance tidal marsh resilience to sea-level rise. Published in collaboration with the National Estuarine Research Reserve System Science Collaborative.
	Elevation Change and the Vulnerability of Rhode Island (USA) Salt Marshes to Sea-Level Rise: Raposa K.B., Cole Ekberg M.L., Burdick D.M., Ernst N.T., Adamowicz S.C. (2017) Elevation change and the vulnerability of Rhode Island (USA) salt marshes to sea-level rise. *Regional Environmental Change* 17(2) 389-97.
	Mitigating the Legacy Effects of Ditching in a New England Salt Marsh: Burdick D.M., Moore G.E., Adamowicz S.A., Wilson G.M., Peter .CR. (2020) Mitigating the legacy effects of ditching in a New England salt marsh. *Estuaries and Coasts* 43:1672-1679.
	Declining Sediments and Rising Seas: an Unfortunate Convergence for Tidal Wetlands: Weston N.B. (2014) Declining sediments and rising seas: An unfortunate convergence for tidal wetlands. *Estuaries and Coasts* 37:1-23.

Additional resources that were shared by participants in the Chat function of the online workshop are also provided below:

- USGS UVVR: unvegetated: vegetated ratio for salt marshes: https://wim.usgs.gov/geonarrative/uscoastalwetlandsynthesis/U.S. Coastal Wetlands Synthesis
- Sesame framework. See also Bierbaum, R., Smith, J. B., Lee, A., Blair, M., Carter, L., Chapin, F. S., ... & Verduzco, L. (2013). A comprehensive review of climate adaptation in the United States: more than before, but less than needed. Mitigation and adaptation strategies for global change, 18(3), 361-406.
- Lauren I. Josephs and Austin T. Humphries. 2018. Identifying social factors that undermine support for nature-based coastal management. Journal of Environmental Management 212: 32-38. https://doi.org/10.1016/j.jenvman.2018.01.085.
- Reilly, T.J., Jones, D.K., Focazio, M.J., Aquino, K.C., Carbo, C.L., Kaufhold, E.E., Zinecker, E.K., Benzel, W.M., Fisher, S.C., Griffin, D.W., Iwanowicz, L.R., Loftin, K.A. and Schill, W.B., 2015, Strategy to evaluate persistent contaminant hazards resulting from sea-level rise and storm-derived disturbances—Study design and methodology for station prioritization: U.S. Geological Survey Open-File Report 2015–1188A, 20 p., http://dx.doi.org/10.3133/ofr20151188A. ISSN 2331- https://pubs.er.usgs.gov/publication/ofr20151188A
- How Wetlands & Living Shorelines Support Programs & Policies: Virginia: https://www.chesapeakebay.net/channel_files/44615/wetlands_co-benefits_factsheet_virginia.pdf
- Narragansett Bay Estuary Program, Planning for Equity: https://www.nbep.org/planning-for-equity
- Bringing EJ and restoration efforts together--highlights the disparities in where restoration projects were funded: Matthew Adam Dernoga, Sacoby Wilson, Chengsheng Jiang, and Fred Tutman. 2015. Environmental justice disparities in Maryland's watershed restoration programs. Environmental Science & Policy 45: 67-78. https://www.sciencedirect.com/science/article/pii/S1462901114001634
- Chesapeake Bay Program science needs database: https://star.chesapeakebay.net/
- Here is the link to the report that reviewed existing literature on climate change impacts on best management practices (BMPs) and uncertainty: https://www.chesapeakebay.net/documents/A_Systematic_Review_of_Chesapeake_Bay_Climate_Change_Impacts_and_Uncertainty__Watershed_Processes,_Pollutant_Delivery,_and_BMP_Performance_Final_14Feb2022.pdf
- Here's a project webpage for the EESLR study on Assessing Nature's Role in Resilience--The Conservation Gateway is for the conservation practitioner, scientist and decision-maker; share the best and most up-to-date information to inform our work at The Nature Conservancy): https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/md/Pages/EESLR-Study.aspx
- An example of restoring wetlands in urban areas : https://www.researchgate.net/publication/307191168_Assessing_the_Benefits_of_Wetland_Restoration_A_Rapid_Benefit_Indicators_Approach_for_Decision_Makers