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Natural and Nature-Based Features Workshop

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Proceedings from the U.S. Army Corps of Engineers (USACE) and the National Oceanic and Atmospheric Administration (NOAA)

Natural and Nature-Based Features Workshop

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ABSTRACT

This proceedings report summarizes the activities of a collaborative workshop conducted on the topic of Natural and Nature-Based Features (NNBF) by the U.S. Army Corps of Engineers (USACE) and the National Oceanic Atmospheric Administration (NOAA). The workshop was held on March 01-03, 2016, in Charleston, South Carolina. NNBF refers to those features that define natural coastal landscapes and are either naturally occurring or engineered to mimic natural conditions. Some examples of NNBF are beaches and dunes, salt marshes, and barrier islands. Thirty-eight workshop participants represented USACE and NOAA. The objectives of the workshop included were to 1. identify high-priority, resilience-based NNBF projects of common interest to USACE and NOAA; 2. categorize and prioritize projects identified for future collaboration; and 3. form a USACE/NOAA Leadership and Implementation Group to provide advocacy and oversight. The workshop included a plenary session where USACE and NOAA senior leaders presented their respective organization's NNBF overviews. Interactive breakout sessions were also convened to gather input on uncertainty, opportunities, and challenges concerning NNBF. Over the course of the three-day workshop, fourteen short- and long-term opportunities emerged. It will be essential to capture and share lessons learned as the two organizations plan and implement selected NNBF projects.

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PREFACE

This report summarizes the activities of a collaborative workshop conducted on the topic of Natural and Nature-Based Features (NNBF) by the U.S. Army Corps of Engineers (USACE) and the National Oceanic Atmospheric Administration (NOAA). The workshop was held from March 1-3, 2016, in Charleston, South Carolina.

Dr. Todd Bridges from the U.S. Army Engineer Research and Development Center (ERDC) and Dr. Jeff King (NOAA) organized the workshop and served as workshop chairs; Cynthia Banks (ERDC) led logistics; and Julie Marcy (ERDC) was lead facilitator and reviewer. Ginny Dickerson (ERDC) developed and maintained the registration website. Dave Eslinger, Melissa Ladd, Rebecca Love, and Jennifer Mintz (all of NOAA) facilitated breakout sessions. Suzanne Smith and Donna Owens (both of NOAA) provided meeting support. Additionally, the workshop organizers would like to acknowledge the many individuals who provided on-site computer and facility support. Finally, the organizers wish to thank all of the workshop participants who shared their knowledge and experience to identify potential collaborative opportunities for USACE and NOAA so that these two organizations may advance their mutual NNBF practice.

At the time of publication of this report, Dr. Beth Fleming was Director of the ERDC Environmental Laboratory. COL Bryan S. Green was Commander of ERDC and Dr. Jeffery P. Holland was Director of ERDC.

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EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE) and National Oceanic and Atmospheric Administration (NOAA) conducted a national workshop from March 1-3, 2016, on the subject of Natural and Nature-Based Features (NNBF). The purpose of the NNBF workshop was to provide a forum for strengthening USACE and NOAA understanding and application of NNBF and for facilitating appropriate implementation of these solutions for increased resilience. The use of NNBF is an example of Engineering With Nature (EWN) and refers to those features that define coastal landscapes while reducing storm risks and enhancing coastal resilience. Features are either natural: created and evolving over time through the forces of nature, or nature-based: those that may mimic characteristics of natural features, but are engineered by humans to provide specific services.

Thirty-eight participants attended the USACE/NOAA workshop; attendees represented USACE (Headquarters (HQ); Engineer Research and Development Center (ERDC); Institute for Water Resources; North Atlantic Division; Philadelphia District; South Atlantic Division; Galveston District) and NOAA (National Ocean Service; National Centers for Coastal Ocean Science; Office for Coastal Management; Center for Operational Oceanographic Products and Services; National Geodetic Survey; and National Marine Fisheries Service (NMFS)). Over a period of three days, the participants gained a deeper understanding of the ongoing and future NNBF-related work undertaken by these organizations. Workshop attendees were divided into four working (i.e., breakout) groups; each group was comprised of a mixture of USACE and NOAA participants. The working groups, through a series of discussions, identified areas where the two organizations could increase collaboration and help address information gaps on a range of NNBF projects and activities. Ideas developed in working groups were subsequently presented to all participants in plenary sessions.

The effectiveness of USACE and NOAA participant engagement was repeatedly evidenced by the focused, energetic, and productive dialogue that resulted in the identification of high priority needs for both organizations. Workshop participants identified priority gaps in science and engineering and management practice to reduce uncertainties and increase confidence in NNBF design, construction, performance, and ecosystem services. Current USACE and NOAA projects and activities were

identified as opportunities for coordinated action to address these gaps. Workshop participants developed an initial prioritization of specific collaborative opportunities within a mixed portfolio of near- to long-term efforts that extend across a range of geographic areas and include a variety of habitat types. Prioritized NNBF collaboration opportunities included:

1. Development of a strategic collaboration framework that will support and strengthen the coordination between USACE and NOAA, including actions supporting technical resource sharing, regional coordination, and articulation of next steps;
2. Pursuit and application of NNBF techniques and approaches (e.g., application of thin-layer sediment placement to support NNBF; dune construction and management; incorporation of environmental features into existing infrastructure; and use of native vegetation on dredged material placement areas);
3. Planning and feasibility studies (e.g., Texas coastal, Hurricane Sandy focus areas, South Atlantic Division's Regional Systems Management Strategy); and
4. Establishment of regional test beds for increased collaboration (e.g., Delaware and Barnegat Bays).

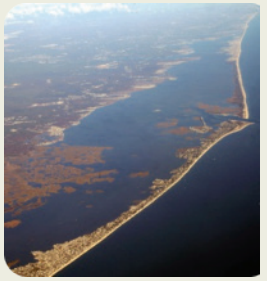
Additional information related to the collaborative workshop can be accessed at the NNBF page at https://ewn.el.erdc.dren.mil/nnbf.html.

1 Introduction

The U.S. Army Corps of Engineers (USACE) and the National Oceanic and Atmospheric Administration (NOAA)'s National Ocean Service (NOS) organized a joint workshop on Natural and Nature-Based Features (NNBF) to strengthen understanding and application of NNBF, and facilitate appropriate implementation of these solutions for increased resilience. The two organizations held the workshop March 1-3, 2016, at two NOS laboratories located in Charleston, South Carolina. NNBF refer to those features that define coastal landscapes, including barrier islands, beaches and dunes, maritime forests, wetlands and seagrass beds, biogenic reefs, and more (Figure 1). Utilizing and restoring NNBF for the purpose of providing ecosystem services, reducing storm risks, and enhancing coastal resilience is a prime example of the Engineering With Nature initiative (www.engineeringwithnature.org) to achieve multiple benefits. NNBF include both natural features and those that are nature-based; i.e., features that are designed and constructed to provide functions and services comparable to natural features.

Following Hurricane Sandy, several government-wide initiatives were pursued that supported the use of coastal green infrastructure (CGI) as a means of reducing future storm risk while encouraging innovative, nature-based alternatives for resilience planning and decision making. In fact, integration of CGI strategies into resilience planning efforts was further prioritized with the publication of The Coastal Green Infrastructure and Ecosystems Services (CGIES) Task Force's assessment of research needs and recommendations for prioritized federal research (NSTC 2015). Others like Sutton-Grier et al. (2015), have also identified the importance of continued research focused on natural and hybrid infrastructure projects. These projects will translate into additional data and information that enable coastal communities and decision makers to more fully integrate ecosystem protection and restoration into coastal resilience planning efforts.

Figure 1. Examples of NNBF relevant to coastal systems (USACE 2013).

NATURAL AND NATURE-BASED FEATURES AT A GLANCE				
				
Dunes and Beaches	**Vegetated Features (e.g., Marshes)**	**Oyster and Coral Reefs**	**Barrier Islands**	**Maritime Forests/Shrub Communities**
Benefits/Processes Breaking of offshore waves Attenuation of wave energy Slow inland water transfer	**Benefits/Processes** Breaking of offshore waves Attenuation of wave energy Slow inland water transfer Increased infiltration	**Benefits/Processes** Breaking of offshore waves Attenuation of wave energy Slow inland water transfer	**Benefits/Processes** Wave attenuation and/or dissipation Sediment stabilization	**Benefits/Processes** Wave attenuation and/or dissipation Shoreline erosion stabilization Soil retention
Performance Factors Berm height and width Beach slope Sediment grain size and supply Dune height, crest, and width Presence of vegetation	**Performance Factors** Marsh, wetland, or SAV elevation and continuity Vegetation type and density Spatial extent	**Performance Factors** Reef width, elevation, and roughness	**Performance Factors** Island elevation, length, and width Land cover Breach susceptibility Proximity to mainland shore	**Performance Factors** Vegetation height and density Forest dimension Sediment composition Platform elevation
General coastal risk reduction performance factors include: Storm surge and wave height/period, and water levels				

Passage of Public Law 113-2 also followed Hurricane Sandy, and directed the USACE to "conduct a comprehensive study to address flood risks of vulnerable coastal populations in areas that were affected by Hurricane Sandy." The resulting report of The North Atlantic Coast Comprehensive Study (NACCS) was published in January 2015 (USACE 2015). As a part of the NACCS, the USACE developed a technical framework for evaluating and implementing the use of NNBF, in combination with structural and non-structural measures, to reduce flood risks and enhance coastal resilience (Bridges et al. 2015). NNBF include beach-dune complexes, barrier islands (and associated habitats), wetlands, oyster reefs, and other features that can be used to address a range of processes impacting coastal systems, including sea level rise, shoreline erosion, wave run-up, and storm surge. Along those lines, NOAA's resilience planning efforts have encouraged the use of living shorelines as a stabilization technique to preserve and improve habitats and their ecosystem services at the land–water interface (NOAA 2015).

As part of an ongoing USACE and NOAA effort to partner on priority areas of common interest to the two organizations, USACE and NOAA leaders identified NNBF as an important topic that could be advanced collaboratively. An important first step in this effort was to organize an initial technical workshop to identify opportunities, establish relationships among related and supporting efforts, and organize for NNBF follow-on engagement. The workshop and its outcomes received strong support from USACE and NOAA leadership, as reflected by statements from USACE Chief of Engineers, Lieutenant General Thomas Bostick, and NOAA Vice Admiral Manson Brown (Appendices A and B).

2 Workshop Objectives and Process

2.1 Objectives

The objectives of the workshop were to:

- Assemble senior USACE/NOAA leaders and technical staff to identify opportunities for leveraging each organization's investments and capabilities with respect to design, development, implementation, monitoring, and adaptive management of NNBF and associated ecosystem services;
- Identify high-priority, resilience-based NNBF projects of common interest to USACE and NOAA through use of plenary and breakout sessions; then, categorize and prioritize projects identified by USACE and NOAA for future collaboration;
- Form a USACE/NOAA Leadership and Implementation Group to provide agency advocacy, track progress, provide ongoing direction/oversight, and ensure accountability; and
- Develop and publish a joint USACE/NOAA proceedings report that documents results of the meeting.

2.2 Participants

Thirty-eight participants attended the USACE/NOAA workshop. The group of attendees was comprised of individuals representing USACE (Headquarters (HQ), Engineer Research and Development Center (ERDC), Institute for Water Resources, North Atlantic Division, Philadelphia District, South Atlantic Division, Galveston District) and NOAA (National Ocean Service, National Centers for Coastal Ocean Science, Office for Coastal Management, Center for Operational Oceanographic Products and Services, National Geodetic Survey, and National Marine Fisheries Service). Please see Appendix C for listing of workshop participants and their respective organizations and positions. A group photo is shown below (Figure 2).

Figure 2. USACE and NOAA workshop participants.

2.3 Agenda and Workshop Structure

The workshop was structured with both plenary and breakout group sessions (as indicated in the workshop agenda, Appendix D). The first day of the workshop included an opening plenary session that afforded USACE and NOAA leadership the opportunity to communicate expectations. Background information, which focused on the organizations' coastal resilience and NNBF capabilities/expertise, and example projects were also presented in the initial plenary session. Introductory plenary presentations can be found at Appendix E.

Following the opening plenary session, participants were assigned to one of four pre-determined breakout groups (four groups of nine individuals). These four groups remained intact for the duration of the workshop, and they used their initial responses to the pre-workshop assignment to assimilate a unified group response. In turn, each of the four breakout groups identified a spokesperson who presented his/her respective group's thoughts and ideas when all participants reconvened after the Day 1 and Day 2 breakout sessions. There was a total of three breakout sessions

(sessions 1-3) that corresponded to the three worksheets (Appendix F), which were provided to participants one week prior to the start of the workshop. Each breakout session was followed by a plenary session where the four breakout groups individually reported. Appendices G and H provide summaries of results from breakout sessions 1-2, respectively. The following set of questions were provided to the participants of each breakout group as a means of stimulating and focusing discussion:

- Breakout Session 1: What are the most significant causes of uncertainty concerning NNBF design, performance, and management (including Operations & Maintenance)? How might an improved understanding of the ecosystem services provided by NNBF be used for decision-making in coastal communities (for example, understanding the performance of specific features)? Please provide your rationale succinctly. Given these levels of uncertainty, what specific physical, ecological, or social processes/science should be targeted and considered in order to advance the use and integration of NNBF into coastal infrastructure strategies?
- Breakout Session 2: What types of NNBF projects are currently underway in your organization? What types of NNBF projects present the best opportunities and biggest challenges for USACE and NOAA going forward (considering research priorities, policy, planning, permitting issues, construction, operations, etc.)? With respect to your answer(s) above, what geographic settings present the best opportunities and biggest challenges? Please provide your rationale succinctly.

The plenary session that followed breakout session 3 afforded each of the four groups an opportunity to present their 3-5 priority projects for USACE and NOAA collaboration (Appendix I). The following set of questions was provided to each breakout group for consideration during Session 3:

- Breakout Session 3: What future NNBF projects would you prioritize for USACE/NOAA collaboration? Existing projects that can be leveraged should also be included. What do you consider to be the key aspects or elements of these collaborative projects? When considering your priority project(s), what key next steps should be taken to advance the collaborative efforts? Use worksheet 4 for individual project ranking. Then, combine scores for the final team rankings of 3-5 ideas from the team to present in the plenary session. Prioritization criteria that were used included the following (where applicable):

Feasibility: Is this an ongoing or planned project that could be a modified vs. a new effort?

Project Timeline: Would the project be implemented in the near- (immediate to 1 year), mid- (2-4 year), long-term (5-7 year) timeframe? (Note: Ideally, the project portfolio would include a range of timeframes, with a bias toward the near-term timeframe).

Interagency Involvement: Will the project be suitable for both NOAA and USACE involvement, at a minimum, and is it appropriate for investment by both organizations and perhaps by other stakeholders?

Regulatory Challenges: Are there any particular regulatory/legal challenges that might delay or prevent project implementation?

Geographic and Habitat Diversity: Is there diversity in geographical location and habitat type across the portfolio of collaborative projects (e.g., coastal, wetland, seagrass, oyster castles, etc.)?

Participants were asked to vote at the end of Day 2 which 14 projects should be considered priority. Appendix J contains the results of the voting exercise. Day 3 began with a recap and discussion of the 14 priority projects identified by workshop participants. This was followed by the breakout sessions, which included a tour of the Hollings Marine Laboratory for most attendees and a senior leader coordination meeting.

3 Key Outcomes

3.1 Breakout Session 1

Breakout Session 1 (Figure 3) provided a forum for participants to discuss NNBF-related uncertainties, ecosystem services, and processes/science. When asked to identify areas of uncertainty concerning NNBF design, construction, and management, all four breakout groups identified a lack of baseline information and an incomplete understanding of system dynamics as major factors that must be addressed. An inability to anticipate the magnitude of future, physical drivers (i.e., storm intensity, climate change, sea level rise, wave energy, etc.) was also identified by the groups as contributing to uncertainties with NNBF. In association with these considerations, uncertainty about the durability of NNBF projects — and ultimately, uncertainty about NNBF project implementation — also posed challenges for their prioritization over more traditional, engineered structures. The groups identified other uncertainties including — but not limited to — developing standard, quantifiable metrics for determining success; obtaining funding associated with initial construction and adaptive management; and achieving the ability to reach regulatory consensus about NNBF construction or use.

Figure 3. Work Group meeting during Breakout Session 1.

When asked how an improved understanding of ecosystem services provided by NNBF can be used for decision-making in coastal communities, two of the breakout groups indicated that a standard method of quantifying or measuring ecosystem services attributed to NNBF — and specifically of monetizing these services whenever possible — are priority needs that would help justify and expand use of NNBF in coastal communities. Others reported that ecosystem services, and their importance when considering or justifying NNBF initiatives, would be greatly enhanced through the establishment of a universally accepted valuation framework that includes more advocacy with messaging. Finally, there was general agreement by all breakout groups that an improved understanding of ecosystem services benefits provided by NNBF-related projects will only occur through continued efforts to engage stakeholders and build community support. Seeking interagency agreement that incorporates both "top down" and "bottom up" approaches was also identified as important when establishing a common understanding of important ecosystems services provided by NNBF.

The final question in Breakout Session 1 focused on the identification of physical, ecological, and social process/science that should be targeted to advance the use and integration of NNBF. This question resulted in a number of diverse responses. With respect to physical and ecological pursuits, two groups responded that there was a need for science focused on morphodynamics; elevation, sediment, climate modeling downscaled to a respective coastal zone; ecological predictions/modeling to overcome uncertainty; and studies focused on species response to climate change. Most groups included elements that identified social science/economics-related themes, including: ecosystem service valuations; development of target life-cycle analysis tools; community engagement; developing technical guidance applicable in different regions; data collection and a "state-of-the-art" repository associated with NNBF-related information including cost, metrics, etc. Several groups also opted to provide more tangential responses to the last question in Breakout Session 1, such as the need for more demonstration projects, the promotion of more private-sector involvement, the development of clear NNBF project design criteria, the establishment of measurement protocols for NNBF performance and benefits, and the need to produce technical guidance that is applicable at different regions/scales. Raw output from breakout groups is presented in Appendix G.

3.2 Breakout Session 2

Breakout Session 2 (Figure 4) offered participants a chance to discuss specific NNBF projects and the projects' associated opportunities/ challenges. When asked to identify the types of NNBF projects currently underway within participants' respective organizations, the four breakout groups collectively identified numerous examples that were located in various geographical settings. Those examples included, but were not limited to vegetation plantings on dredged material placement areas and dunes; ecosystem restoration projects (i.e., beach nourishment, oyster beds, wetlands, and sand dunes); thin-layer placement of sediment on low-lying marshes; salt pond restoration and wave attenuation using vegetation. The groups also identified other ongoing NNBF-supporting activities that could be classified as laboratory, computer or social science, which included ecosystem service valuations, coastal modeling, dune and marsh modeling, and development of a green infrastructure database.

Figure 4. Work Group meeting during Breakout Session 2.

When breakout groups were asked to consider which NNBF projects represent the best opportunities for USACE and NOAA pertaining to policy, planning, regulatory, construction, operations, etc., several "broad-based" topics were put forward by the groups. Those recommendations

included: coastal/storm damage prevention, navigation, regional sediment management, ecosystem response to sea level rise, and connections with NOAA's sentinel sites. More specific project opportunities that were identified included the leveraging of many ongoing, large initiatives such as the Coastal Texas Protection and Restoration Feasibility Study, Hurricane Sandy Focus Areas, the Port Everglades Harbor Mitigation Project, and the South Atlantic Regional Systems Management Strategy. One group also identified more specific, ongoing projects, including thin-layer sediment placement at Camp Lejeune, North Carolina and Avalon, New Jersey; a living shoreline and dune rebuilding at Deal Island, Maryland; the Port Everglades Harbor Mitigation Project; habitat enhancement of infrastructure; and an on-the-ground project at Spring Creek South, which is a smaller effort within a larger plan for Jamaica Bay/Rockaway.

Several of the breakout groups also identified future opportunities that were more strategic in nature. For example, leveraging the Systems Approach to Geomorphic Engineering (SAGE) working groups; prioritizing non-funded, coastal resilience and/or NNBF proposals developed in response to a request for proposals and funds for operations by granting institutions/agencies; leveraging existing research and development infrastructure in NOAA and USACE; and identifying connections to NOAA's sentinel sites were all identified as strategic ideas worthy of pursuit. NOAA's sentinel sites combine coastal monitoring and data collection tools with sanctuaries, estuarine reserves, marine protected areas, and other assets located in coastal areas around the nation. These places and equipment serve many functions, such as protecting natural resources, measuring tides, and establishing accurate height measurements. The NOAA Sentinel Site Program directly engages local, state, and federal managers as part of a cooperative team. By doing so, managers help ensure the types of science conducted, information gathered, and products developed are immediately used for better management. For more information, please visit: http://oceanservice.noaa.gov/sentinelsites/.

Development of an advocacy team (NOAA and USACE) that is committed to working NNBF issues and projects was also identified as a project opportunity that aligns with the broader strategic initiatives of both agencies.

When breakout groups were asked to consider the biggest challenges that pertain to policy, planning, regulatory, construction, operations, etc., all four groups identified the existing regulatory requirements (and associated variability across USACE districts and states) as a significant challenge. Three of the groups identified some aspect of cost as a hindrance as well, including requirements for selecting least cost alternatives for dredging projects that may limit sediment beneficial use options incorporating NNBF construction. Lack of funding that supports agency collaboration and NNBF construction costs were also specified in group discussions. Two groups identified the scaling of projects, which may include geography and resource elements, as a potential challenge for the two agencies. For example, the USACE has traditionally worked on large projects that include NNBF (for example, deep draft navigation or flood control studies), while NOAA's projects have been smaller in scale. Other challenges that were identified included lack of available data and success stories, and the need for expanded communication, stakeholder buy-in and coalition building. Raw output from breakout groups is presented in Appendix H.

3.3 Breakout Session 3

Breakout Session 3 (Figure 5) offered each of the four working groups an opportunity to reconvene following presentations and discussions in plenary, which featured results derived during Breakout Sessions 1 and 2 (see Appendix D for outline of agenda). Based on the information shared and exchanged in plenary, each of the working groups was then asked to identify and prioritize future NNBF projects for USACE and NOAA collaboration. Raw outputs from the breakout groups is presented in Appendix I. The following list is a composite of the total number of proposed projects (19 total) recommended across the breakout groups. When applicable, information specific to description, location, rationale for selection and recommended next steps has also been included.

1. NNBF Advocacy Team: This proposed project would initiate a team to continue the NNBF workshop collaboration. There is a clear need to capitalize on the momentum achieved in the workshop. This team would continue to promote NNBF awareness and design, construction, and management efficiencies in order to improve effectiveness with implementation. Next steps would include clarifying the team's scope and identifying relevant participating offices. The team would also prioritize

USACE and NOAA's need to determine an information sharing process (e.g., databases, catalogs, etc.).

2. Hurricane Sandy Focus Areas: This topic represents an existing area of extensive work by USACE and NOAA. Pursuit of this project would result in the development of a strategic NNBF direction while leveraging NOAA/USACE's established collaboration and subsequent planning activities in the area. The project would be located in New Jersey Back Bays (Barnegat Bay), Norfolk (York River), and New Jersey Harbors and Tributaries (Hudson River). Next steps would be to establish a common USACE/NOAA emphasis with clear roles/responsibilities that are focused on an NNBF approach. Funding for "on-the-ground" implementation is available.
3. Coastal Texas Protection and Restoration Feasibility Study: This is a USACE feasibility study to collect data that supports the development of a strategy for reducing coastal storm flood risk through structural and non-structural measures. Incorporating NNBF into the study is a realistic expectation. The project is located from Sabine Pass to Galveston Bay and also includes Matagorda Bay, Corpus Christi Bay, and Padre Island. This feasibility project has been approved and funded. Next steps should include developing ideas for NNBF and determining clear USACE and NOAA roles/responsibilities.
4. Camp Lejuene Thin-Layer Placement: This is a NOAA-initiated project that is focused on thin-layer application of dredged material to improve marsh resilience. The project would be located at the Marine Corps Base - Camp Lejeune, North Carolina. This funded project allows USACE and NOAA an opportunity to collaborate and build a regulatory framework in the southeastern U.S. It will test logistics for application and develop monitoring protocols. The project also leverages NOAA and DoD-funded research. Recommended next steps include the development of a working group that will establish a clear approach for project implementation. USACE and NOAA roles and responsibilities also need to be clearly defined.
5. Jamaica Bay Rocks: This Hurricane Sandy-funded project is designed to provide coastal storm risk management benefits. Natural infrastructure alternatives that include NNBF are under development. The project is located at Jamaica Bay - Rockaway Peninsula, New York City, New York. Construction funds are in place through Hurricane Sandy legislation. Next steps include an evaluation of the Spring Creek Project and a proposal of alternatives for the Jamaica Bay - Rockaway Project.

6. Chesapeake Bay NNBF Project: This project includes NNBF design and construction approaches in salt marsh and dune systems. It is located at Deal Island, Tangier, and Franklin Point Park. The project offers value because several communities at risk would realize benefits from NNBF projects. Several partners have already been identified, including Maryland Department of Natural Resources (DNR), Chesapeake Bay Sentinel Cooperative, Monie Bay, USACE Baltimore and Norfolk Districts. Next steps would include efforts to connect lessons learned and partners from the Choptank Habitat Focus Area. Coordination between NOAA's Community-Based Restoration Program and USACE, connecting floodplain management planning assistance to states (and continuing authority programs) are also proposed as next steps.
7. Develop Strategic Collaboration Framework: The proposed framework would enhance collaboration across agencies and programs to facilitate NNBF research, planning, design, and information sharing. The framework would identify mechanisms to form and facilitate the exchange of technical information, communication and outreach, and planning. Next steps would include the establishment of improved and sustained collaboration plans to advance "state-of-the- art" NNBF, leading to a future approach that is less opportunistic and more strategic. Near-term next steps would also include identifying a leadership and technical team, building the framework, and designating a champion on each side. Additional steps would include development of a strategic communication plan to inform agency leadership, inclusion of core technical documents into a natural infrastructure database used by collaborators, creation of an interagency employee exchange program, and a revisit of the role and use of SAGE and test metrics to inform effectiveness of NNBF.
8. Investigation of Dune Management Approaches: This investigation would focus on the science and engineering of building dunes. Initial locations would include North Carolina and South Padre, Texas. This would be an applied research project. Development and application of dune-building techniques are somewhat new engineering techniques being applied in support of coastal resilience, and coastal managers are faced with challenges in their utilization/application. Broad application and collaboration between NOAA and USACE is a logical next step given the already existing investments, capabilities, and infrastructure. Future efforts would include identifying partners, developing demonstration projects in these locations, recording lessons learned, and determining applicability in other regions.

9. Vegetation on Dredged Material Placement Areas: This proposed project would use native plants as engineering materials for developing NNBF in dredged material placement areas while exploring potential engineering, ecological, socio-economic, and environmental benefits. This effort is in progress under the USACE Engineering With Nature initiative and additional partners would expand the effort and the locations benefitting by the project. Locations for this project are proposed in Galveston, Texas, the Great Lakes, and the North Atlantic Region. This proposed project has broad application, and vegetating dredged material placement areas have the potential to provide many benefits, including multiple ecosystem services (e.g., habitat provision, erosion control), improved perception of dredging operations, and cost savings. Next steps would include identifying partners, developing demonstration projects in these proposed locations, archiving lessons learned, and determining applicability in other regions.
10. Habitat Enhancement of Infrastructure: The proposed project(s) would focus on redesigning structural measures and conventional infrastructure to provide environmental benefits through the addition/inclusion of vegetation and other natural materials. These activities would take place in a variety of locations and would follow where work is already taking place. Several successful efforts have been achieved in the Great Lakes region through Engineering With Nature in partnership with the Great Lakes Restoration initiative and other organizations. Next steps would include the alignment of current research in this area within the Engineering With Nature initiative and other efforts and a better understanding of which existing infrastructure would benefit from such an initiative.
11. Improve Collaborative Transfer of Tech and R&D: This proposed project would assemble a sub-working group that meets regularly to sustain momentum and encourage collaboration across agencies. This group would ensure that NNBF results for completed projects are shared, and make results readily available when and where people need it. From a science-to-management perspective, this group proposes connectivity with NOS's Office for Coastal Management and NOAA's Sea Grant Program to assist USACE and NOAA with disseminating information to community partners. Likewise, establishing a science-to-science connection between NOS's National Centers for Coastal Ocean Science (NCCOS) and USACE's ERDC would be beneficial for the purpose of sharing models and science that supports use of NNBF. This project would also seek to enhance NOAA and USACE collaborations at a staff level and establish a tech transfer approach for NNBF that can be used repeatedly with multiple projects. Proposed next steps would be to assemble a team to scope what would be

required to develop a collaborative tech transfer process. Sharing USACE, NOAA, and U.S. Fish and Wildlife Service (USFWS) tech transfer documents was also recommended as a first step. Finally, the inclusion of USACE-completed, NNBF projects in the NOS database was proposed as an initial next step.

12. Development of Beach Nourishment Habitat Guidance: This project would develop guidance that makes the habitat component stronger in beach nourishment projects. USACE has initiated the development of guidance focused on this topic, and NOAA would contribute technical expertise. For example, NOAA's assistance would add to the guidance proposed on beach erosion while also providing a perspective on protected species. The establishment of joint guidance would enhance relationship-building efforts between agencies. As guidance is implemented and projects are identified, NOAA can support USACE with monitoring using techniques derived from NOS expertise in marine spatial ecology.
13. Boston Harbor Beneficial Use (Rock) Project: This project would provide an opportunity to identify the use of rock to create NNBF habitat. It also provides a unique opportunity for NOAA/NMFS to contribute experience and knowledge about the possible beneficial uses of rock. The project would be located in Boston Harbor, Massachusetts. Use of these rock materials would provide an opportunity to learn more about their beneficial use and increase the potential for tech transfer to other projects. An initial next step includes communication with New England District to identify additional opportunities to collaborate.
14. Leverage Science and Partnerships from Mobile Bay (Beneficial Use/Placement) Projects: This project would leverage science to identify beneficial uses of dredged material placement and explore new opportunities for NNBF with best economic outcomes. The project would be located in Mobile Bay, Alabama, and would take advantage of a large deepening project, which includes large volumes of dredged material that could be used beneficially. USACE and NOAA already have mutual R&D and collaborative relationships in the area. Lessons learned in association with this project could have implications for many other projects. Recommended next steps include communication with Mobile District to identify additional opportunities for NOAA to participate on a study team when considering/identifying NNBF features as elements of this large project.
15. South Atlantic Regional Systems Management Strategy: This is a USACE project in the planning phase that would identify coastal vulnerability and risk. NNBF is proposed in the future project plans. The project is located

along the coasts of North Carolina, South Carolina, Georgia, and Florida. Development of this strategy could have impact on a large number of USACE Operation and Management (O&M) projects, which may include an opportunity for a large number of diverse NNBF projects. This effort leverages tools and lessons identified in the North Atlantic Comprehensive Coastal Study (NACCS). The next recommended step would be to name a NOAA POC during this early stage to be involved with stakeholder group identification and participation.

16. Delaware and Barnegat Bay Integrated Test Bed: This project pulls together multiple elements of NNBF implementation, including use of monitoring data, island creation, and thin-layer wetland restoration. It also leverages the SAGE community of practice and Jacques Cousteau National Estuarine Research Reserve. The Engineering With Nature initiative also has several efforts underway in coastal New Jersey. There is low technical and social risk associated with projects in this area, and there is a good opportunity for USACE and NOAA to work through regulatory issues, which could then be used as a template for other U.S. regions. Recommended next steps include a USACE and NOAA meeting with key parties in the area to develop collaborative strategies and integrate them with an NNBF approach.
17. Advancing Thin-Layer Placement for Resilience: This project represents a broad topic covering all existing thin-layer projects. This effort would continue to develop/refine thin-layer methodologies that support coastal resilience. Initially identified project sites include: New Jersey, North Carolina, and Delaware. Continued focus on thin-layer techniques through a combination of R&D and pilot projects would reduce the level of uncertainty associated with such efforts. Over time, continued initiatives focused on thin-layer application would make the engineering practice more cost-effective by reducing inefficiencies, and increased application improves confidence with the technology while streamlining regulatory processes. A proposed next step would be the identification of POCs from USACE and NOAA that would champion this effort. In addition, a 1-2 day long working meeting would contribute greatly to the delivery of thin-layer placement projects.
18. Port Everglades Harbor Mitigation Project: This project includes reef tract enhancement (collecting, propagating, and planting coral) as well as seagrass and mangrove enhancement efforts. This is a mitigation project developed jointly with NMFS in Broward County, Florida. Presently, this project is in a design phase, and working with the existing interagency team is a requirement. The project spans ecosystems of interest and would

expand the geography of aquatic resources in the area. In addition to NNBF, the opportunity exists to incorporate additional research, such as blue carbon and sea-level rise impact assessments. An immediate next step would be to identify a NOAA POC to integrate with the project team.

19. Synthesis of Approaches for Resilience and Beneficial Use Projects in Order to Advance NNBF: This proposed project would integrate the best available information focused on resilience-based efforts like NNBF and beneficial use of dredged materials. It would also include developing national guidance based on pilot projects, defining terminology, establishing a common language, compiling relevant literature, and developing guidance focused on NNBF, with inclusion of national with local case studies. There is a clear need to curate information to show benefit and successes of these techniques. This recommended action would also develop common messaging associated with NNBF while integrating different types of projects. A recommended next step is establishment of a working group that identifies which agencies are developing and prioritizing action items.

Figure 5. Work Group meeting during Breakout Session 3.

3.4 Participants' Voting/Ranking Exercise

Following the reporting of results derived in Breakout Session 3, the 19 project ideas that were identified/prioritized were subsequently evaluated in plenary session to identify possible overlaps and duplication (see Section 3.3 for a listing of project ideas). In brief, the participants agreed that project ideas #1, #7, #11, and #19 were sufficiently similar in description that they could be consolidated into one. Likewise, project ideas #4 and #17 were integrated into one project.

The integration analysis resulted in a total of 15 projects for the participants to consider and rank in terms of priority. At this point, participants agreed that the first priority for USACE and NOAA is to develop a strategic NNBF framework, which captures elements from project ideas #1, #7, #11, and #19. Thus, it was decided that development of the NNBF framework should be fast tracked as a workshop outcome. Moreover, all of the attendees agreed that the strategic framework should not be included in the voting/ranking exercise, given the framework's overall importance to future collaborations between the two organizations. With unanimous agreement on this approach, a total of 14 project ideas were ultimately considered in the voting/ranking exercise.

Prior to voting, titles for the 14 project ideas were written on poster boards and displayed prominently on the wall. Each of the participants was also provided with four stickers that represented different monetary values (i.e., $2.00, $1.00, 75¢ and 25¢). Next, each participant was asked to affix the sticker with the largest value next to his/her vote for the highest priority project. Once all participants had assigned values to the 14 project ideas, the total value of each project was calculated. The results of the voting/ranking exercise are provided in Table 1 below and Appendix J. All information was transcribed for future use. Project rankings and actual collaborative starts are subject to change based on opportunities and changes in selection criteria.

Overall, participants agreed the voting/ranking exercise was very effective and it efficiently captured all the noteworthy ideas from every group member. Most significantly, a valuable mix of short- and long-term opportunities emerged from the exercise, and these will serve as a roadmap for future collaborative action (e.g., for research, technology). It should be noted that a couple of areas were not discussed at the workshop and were left for future discussions; these areas include ecosystem restoration and flood risk management opportunities.

Table 1. Results of the Voting/Ranking Exercise.

Project Name	Score
Advancing Thin-Layer Placement	25.25
Coastal Texas Protection and Restoration Feasibility Study	21.0
Vegetation of Dredged Material Placement Areas	14.50
Sandy Focus Areas Collaboration	13.25
Investigation of Dune Management Approaches	10.25
Habitat Enhancement of Infrastructure	9.25
South Atlantic Regional Systems Management Strategy	8.75
Delaware and Barnegat Bay Integrated Test Bed	6.0
Leveraging Science and Partnerships from Mobile Bay	5.75
Development of Beach Nourishment Habitat Guidance	3.0
Jamaica Bay Rocks	3.0
Port Everglades Harbor Mitigation Project	2.75
Boston Harbor Beneficial Use Project	1.25
Chesapeake Bay Project	0.75

Workshop participants noted that the strategic collaboration framework will be essential for charting how the team progresses and maintains its momentum; however, in order to realize meaningful progress and accomplish its ambitious goals, the team must be actualized quickly. As the team moves forward, it will be important to demonstrate to the Nation the value of the organizations' joint actions. Consequently, as the partnership strives to achieve national and system-scale results, efforts must be both impactful and correspondingly broad in scope. Governments of other countries appear to be very interested in how the U.S. is applying NNBF as well, and they likely will receive information about USACE-NOAA progress. It will be critical to capture and share lessons learned as the two organizations plan and implement NNBF projects. The USACE-NOAA partnership will certainly draw worldwide and national attention and will serve as a model for sharing with other organizations such as the U.S. Geological Survey, the U.S. Environmental Protection Agency, and USFWS.

4 Senior Leaders' Report to Plenary

Following the voting/ranking discussion by all workshop participants, senior leaders from USACE and NOAA adjourned for a special session. The goal of this session was for senior leaders to prepare an overall assessment of the workshop for participants and to develop final comments for delivery in the closing session. The following bullets represent key thoughts shared by the senior NOAA and USACE leaders who participated in the workshop:

- Leadership was very positive about the engagement and enthusiasm of workshop participants. Overall, the workshop met or exceeded expectations. The workshop had a beneficial mix of attendees and there was a fluid chemistry among the participants. Many productive ideas and thoughts were shared during the three-day event. The quality of the ideas was very high, and there are a rich set of goals and proposals to pursue.
- Leadership agreed that developing a framework that codifies USACE and NOAA engagement on NNBF work is a high priority. The framework should be strategic in nature and separate from the workshop proceedings. The framework should be focused and not ponderous. It should guide how the organizations work together while providing direction and vision. Breakout groups that identified this as a priority had thought-provoking ideas that should be reviewed and incorporated. Tracks for the framework should include, but are not limited to (1) communication and engagement, (2) policies, and (3) research and development. The framework should provide support and flexibility to individuals already engaged in NNBF implementation.
- Leadership commented that the projects identified represented a good mix of short-term and long-term projects. Initially, some expressed concern that the workshop would focus solely on R&D opportunities for collaboration. However, the workshop participants explored many other opportunities that exist across NOAA and USACE's Operations, Planning, and Regulatory Divisions. It was made clear during the workshop that NOAA and USACE have common interest in R&D, and collaborative NNBF science can inform many planning, operations, and regulatory activities. For example, USACE is beginning the reauthorization process for nationwide permits. NOAA reviews five-year plans for this action, and issuance of Coastal Zone Management (CZM) Consistency at a state level is also part of this activity. USACE

Regulatory needs information on NNBF R&D, good science, and work that achieves desired outcomes. NOAA also has expressed a need for the same information.

- Future NNBF efforts should leverage existing state relationships. NOAA/NOS has excellent rapport with states and outreach capabilities could be enhanced by the collaborative NNBF efforts discussed in the workshop.

5 Workshop Products, Recommendations, and Next Steps

There were a number of actions recommended going forward, including:

- Assemble a Collaborative Framework Team. This team will draft a high-level collaborative framework to organize future communications.
- Produce a joint, one-page executive summary, which succinctly describes the workshop outcomes.
- Produce a joint proceedings report summarizing the workshop outcomes into a readable form that includes all workshop materials.
- Schedule a senior leader conference call for input on the collaborative framework and provide internal and interagency updates.
- Obtain an NOAA response to LTG Bostick's letter through Vice Admiral Brown.
- Develop an NNBF webpage to serve as a point source for updates, technical documents, and other resources. The NNBF webpage (https://ewn.el.erdc.dren.mil/nnbf.html) is a living resource and currently houses 26 USACE and NOAA publications and other resources related to NNBF (Appendix XI).

REFERENCES

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Appendix A: Letter of Support from USACE Leadership

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

REPLY TO
ATTENTION OF

29 FEB 2016

CECW

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: USACE and NOAA Collaboration Efforts of Effective Coastal Infrastructure and Restoration of Coastal Ecosystems

1. The resilience of our coastal systems and communities is vital to the integrity of our country's national security, economy, environment, and the well-being of its citizens. The U.S. Army Corps of Engineers (USACE) and the National Oceanic and Atmospheric Administration (NOAA), along with many other organizations, have worked for decades to support the development of effective coastal infrastructure and the restoration of coastal ecosystems. The experience and knowledge gained from our collective efforts have helped us identify needs and opportunities to address both current and future challenges. We all recognize the critical need to enhance the resilience of our coastal systems. It is also important that we pursue coastal resilience and guide investments in an efficient manner that will produce reliable and sustainable function and performance of our coastal infrastructure and ecosystems. One of the key enablers for achieving these objectives is the use of sound science and engineering practice to inform our common goal of coastal resilience.

2. I am encouraged and excited by the fact that USACE and NOAA have joined in the collaboration that has brought you together in Charleston to consider how Natural and Nature-Based Features (NNBF) can be used to support coastal resilience. One of the key findings of the North Atlantic Coast Comprehensive Study, a finding that is consistent with a long history of practical experience, is that effective solutions will integrate structural and non-structural measures with NNBF. These integrated solutions should be developed so that our coastal systems will be prepared for threats, resist loss of function, recover quickly when damaged, and be adaptable with respect to future challenges.

3. I look forward to hearing about the results of the NNBF workshop and the opportunities that you identify for USACE and NOAA to collaborate as we engineer with nature in support of our coastal systems and country. I am confident that you will achieve great things together this week!

THOMAS P. BOSTICK
Lieutenant General, USA
Chief of Engineers

Appendix B: Letter of Support from NOAA Leadership

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Environmental Observation and Prediction
Washington, D.C. 20230

May 9, 2016

Dear USACE/NOAA Collaboration Workshop on Natural and Nature-Based Features attendees,

I am writing to thank you for your participation and collaboration during the March 1-3, 2016 workshop in Charleston, South Carolina. Natural and nature-based infrastructure along our nation's coasts helps protect communities from storm impacts and supports healthy and productive ecosystems and fisheries, coastal recreation, water quality, and other related economic and social activities. The nation is increasingly recognizing this value, prompting accelerating demand from governments at all levels for planning approaches that promote resilient communities and ecosystems. In response, the private sector and nongovernmental organizations are beginning to add their own investments in the design of natural and nature-based solutions. With this mounting demand and activities, it is increasingly critical that the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Army Corps of Engineers (USACE) continue to be leaders, collaborators, and advocates in this field of science, engineering, and management.

I consider the results from our recent highly successful combined workshop to be key steps in reducing uncertainties and increasing the confidence in the design, construction, performance, and ecosystem services produced by natural and nature-based features. Clearly, we were able to identify high priority projects that will help to frame future collaboration by bringing together a diverse group of talented and committed individuals. These promising outcomes reflect very highly on your collective contributions throughout the three-day workshop and are supportive of the four themes of the USACE-NOAA collaboration begun last year between Lieutenant General Bostick and me. Perhaps more importantly, your efforts are a testimony to the synergy and ideas that historically have been, and will continue to be, harnessed through NOAA and USACE interactions.

I am grateful for your participation in the workshop and your continued efforts to implement the identified action items. I look forward to receiving more updates on the progress that has been achieved as NOAA and USACE continue to build upon this success.

Sincerely,

Manson K Brown
Assistant Secretary for Environmental
Observation and Prediction and
NOAA Deputy Administrator

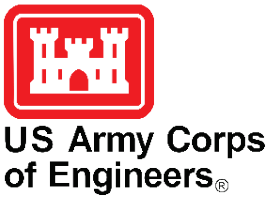
Appendix C: Participant List

USACE and NOAA National Ocean Service Workshop: Natural and Nature-Based Features
01-03 March 2016
Charleston, South Carolina

Last Name	First Name	Agency/Organization	Position/Job Title
Banks	Cynthia	USACE-ERDC-EL	Research Biologist/Program Manager
Bridges	Dr. Todd	USACE-ERDC-EL	Senior Research Scientist/Program Manager
Bryant	Mary	USACE-ERDC-CHL	Civil Engineer
Bush	Eric	USACE-SAD	Chief, Planning and Policy Division
Cary-Kothera	Lori	NOAA OCM	Science/Geospatial Solutions Operations Manager
Chasten	Monica	USACE-NAP	Hydraulic Engineer
Cofer-Shabica	Nancy	NOAA-OCM	Program Manager/Learning Products Manager
Currin	Carolyn	NOS-NCCOS	Plant Ecologist
Davis	Jenny	NOS-NCCOS	Plant Ecologist
Edwing	Richard	NOS: CO-OPS	Director, CO-OPS
Erickson	Mary	NOS-NCCOS	Director, NCCOS
Eslinger	Dave	NOS-OCM	Oceanographer/Facilitator
Eslinger	Sandy	NOS-OCM	Policy Advisor
Fleming	Dr. Beth	USACE-ERDC-EL	Director, ERDC Environmental Laboratory
Foley	Jessica	NOS	Plant Ecologist and NOS Policy
Gaffney-Smith	Meg	HQ USACE CECW-CO	Deputy Chief, USACE Operations
Gailani	Dr. Joseph	USACE-ERDC-CHL	Research Hydraulic Engineer
Harmon	Michelle	NOAA/NOS/NCCOS	Physical Scientist
Henn	Roselle	USACE-NAD & CSRM-PCX	Environmental Team Leader
Hughes	Sue	USACE CECW-P	Deputy, Planning Community of Practice
Irigoyen	Eddie	USACE-SWG	Project Manager
Kidwell	David	NOS-NCCOS	Oceanographer, EESLR Program Manager
King	Dr. Jeff	NOS-NCCOS	Acting Director, Hollings Marine Laboratory
Ladd	Melissa	NOS-OCM	Facilitator
Love	Rebecca	NOAA OCM	Facilitator
Luscher	Audra	NOAA NOS CO-OPS	Resilience Program Manager
Marcy	Julie	USACE-ERDC-EL	Research Biologist/Certified Facilitator
Mintz	Jennifer	NOAA-OAR-OAP	Regional Coordinator-Ocean Acidification Program/Facilitator
Payne	Dr. Jeff	NOS-OCM	Director, OCM
Penn	Kim	NOS-OCM	Climate Change Coordinator
Piercy	Dr. Candice	USACE-ERDC-EL	Research Environmental Engineer

Last Name	First Name	Agency/Organization	Position/Job Title
Scott	Galen	NOS-NGS	Program Analyst
Sekoni	Tosin	USACE-ERDC-EL	Research Ecologist
Tortorici	Cathy	NOAA-NMFS	Chief, ESA Interagency Cooperation Division
Vuxton	Emily	USACE-IWR	Biologist
Wamsley	Dr. Ty	USACE-ERDC-CHL	Research Hydraulic Engineer
Welp	Tim	USACE-ERDC-CHL	Research Hydraulic Engineer
Whitfield	Paula	NOS-NCCOS	Environmental Compliance Coordinator

Appendix D: Workshop Agenda



USACE NOAA-NOS Collaboration Meeting Agenda on Natural and Nature-Based Features (NNBF)
National Centers for Coastal Ocean Science (NCCOS) Laboratories
331 Fort Johnson Rd
Charleston, SC 29412
March 1-3, 2016

Workshop Outcome:

- Strengthen application and facilitate implementation of NNBF.

Objectives:

- Assemble senior USACE/NOS leaders and technical staff to identify opportunities to leverage each agency's investments and capabilities with respect to design, development, implementation, monitoring, adaptive management of NNBF and associated ecosystem services.
- Identify high-priority, resilience-based NNBF projects of common interest to USACE and NOS through use of plenary and breakout sessions. Categorize and prioritize projects that are identified for future collaboration by USACE and NOS.
- Form a USACE/NOS Leadership and Implementation Group to provide agency advocacy, track progress, provide ongoing direction/oversight, and ensure accountability.
- Develop and publish a joint USACE/NOS report that documents results of the meeting.

February 29 **Travel to Charleston, SC**

March 1

Time	Action	Lead or Speaker
7:30 – 8:00	Arrive at CCEHBR Laboratory (Please see Ft. Johnson Campus Map)	All
8:00 – 8:10	Welcome/Quick Introductions	King, Bridges
8:10 – 8:30	Initial Thoughts	Erickson/Fleming
8:30 – 9:00	Approach to Workshop/Expectations	Marcy
Plenary Session Begins: USACE "Setting the Stage"		
9:00 – 9:45	Engineering with Nature (EWN) for Coastal Resilience – Application to NNBF	Bridges
9:45 – 10:30	Engineering Considerations for NNBF	Piercy/Welp/Bryant
10:30 – 10:45	Break	
Plenary Session Continues: NOS "Setting the Stage"		
10:45 – 11:15	Overview of NOAA/NOS Work with Linkages to Coastal Resilience and Natural and Nature-Based Solutions	Payne
11:15 – 11:45	Applying NOAA/NOS Coastal Intelligence to Inform Planning and Implementation of NNBF	Edwing
11:45 – 12:15	NOAA/NOS Science Supporting Coastal Resilience and NNBF	Erickson
12:15 – 1:00	Lunch Catered by Black Bean Company	All
1:00 – 1:15	Plenary: Introduction of Breakout Group Process	Marcy
1:15 – 3:15	Breakout Session 1 – Question 1 for All Groups (Walk to Hollings Marine Laboratory)	All
3:15 – 3:45	Break	
3:30 – 5:00	Plenary: Session 1 Report Out & Discussion of Results (15 mins per group including Q&A)	Marcy, Team POCs
5:00 – 5:15	Dinner Instructions & Adjourn Day 1	Marcy
5:15 – 8:00	Group Dinner in Downtown Charleston	

March 2

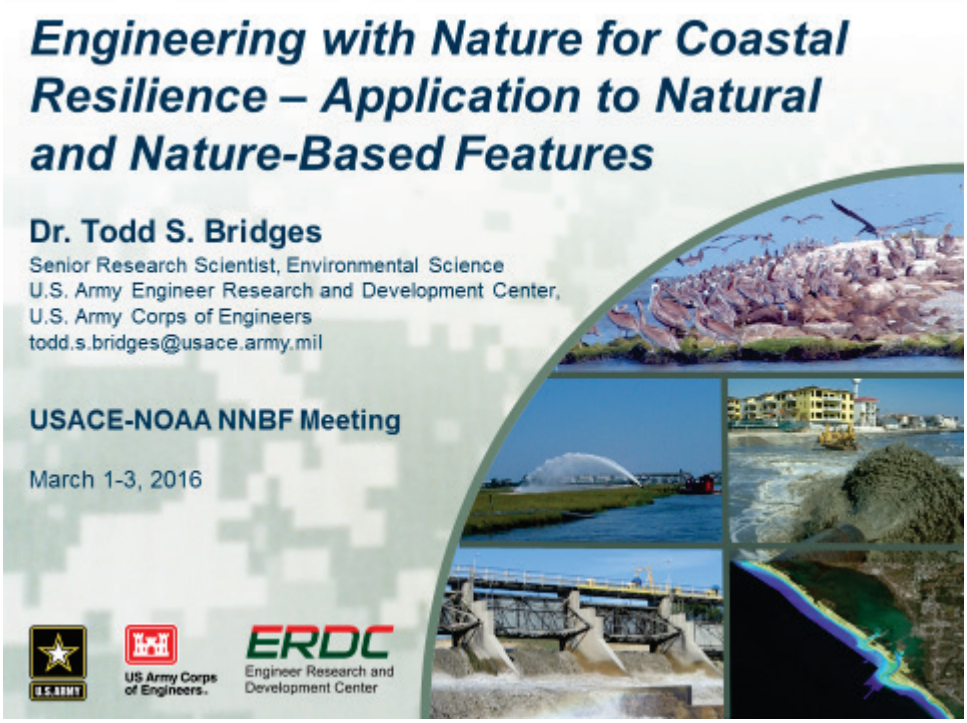
Time	Action	Lead or Speaker
7:30 – 8:00	Arrive at CCEHBR Laboratory	All
8:00 – 8:30	Plenary: Plan for Day 2 & Instructions for Breakout Session 2	Marcy
8:30 – 10:15	Breakout Session 2 – Question 2 for all Groups (Walk to Hollings Marine Laboratory)	All
10:15 – 10:30	Break	
10:30 – 11:45	Plenary: Session 2 Report Out & Discussion of Results (15 mins per group including Q&A). Assign lead group for duplicative ideas.	Marcy, Team POCs
11:45 – 12:00	Plenary: Instructions for Breakout Session 3	Marcy
12:00 – 2:15	Working Lunch (Catered by Panera Bread) & Breakout Session 3 – Question 3 for All Groups & Prioritization of Team Ideas (Walk to Hollings Marine Laboratory)	All
2:15 – 2:30	Break	
2:30 – 3:45	Plenary: Session 3 Report Out & Discussion of Results Plus Chart Posting of Prioritized List of Project Ideas from Each Team	Marcy, Team POCs
3:45 – 4:30	Plenary: Voting Exercise to Prioritize/Rank Top 4 Proposed Projects & Day 2 Recap	Marcy, All
4:30	Adjourn Day 2 (Dinner on your Own)	

March 3

Time	Action	Lead or Speaker
7:30 – 8:00	Arrive at CCEHBR Laboratory	All
8:00 – 8:15	Plenary: Plan for Day 3	Marcy
8:15 – 9:30	Plenary: Discussion of Prioritization Results	Marcy
9:30 – 9:45	Break	
9:45 – 11:00	Concurrent: Tour of HML for Most Attendees & Senior Leader Coordination Meeting	All – 2 Groups
11:00 -11:30	Plenary: Senior Leader Report Out	Bridges, King
11:30 – 11:45	Closing Thoughts & Next Steps	Bridges, King
11:45	Meeting Adjourns	

Appendix E: Introductory Plenary Presentations

Engineering With Nature for Coastal Resilience -Application to Natural and Nature-Based Features - *Dr. Todd Bridges*



Coastal Resilience is Serious Business: Lives are at Stake

Galveston Hurricane (1900)

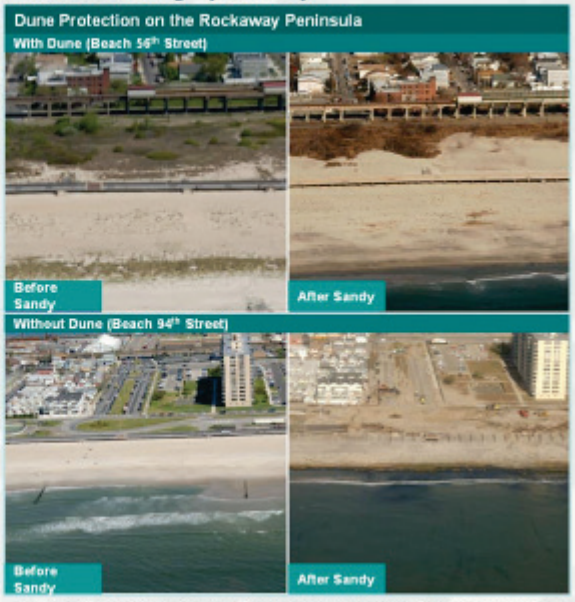
- Landfall 8 September 1900
- Estimated Category 4 Hurricane
  - ► 145 mph winds
- Estimated death toll: 6,000-12,000
- Galveston Seawall
  - ► Constructed:1902-1963
  - ► >10 miles long

Coastal Resilience is Serious Business: Lives are at Stake

Galveston Hurricane (1900)

- Landfall 8 September 1900
- Estimated Category 4 Hurricane
  - ► 145 mph winds
- Estimated death toll: 6,000-12,000
- Galveston Seawall
  - ► Constructed:1902-1963

Nature-Based Features Perform During Hurricane Sandy (2012)

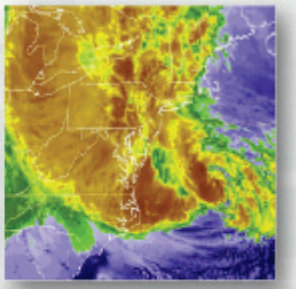


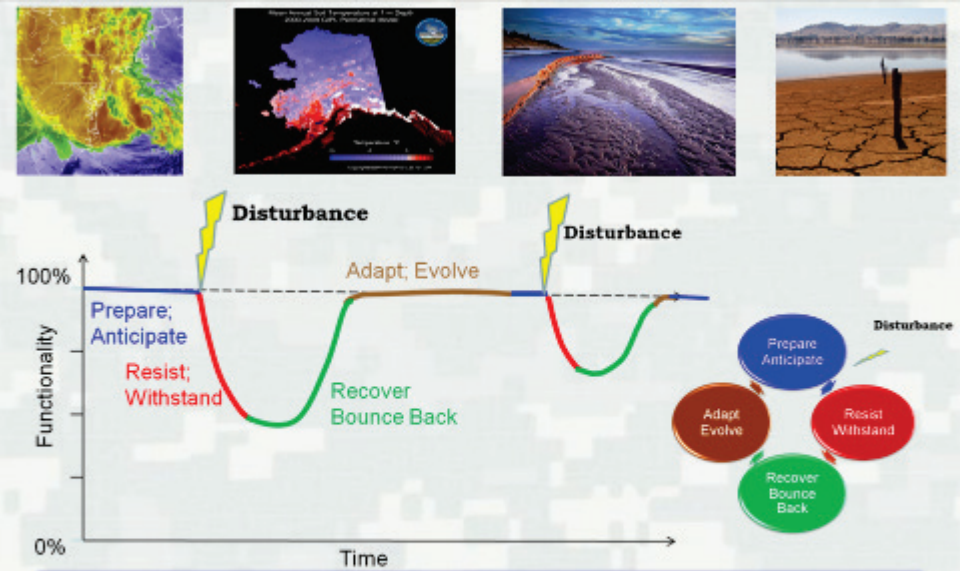
http://www.nyc.gov/html/sirr/html/report/report.shtml

Hurricane Sandy

Storm Impacts and Damages: 22-29 October 2012

- **Human**
  - 286 people killed (159 in the US)
  - 500,000 people affected by mandatory evacuations
  - 20,000 people required temporary shelter
  - Extensive community dislocations – continuing today in some areas
- **Economic**
  - $65B in damages in the U.S.
  - 26 states affected (10 states and D.C are in the NACCS study area)
  - 650,000 houses damaged or destroyed

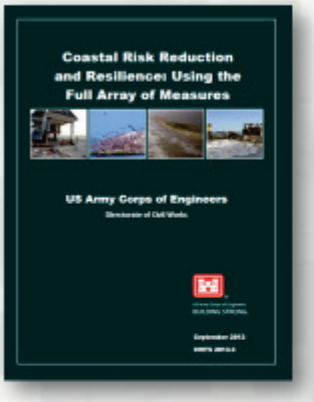


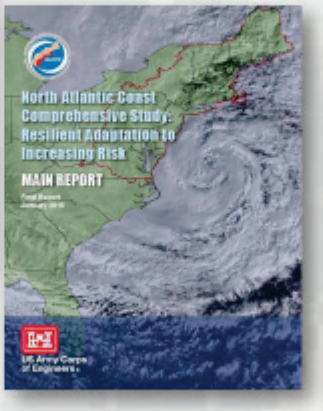


Resilience: the ability of a ***system*** to **Prepare for**, **Resist**, **Recover**, and **Adapt** to achieve functional performance under the stress of disturbances through time.

Engineering Performance: Nature-Based Features Work in Different Ways

The North Atlantic Coast Comprehensive Study



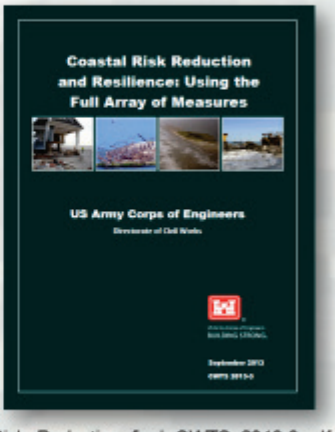


BUILDING STRONG®

http://www.nad.usace.army.mil/CompStudy

A Systems Approach: Coastal Risk Reduction and Resilience

"The USACE planning approach supports an ***integrated approach*** *to reducing coastal risks and increasing human and ecosystem community resilience through a combination of* ***natural, nature-based, non-structural and structural measures****. This approach considers the engineering attributes of the component features and the dependencies and interactions among these features over both the short- and long-term. It also considers the* ***full range of environmental and social benefits*** *produced by the component features."*



http://www.corpsclimate.us/docs/USACE_Coastal_Risk_Reduction_final_CWTS_2013-3.pdf

ERDC

BUILDING STRONG®

Innovative solutions for a safer, better world

Exploring nature-based solutions: the role of green infrastructure in mitigating the impacts of weather- and climate change-related natural hazards

- "…instead of automatically defaulting to grey solutions like dikes and pipes for flooding, we first should look at restoring floodplains or wetlands. Rather than building sea walls, we need to think about conserving sand banks…Planners should compare green to grey and identify new opportunities for investing in nature, including a combination of green and grey approaches when nature-based solutions alone are insufficient. As planners explore how to accommodate infrastructure demands in the future, the lesson is clear: think about green before investing in grey."

EEA Technical Report No 12/2015

ERDC

BUILDING STRONG®

Innovative solutions for a safer, better world

Caterpillar Corporation's *Restoring Natural Infrastructure Summit* 4 November 2015, New York City

ERDC

BUILDING STRONG®

Innovative solutions for a safer, better world

In the Context of Coastal Resilience…

- What opportunities are there for achieving better alignment of natural and engineered systems?
  - Can improved alignment reduce risks to life and property?
  - What range of services can be produced through such alignment?
  - What are the science and engineering needs in order to achieve better alignment?

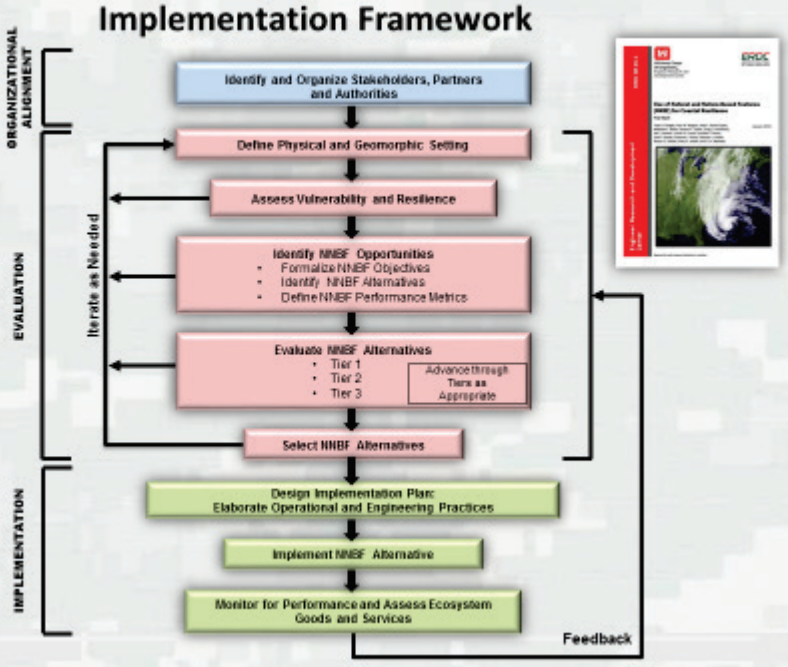
Sustainable Solutions Vision: "Contribute to the strength of the Nation through innovative and environmentally sustainable solutions to the Nation's water resources challenges."

ERDC

BUILDING STRONG®

Innovative solutions for a safer, better world

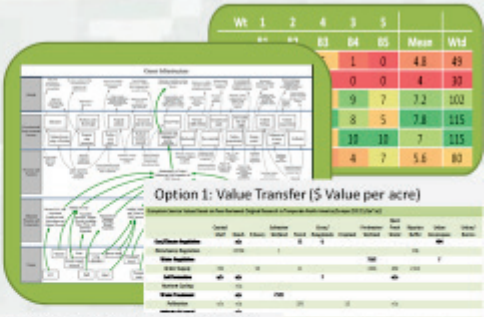
Natural and Nature-Based Features Evaluation and Implementation Framework



System Performance Evaluation

- **Level 1** – Qualitative characterization of performance
- **Level 2** – Semi-quantitative characterization of performance
- **Level 3** – Quantitative characterization of performance

72 individual performance metrics identified for NNBF



Option 1: Value Transfer ($ Value per acre)

Option 2: Ecosystem Production Functions

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North Atlantic Coast Comprehensive Study: Identifying NNBF Ecosystem Services

Metric	Average	Stdev	Max	Min	Relative Mean	Median	n
Reduce storm surge and related flooding	81.2	25.9	100	0	7%	95	47
Reduce wave attack	80.0	26.8	100	0	7%	90	47
Erosion protection and control	78.6	26.7	100	10	7%	85	47
Reduce the peak flood height and lengthen the time to peak flood	75.9	29.3	100	0	7%	90	47
Habitat for fish and wildlife provisioning	69.9	32.4	100	0	6%	80	47
Threatened and Endangered species protection	66.6	32.4	100	0	6%	80	47
Clean water provisioning	64.7	31.3	100	0	6%	75	47
Biological diversity	64.5	32.0	100	0	6%	70	47
Recreation	61.2	37.4	100	0	5%	60	47
Property value protection	60.0	33.3	100	0	5%	70	47
Reduce hazardous or toxic materials in water or landscape	59.9	32.3	100	0	5%	60	47
Nutrient sequestration or conversion	59.6	31.2	100	0	5%	60	47
Increase or maintain land elevation and land-building	59.2	32.8	100	0	5%	50	47
Education and scientific opportunities	49.1	31.3	100	0	4%	50	47
Commercial harvestable fish and wildlife production	48.7	32.8	100	0	4%	50	47
Aesthetics	47.6	28.8	100	0	4%	50	47
Provision and storage of groundwater supply	47.6	31.2	100	0	4%	50	47
Carbon sequestration	46.8	30.1	100	0	4%	50	47
Maintain background suspended sediment in surface waters	46.0	26.6	80	0	4%	50	47
Cultural heritage and identity	44.5	29.1	100	0	4%	50	47
Raw materials production	32.5	25.8	100	0	2%	30	47

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North Atlantic Coast Comprehensive Study (NACCS)

Case Studies from NNBF Report

1. Proof of concept analysis
   - Quantify benefits of environmental restoration projects using an ecosystem goods and services (EGS) analysis framework
2. Hurricane Sandy case study
   - Use extreme event to improve understanding of restoration effectiveness & benefits
3. Focused on two general types of services:
   - Flood damage Reduction
   - Wildlife Habitat (emphasis on T&E species)
4. 3 Study Sites
   - Jamaica Bay
   - Cape May Meadows
   - Cape Charles South

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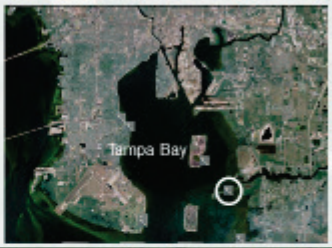
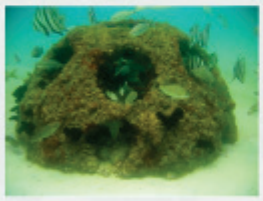
Alafia Banks Bird Sanctuary, FL

- 8000 lb reef module breakwaters (930 ft)
- Shore protection for Audubon bird sanctuary islands
- Help restore oyster populations
- Provide habitat





www.reefball.org

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Dutch Sand Engine

- 2011 construction
- 21.5 mcm of sand

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Fort Pierce City Marina

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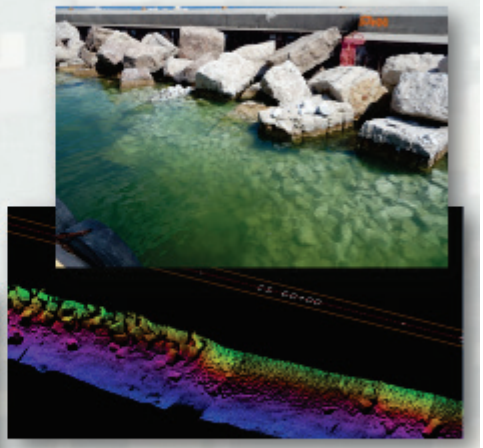
Example EWN Solutions: Green Breakwaters

Ashtabula Harbor

Milwaukee Harbor



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Coastal Dunes
Piha, New Zealand

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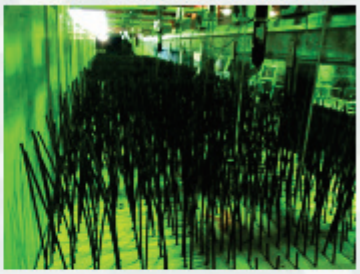
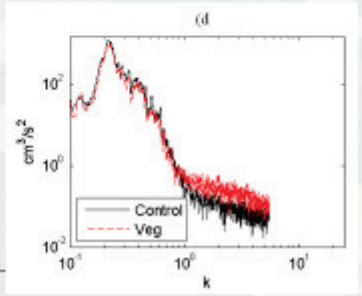
R&D Example: Engineering Performance of NNBF

- What are the engineering benefits of wetlands with respect to waves?
- Studies being performed in the 10 ft flume
  - Complemented with field studies
- Wave attenuation was found to:
  - increase with stem density
  - increase with submergence ratio
  - slight increase with incident wave height
- Sedimentation processes:
  - Reduced velocity, but increased turbulence





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Engineering With Nature…

…the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaborative processes.

Key Elements:

- Science and engineering that produces operational efficiencies
- Using natural process to maximum benefit
- Broaden and extend the benefits provided by projects
- Science-based collaborative processes to organize and focus interests, stakeholders, and partners

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www.engineeringwithnature.org

EWN Status

- *Engineering With Nature* initiative started within USACE Civil Works program in 2010. Over that period we have:
  - Engaged across USACE Districts (23), Divisions, HQ; other agencies, NGOs, academia, private sector, international collaborators
    - Workshops (>20), dialogue sessions, project development teams, etc.
  - Implementing strategic plan
  - Focused research projects on EWN
  - Field demonstration projects
  - Communication plan
  - District EWN Proving Grounds established
  - Awards
    - 2013 Chief of Engineers Environmental Award in Natural Resources Conservation
    - 2014 USACE National Award-Green Innovation

www.engineeringwithnature.org ERDC

Opportunities to *Engineer With Nature*

- **Key Factors, the 4 Ps**
  - Processes
    - Physics, geology, biology…
    - Foundation of "coastal engineering Jujitsu"
  - Programmatic context
    - Planning, engineering, constructing, operating, or regulating
  - Project scale
    - Individual property owner to an entire coastal system
  - Performance
    - Configuring the system
    - Quantifying the benefits

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EWN Action Demonstration Projects, 1

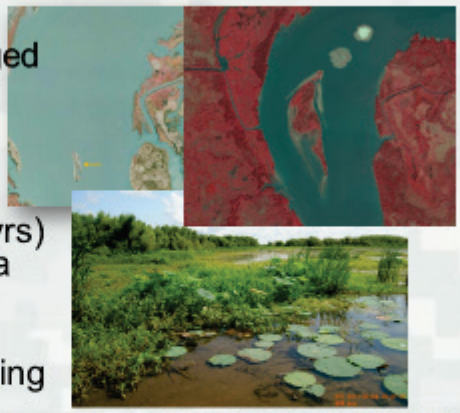
- Sediment Retention Engineering to Facilitate Wetland Development (San Francisco Bay, CA)
- Realizing a Triple Win in the Desert: Systems-level Engineering With Nature on the Rio Grande (Albuquerque, NM)
- Atchafalaya River Island and Wetlands Creation Through Strategic Sediment Placement (Morgan City, LA)
- Portfolio Framework to Quantify Beneficial Use of Dredged Material (New Orleans and New England)
- Engineering Tern Habitat into the Ashtabula Breakwater (Ashtabula, OH)
- Living Shoreline Creation Through Beneficial Use of Dredged Material (Duluth, MN)
- A Sustainable Design Manual for Engineering With Nature Using Native Plant Communities

EWN Action Demonstration Projects, 2

- Landscape Evolution of the Oil Spill Mitigation Sand Berm in the Chandeleur Islands, Louisiana
- Guidelines for Planning, Design, Placement and Maintenance of Large Wood in Rivers: Restoring Process and Function (Collaboration with BoR)
- The Use and Value of Levee Setbacks in Support of Flood Risk Management, Navigation and Environmental Services (a strategy document)
- Strategic Placement of Sediment for Engineering and Environmental Benefit (an initial guide to opportunities and practices)
- Use of Activated Carbon to Manage Contaminant Exposures Associated with Open-Water Placement

Horseshoe Island EWN Project
Atchafalaya River

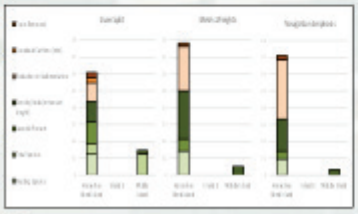
- Options for managing dredged material via shore-based wetland creation were exhausted
- Strategic placement of sediment (0.5-1.8 mcy/1-3 yrs) was used to create a ~35 ha island
- Producing significant environmental and engineering benefits
- Project won WEDA's 2015 Award for Environmental Excellence



Using Dredged Material Best Practices and Nature to Create River Island Habitat in Coastal Louisiana, USA

Approach

1) **Generate** a short list of EGS
2) **Develop metrics** to quantify the EGS benefits using readily available data
   - Species-based
   - Hydrological
   - Landscape-level
3) **Calculate** and **compare** benefits from Horseshoe Island vs. control sites (both natural and artificial)
4) **Develop** and **apply** a tool to perform tradeoffs transparently



Ecosystem Goods and Services	Description	Potential Metrics
Habitat Value	The maintenance of ecosystems' structural and functional qualities and resilience to adapt to change over time. Includes all non-use or passive use services (existence, intergeneration bequest, or altruistic values) derived from the diversity or condition of species, or ecosystems.	acres of habitat added
Water Treatment & Purification	The filtration and renewal of excess nutrients or pollutants by ecosystems from inland, coastal or marine waters.	mass of nitrogen absorbed by the created landscape, that would otherwise pass downstream
Carbon Sequestration	Ecosystem moderation of adverse climate effects through sequestration of greenhouse gases.	difference in kg of carbon contained at the site before and after placement
Recreation Opportunities	Quantity and quality of recreational opportunities.	annual visits for fishing opportunities
Natural Hazard Mitigation	Ecosystem reduction of risk of or vulnerability to natural hazards that threaten property, infrastructure, human safety, or natural resources. Threats include storms, floods, landslides, fires and droughts.	incremental difference in property risk from flooding
Human Health	Ecosystem reduction of the risk of or vulnerability to health hazards other than water quality. Includes changes in air quality, environmental stressors, and animal or insect disease vectors.	value of incremental change in health for people benefitting from hazard mitigation
Cultural, Spiritual & Educational Support	Maintenance of opportunities arising from sites and landscapes that have spiritual or religious significance, contribute to a 'sense of place,' or sustain cultural heritage, including traditional ways of life. Also includes opportunities for scientific discovery and education.	number of classes visiting the site annually
Navigation Maintenance	Ecosystem maintenance and regulation of unobstructed transport of goods and people provided by water bodies.	change frequency of necessary dredging
Raw Goods & Materials Provisioning	Provisioning of or contribution to raw goods and materials.	value of annual harvest
Food Provisioning	Provisioning of or contribution to commercial or subsistence production of food and the ecosystem conditions that support it	value of additional fish resulting from creating of spawning grounds

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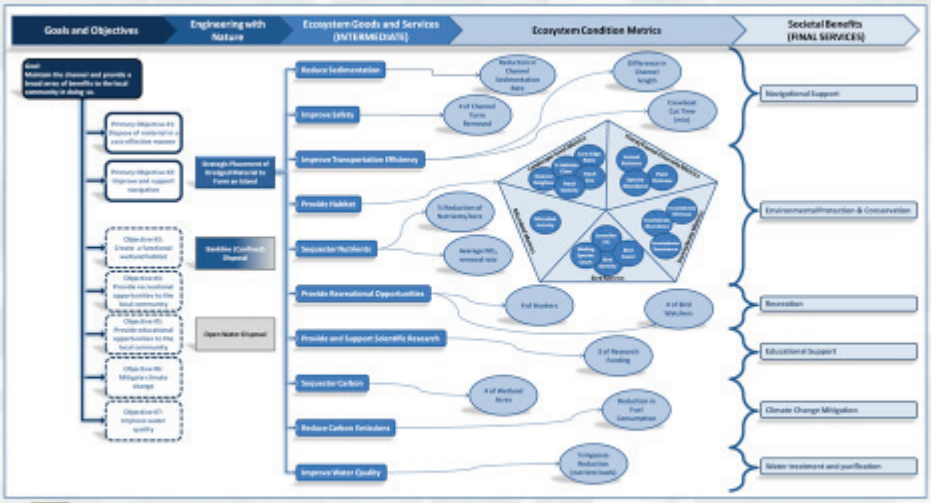
Ecosystem Services Causal Chain



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USACE Galveston, Buffalo, Philadelphia Districts: EWN "Proving Grounds"

- EWN Proving Ground Kick-Off Workshops
  - October (SWG) and December (LRB) 2014
  - ~70 participants
  - SWG, SWD, LRB, ERDC, IWR and HQ
- Identified opportunities to implement EWN within current and future programs and projects
- Emphasis on solution co-development

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Coastal NJ, Philadelphia District

December 2014

Stone Harbor

Avalon

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US Fish and Wildlife Service
Forsythe National Wildlife Refuge

- Forsythe NWR: >40,000 acres of wetlands and other habitat in coastal NJ
- Collaboration objective: Enhance ecosystem resilience through engineering and restoration
- Means: Smart use of sediment resources and EWN principles and practices

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Thin-Layer Placement Website

Coming soon to
www.engineeringwithnature.org

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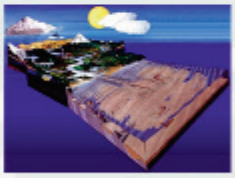
Regional Sediment Management…

…a systems approach to deliberately manage sediments in a manner that maximizes natural and economic efficiencies to contribute to sustainable water resource projects, environments, and communities.

- Recognizes sediment as a valuable resource
- Regional strategies across multiple projects and business lines guide investments to achieve long-term economic and environmental value and benefits
- Enhances relationships with stakeholders & partners to better manage sediments across a region (local actions with regional benefits)
- Share data, tools, technology, and lessons learned



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Science, Engineering, Technology Research Targets

- Fundamental processes
  - Sediment transport through and around NNBF
  - Long-term engineering and environmental performance of features
  - Environmental Services provided by engineered features and structures
  - Processes contributing to system-scale resilience
- Modeling systems that support broad-scale application
  - Planners, stakeholders and decision-makers
  - Engineering design
  - Operations and maintenance
- Reliable, cost-efficient monitoring technologies
  - Measuring system evolution
  - Infrastructure/feature performance
- Demonstration/pilot projects to innovate, evaluate, and learn at relevant field scales
  - Facilitate necessary collaboration
  - Evolve organizational culture and practice
  - Produce credible evidence of success
  - Fuel the "power of the story"

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Next Steps for Science and Engineering…

- How will integrated infrastructure systems evolve over time in dynamic coastal environments?
- What processes and engineering requirements are critical to performance?
- How can integrated systems be assembled to reduce long-term operations and maintenance?
- How can field-scale demonstration projects be used to accelerate progress?

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High Points

- Conservation of existing natural infrastructure can support future resilience
  - Incentivizing and financing
- Development of new nature-based features can enhance system resilience
  - Incentivizing and financing
- Elevate communication about advancing practice
- Accelerate progress through co-development of solutions
  - Across government
  - Between government and industry
  - Among government, industry, academia, and NGOs

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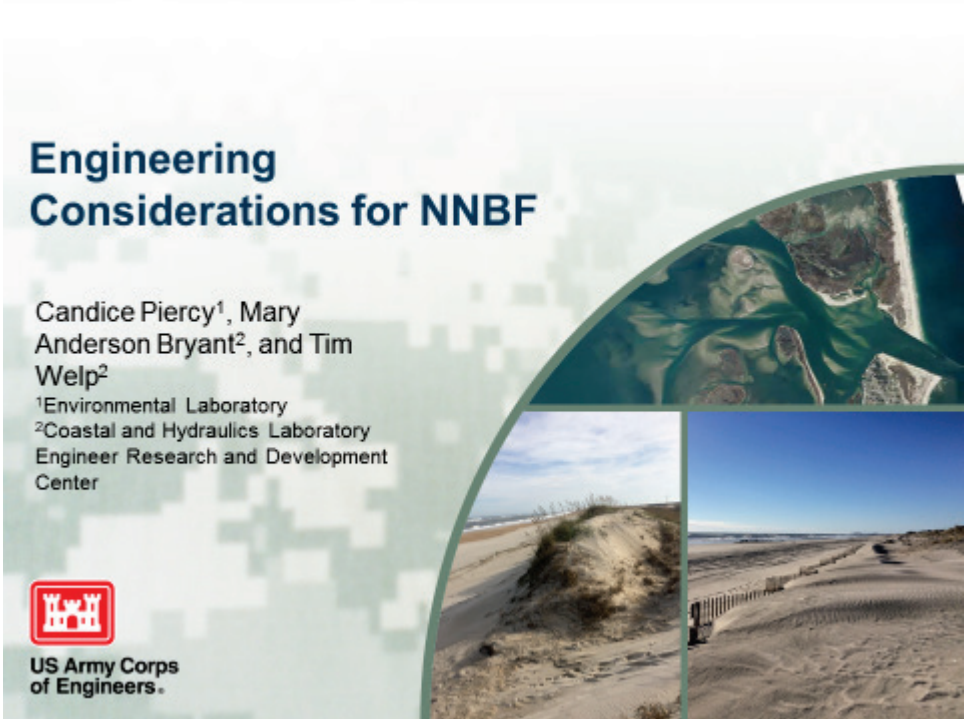
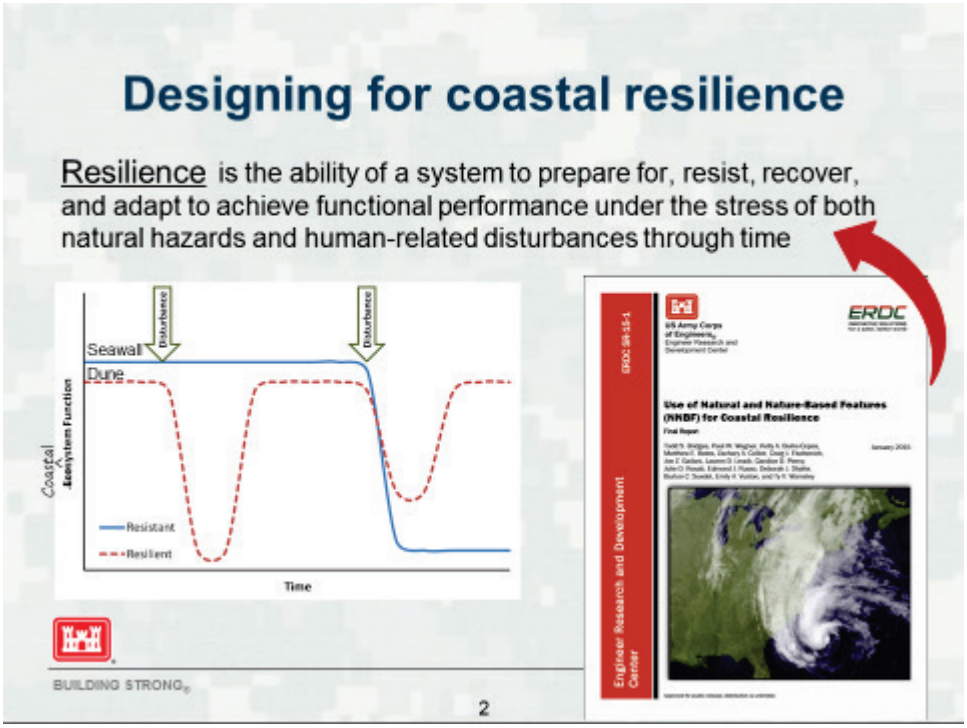
Engineering Considerations for NNBF - *Dr. Candice Piercy, Mary Bryant and Tim Welp*





Engineering design must account for ecosystem function

Structural engineering approach

Traditional engineering deals with uncertainty by employing a margin of safety such as extra freeboard in levee design

Ecological engineering approach

Increasing the height of a constructed marsh to add freeboard will convert the site to an upland that will not function as a marsh

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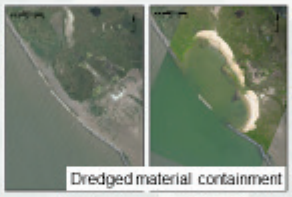
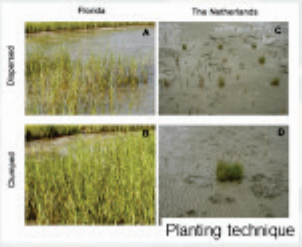
Cross-cutting project: developing NNBF engineering guidance

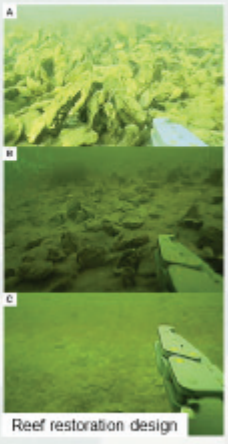
Dunes

Wetlands





Oyster Reefs



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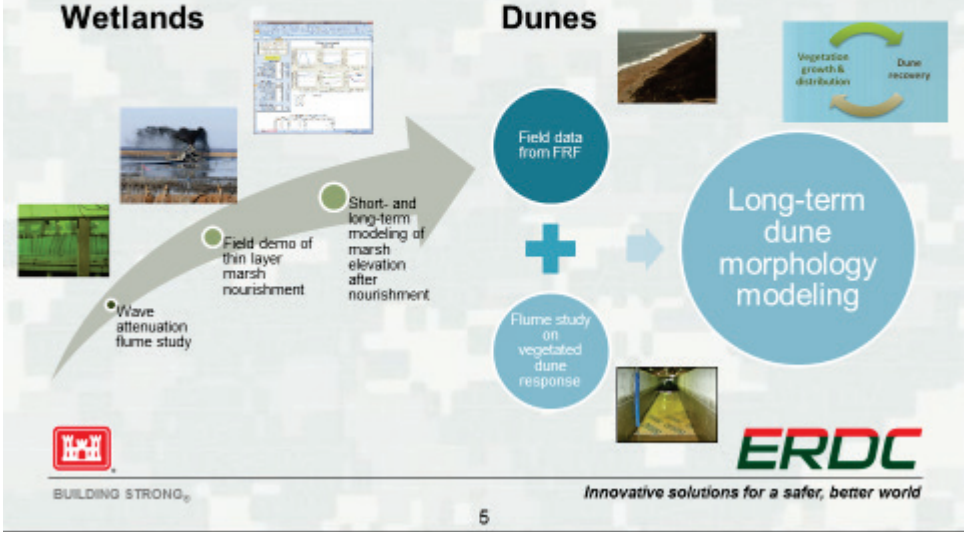
ERDC is trying to fill in the gaps with lab and field studies as well as modeling



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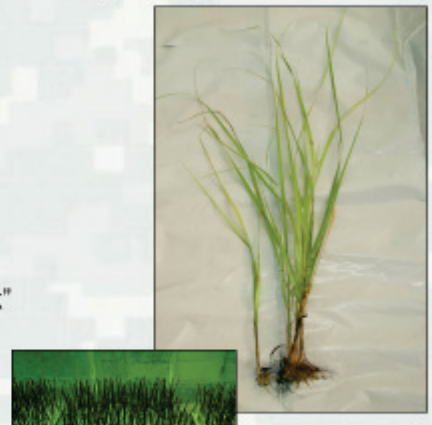
M. A. Bryant and J.M. Smith
Mary.Bryant@usace.army.mil

Wave Attenuation by Vegetation

- investigate the interactions between water waves and wetland plants
- interested in smooth cordgrass (*Spartina alterniflora*)
  - dominant emergent grass species along Atlantic and Gulf of Mexico
- idealized *S. alterniflora* constructed of polyolefin "shrink" tubing
  - flexible under wave action
  - readily available
  - modulus of elasticity and and diameter close to values reported in literature



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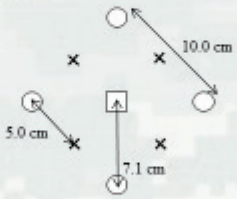
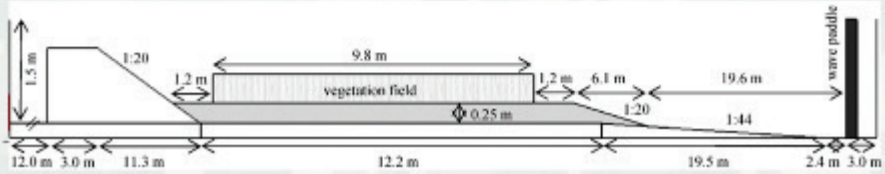
Source: http://plants.usda.gov

Laboratory Setup

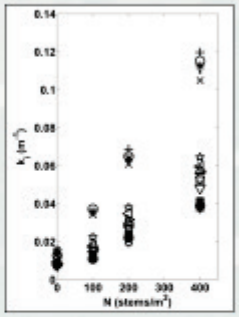
- CHL wave flume
  - 64.1 m long, 1.5 m deep, 1.5m wide
- 9.8 m vegetation field
  - 100, 200, and 400 stems/m^2
- instrumentation
  - 13 wave gauges
  - 4 ADVs
- wave conditions
  - irregular waves

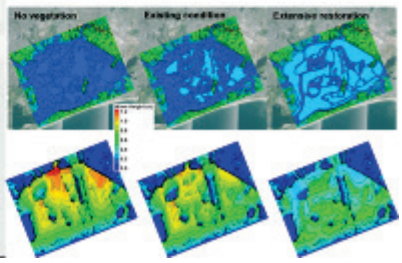




Results and Conclusions

- wave attenuation was found to:
  - increase with stem density
  - decrease with deeper water
  - slightly increase with incident wave height
  - trend with wave period unclear
- application of vegetation in spectral wave model STWAVE shows significant reductions in wave height on project scales
  - resiliency of vegetation?
  - does the benefit justify the cost compared to other shore protection measures?
  - permanence of constructed wetlands?





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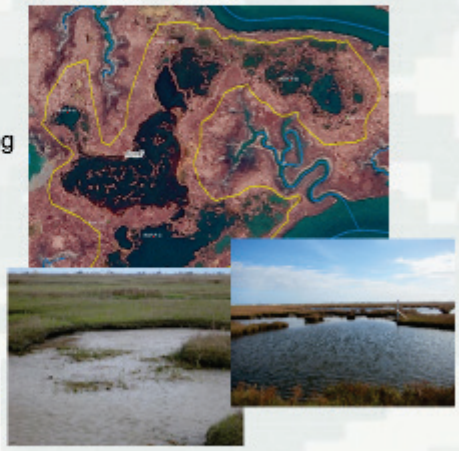
Marsh nourishment with thin-layer application of dredged material

M. Chasten, C. Piercy, T. Welp, D. Golden, M. Yepsen, J. Jahn

- Degraded salt marshes in NJ
  - Edge erosion and subsidence
  - Loss of vegetation
  - Increase in pannes and pools
- Partnered to improve our understanding of science and engineering of marsh restoration with DM
- Additional work with E.B. Forsythe National Wildlife Refuge



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US Army Corps of Engineers
Philadelphia District

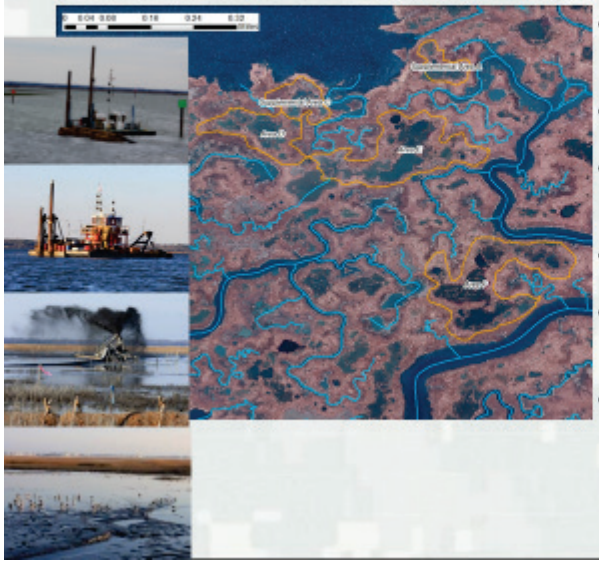
The Nature Conservancy
Protecting nature. Preserving life.

GreenVest

9

Avalon, NJ: design and construction

M. Chasten, C. Piercy, T. Welp, D. Golden, M. Yepsen, J. Jahn



- NAP Post-Sandy emergency dredging of NJIWW federal channel
- ~6 acre pilot constructed Dec 2014
- ~ 35 acres of marsh received DM between Nov 2015 and Feb 2016
- Thicknesses ranged from just a few cm up to ~0.5 m in pools
- Defined target elevation based on vegetation community surveys
- Placed within hydrologically isolated areas on the marsh

Avalon, NJ: monitoring recovery

M. Chasten, C. Piercy, T. Welp, D. Golden, M. Yepsen, J. Jahn

- Before-after control-impact monitoring design
  - Water levels (NFWF partners/ERDC)
  - Soil physical and biogeochemical properties (ERDC)
  - Vegetation and infaunal communities (NFWF partners)
- Will implement similar monitoring scheme at Seal Beach NWR, CA and Narrow River, RI

October 2014

May 2015

Thin-layer in wetlands: Bulking Factor & Consolidation

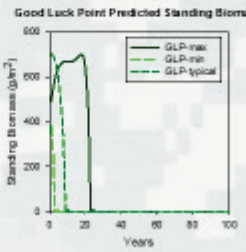
T. Welp, S. Bailey, P. Schroeder

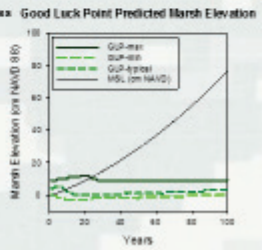
- Appropriate elevation is critical to a successful marsh.
- If material is hydraulically placed, elevation changes over time.
- Elevation change can be modeled.
  - Maximum volume: at end of placement
  - Elevation subsides during primary settling and drainage of ponded water (SETTLE)
  - Long term: consolidation of dredged material and underlying foundation (PSDDF).

Predicting marsh response to DM application long term

C. Piercy, J. Morris, C. VanZomeren, T. Swannack, P. Schroeder

- Marsh Equilibrium Model projects future conditions based on known interactions between biomass and accretion
- Developed at University of South Carolina by Dr. James Morris
- Goal: use MEM to predict the response of marshes to thin-layer and other episodic sediment deposition events





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Leveraging Field Research Facility data to improve model performance

Monthly evolution of an eroding & prograding dune system

K. Brodie, N. Spore

Above- and belowground biomass sampling

C. VanZomeren, D. Evans

Validation dataset for integrated dune morphology model

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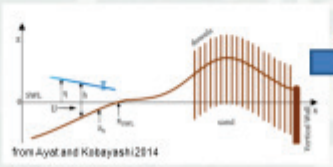
The effect of vegetation during storms: how important is it?

D. Bryant, M. Bryant, A. Priestas, C. Piercy

- Goal: quantify the effects of above- and below-ground biomass on dune erosion during collision and overwash
- Developing series of flume experiments with simulated vegetation
- Will inform how coastal morphology models handle erosion of vegetated dunes



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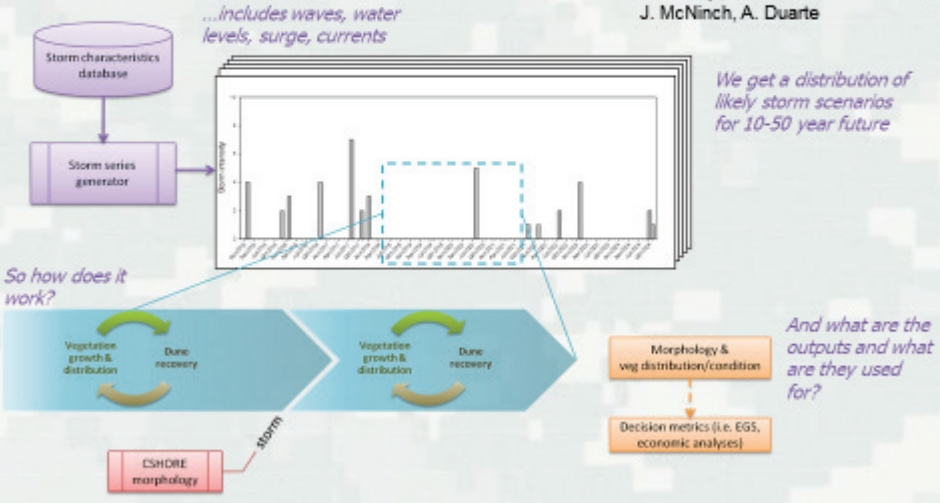
ERDC

Innovative solutions for a safer, better world

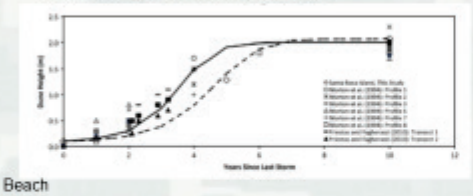
Integrating morphology and ecological modeling to better predict dune response and recovery

C. Piercy, B. Johnson, T. Swannack, J. McNinch, A. Duarte



Modeling the role of vegetation for dune recovery

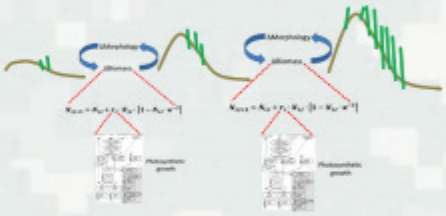
Dune recovery response mimics vegetation growth patterns



Beach recovery

- Bare sand to early successional species
- Establishment and growth of dune-building species
- Transition to mature dune vegetation community

Vegetation biomass enhances dune growth



time

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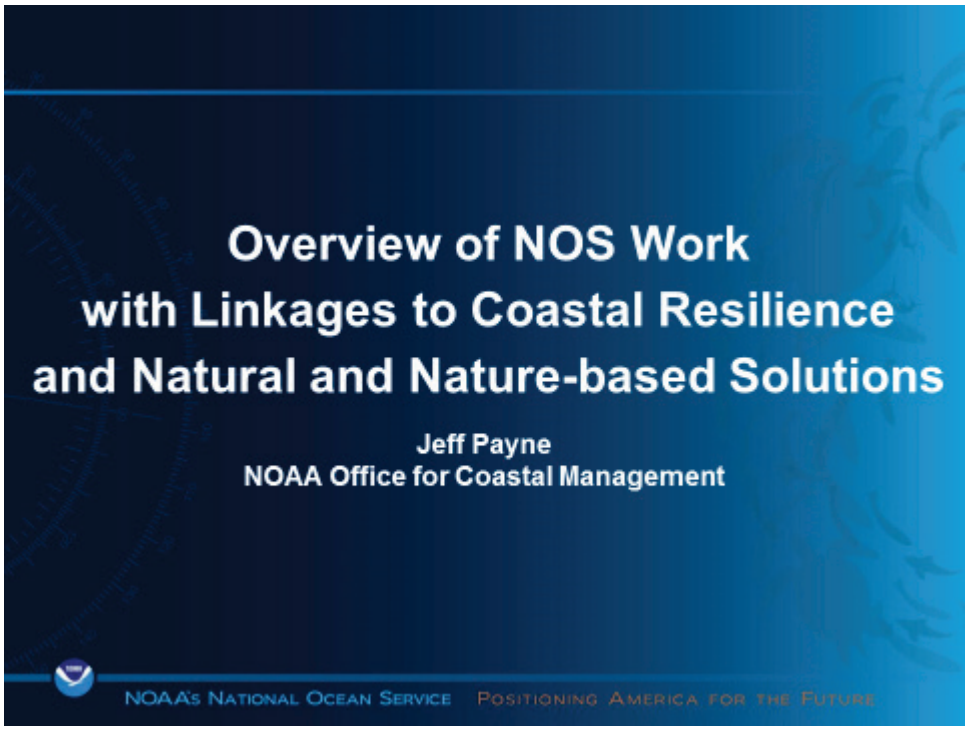
17

Engineering Challenges and Opportunities

1. Appropriate design criteria and performance metrics (beyond survivability)
2. Quantifying costs and benefits (engineering, ecosystem, and social)
3. Designing for constructability
4. Communication (successes, failures, and emerging opportunities)
5. Multidisciplinary collaboration
6. Scaling (lab to project to shoreline to coast)
7. Interaction of multiple features within a system
8. Standardized methodologies/metrics for measurement, analysis, and monitoring

18

Overview of NOS Work with Linkages to Coastal Resilience and Natural and Nature-Based Solutions - *Dr. Jeff Payne, Dr. Richard Edwing and Dr. Mary Erickson*



A Very Real Need

NOAA National Ocean Service

Meeting the nation's coastal management needs

- Coastal Resilience: preparing, responding, recovering
- Coastal Intelligence: informing
- Place-based Conservation: preserving

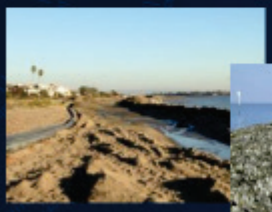
NOAA's National Ocean Service Positioning America for the Future

Natural and Nature-based Solutions

- Valuable approaches for reducing flood hazards
- Increase resilience
- Reduce risk

NOAA's National Ocean Service Positioning America for the Future

Multiple Approaches, Multiple Services



Dune or Oyster
Reef Restoration

NOAA's National Ocean Service Positioning America for the Future

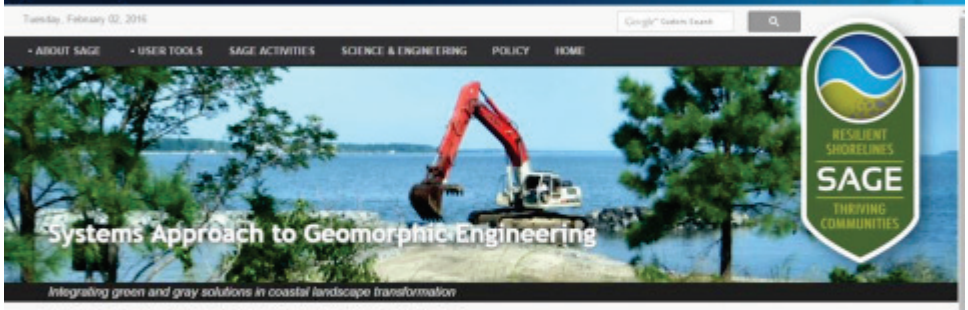

OFFICE FOR COASTAL MANAGEMENT
Coastal Green Infrastructure
URBAN FORESTRY
FORESTED WETLAND
OPEN SPACE
COASTAL WETLANDS
LIVING SHORELINE
SAND DUNES
OYSTER BEDS AND SEA GRASSES
GREEN ROOF
CORALS


Partnerships are Critical
NOAA's National Ocean Service
Positioning America for the Future

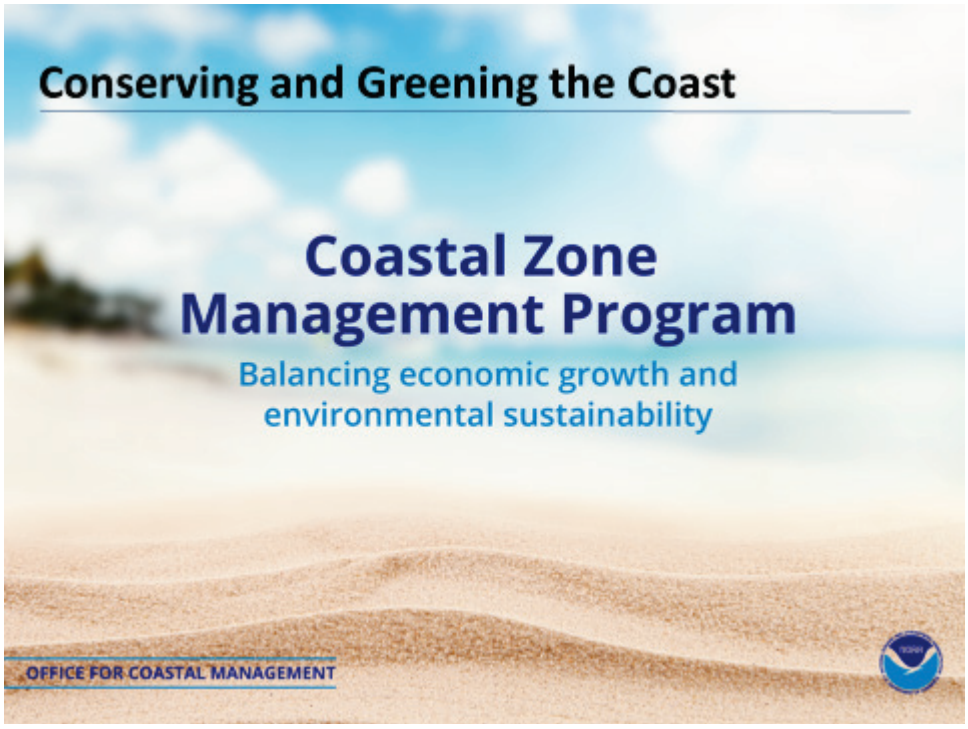
Diverse Needs

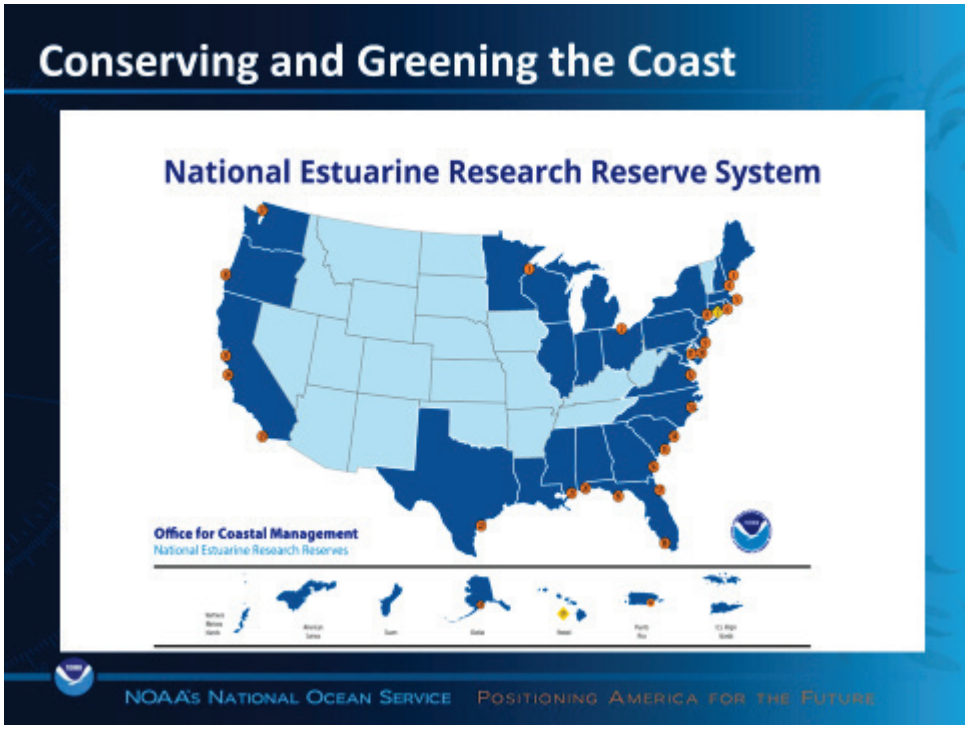
NOAA's National Ocean Service Positioning America for the Future

SAGE - Community of Practice



NOAA's National Ocean Service Positioning America for the Future


Conserving and Greening the Coast
Coastal Zone Management Program
Balancing economic growth and environmental sustainability
OFFICE FOR COASTAL MANAGEMENT


Conserving and Greening the Coast
National Estuarine Research Reserve System
Office for Coastal Management
National Estuarine Research Reserves
NOAA's National Ocean Service
Positioning America for the Future

Digital Coast – What Makes it Work

Focus on coastal management community

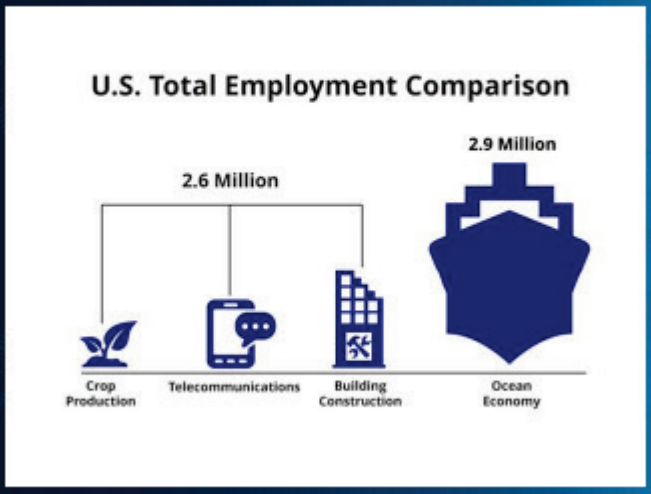
Full suite of helpful data, tools, training, and resources

DIGITAL COAST PARTNERSHIP

NOAA's National Ocean Service Positioning America for the Future

Data

The U.S. Ocean and Great Lakes Economy is large



NOAA's National Ocean Service Positioning America for the Future

Data

COASTAL LAND COVER AND LAND CHANGE DATA

1,535 square miles | 23,274 square miles
5,726 square miles

65,000 square miles

Coastal Land Cover and Land Change Data

National inventory of land cover and change

Added focus on coastal detail and change
- NOAA maps 25% of contiguous U.S.
- Coastal area accounts for
  - 66% of all wetlands
  - 41% of all development
  - 44% of all change (2001-2010)
- Detailed wetlands and change mapping
- Higher resolution in Pacific and Caribbean

Coastal Land Cover and Land Change Data

Coastal Land Cover Applications

Interagency Coastal Wetlands Workgroup

Land Cover Atlas
coast.noaa.gov/digitalcoast/tools/lca

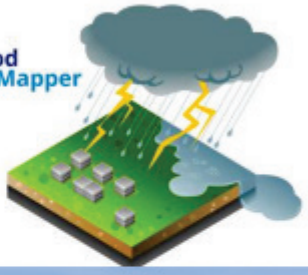
Sea Level Rise Viewer
coast.noaa.gov/digitalcoast/tools/slr

NOAA's National Ocean Service Positioning America for the Future

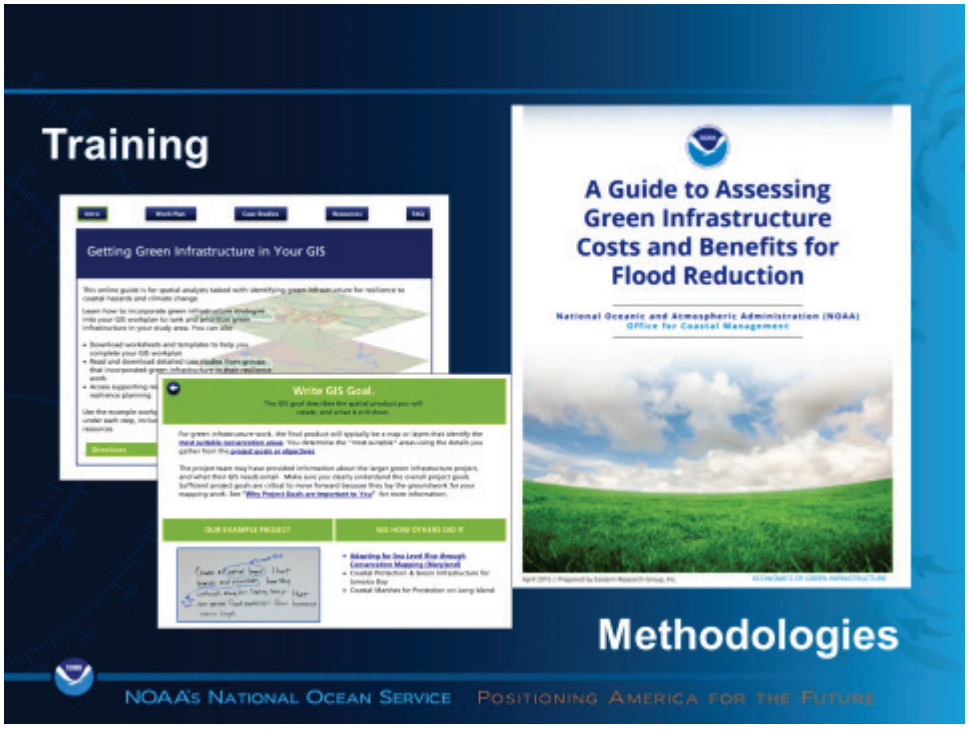
Tools

Coastal County Snapshots

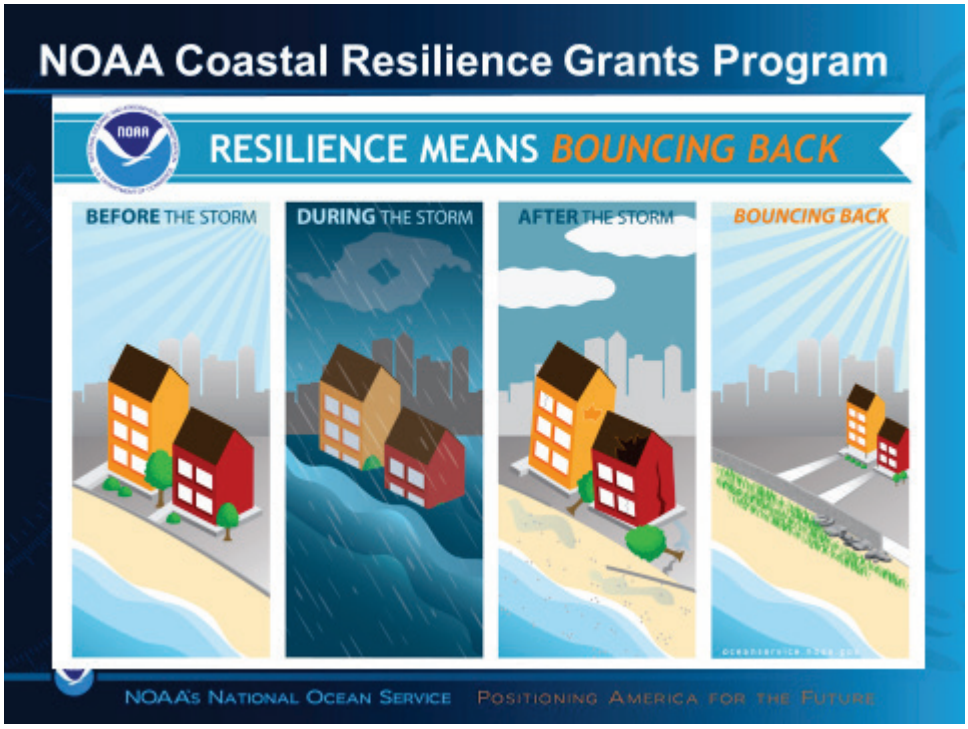
Coastal Flood Exposure Mapper

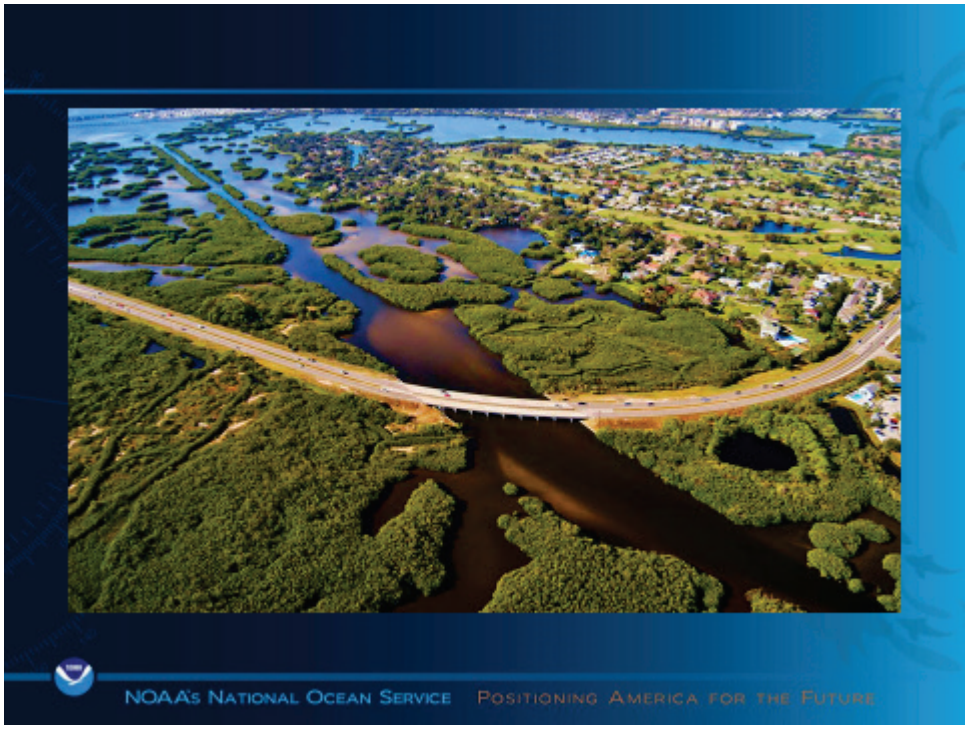


OpenNSPECT


Training
Getting Green Infrastructure in Your GIS
Write GIS Goal.
A Guide to Assessing Green Infrastructure Costs and Benefits for Flood Reduction
National Oceanic and Atmospheric Administration (NOAA)
Office for Coastal Management
Methodologies
NOAA's National Ocean Service
Positioning America for the Future

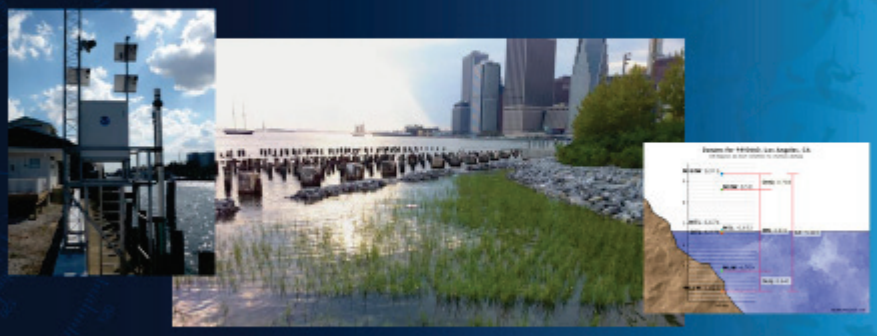

NOAA Coastal Resilience Grants Program
• Nature based solutions
• Geospatial data and tool development
• Economic research
NOAA's National Ocean Service
Positioning America for the Future


NOAA Coastal Resilience Grants Program
RESILIENCE MEANS BOUNCING BACK
BEFORE THE STORM
DURING THE STORM
AFTER THE STORM
BOUNCING BACK
NOAA's National Ocean Service
Positioning America for the Future


NOAA's National Ocean Service
Positioning America for the Future

NOAA's National Ocean Service

Applying NOAA NOS Coastal Intelligence to inform planning and implementation of NNBF

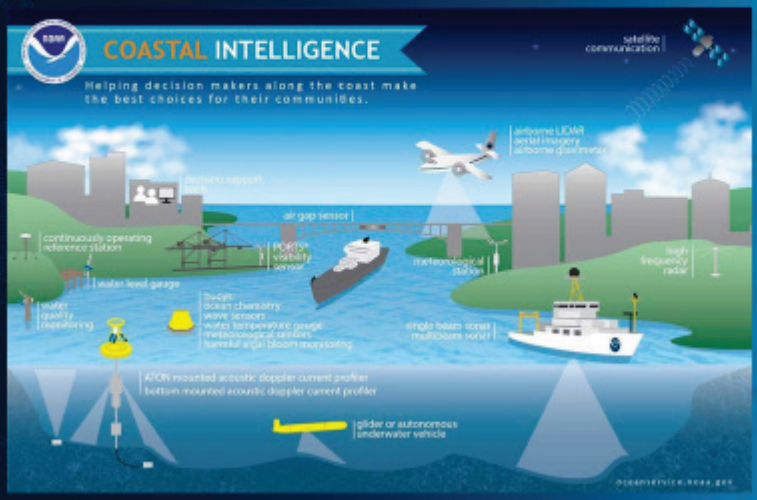


Richard Edwing, Director
Center For Operational Oceanographic Products and Services

NOAA's National Ocean Service Positioning America for the Future

NOS Coastal Intelligence

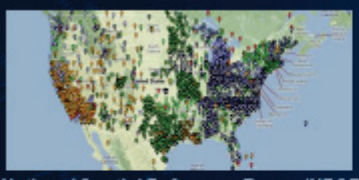
Advancing resilience and natural infrastructure



NOAA's National Ocean Service Positioning America for the Future

NOS Coastal Intelligence

Advancing resilience and natural infrastructure



National Spatial Reference Frame (NRSF)

System-Wide Monitoring Program (SWMP)

National Water Level Observation Network (NWLON)

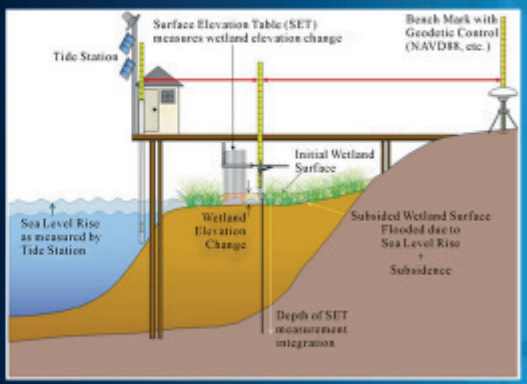
Remote Sensing

NOAA's National Ocean Service Positioning America for the Future

Applying Coastal Intelligence to NNBF

Advancing resilience and natural infrastructure

NOAA Sentinel Sites

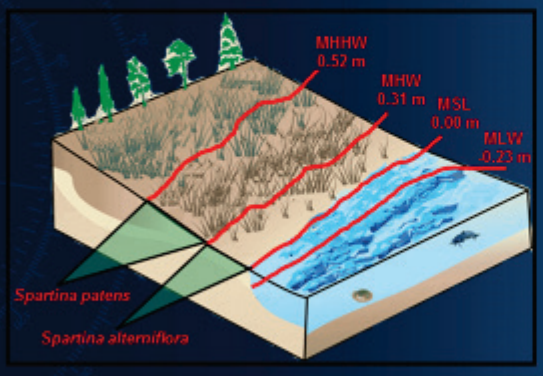


Sentinel Station Cross Section

NOAA's National Ocean Service Positioning America for the Future

Applying Coastal Intelligence to NNBF

Advancing resilience and natural infrastructure

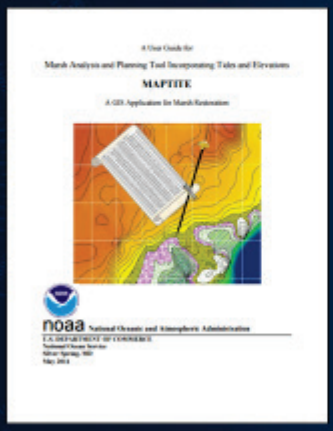


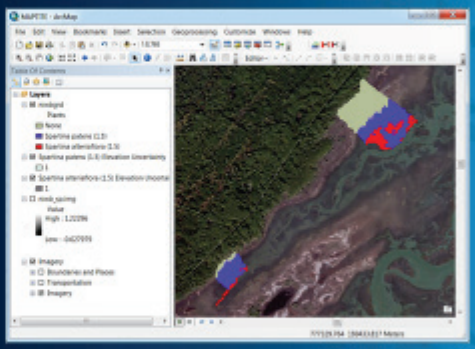
Establishing water and land based datums to support Nature Based Infrastructure

NOAA's National Ocean Service Positioning America for the Future

Applying Coastal Intelligence to NNBF

Advancing resilience and natural infrastructure



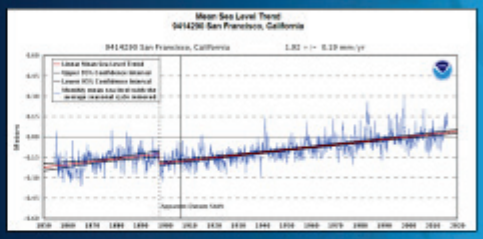


Marsh Analysis and Planning Tool Incorporating Tides and Elevations (MAPTITE)

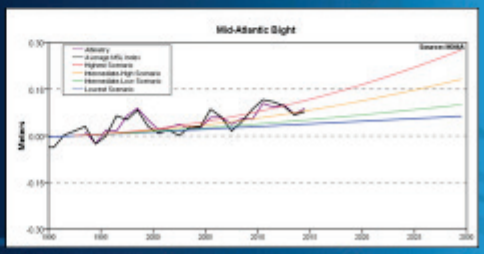
NOAA's National Ocean Service Positioning America for the Future

Applying Coastal Intelligence to NNBF

Advancing resilience and natural infrastructure



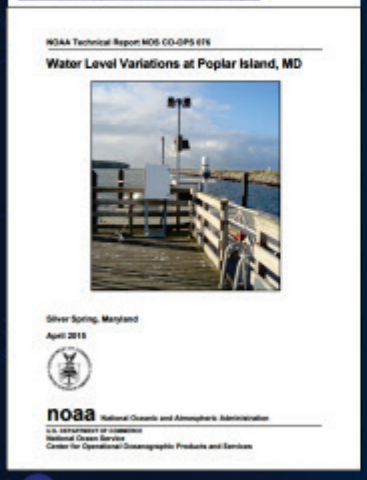
Provide current and future trends to ensure long term project viability



Examples of NOS-USACE Collaboration

Advancing resilience and natural infrastructure

http://tidesandcurrents.noaa.gov/publications/NOAA_Technical_Report_NOS_COOPS_076.pdf


NOAA Technical Report NOS CO-OPS 076

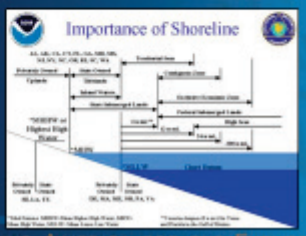
Water Level Variations at Poplar Island, MD

Silver Spring, Maryland

April 2015

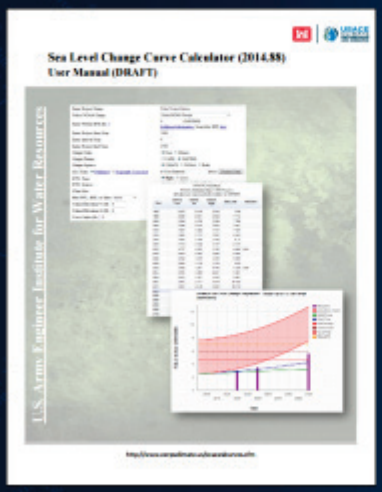
noaa National Oceanic and Atmospheric Administration

- Supporting USACE with adoption of national tidal and geodetic datums through engineering regulations and circulars and applying them to national infrastructure investments
- Poplar Island Water Level Variation Study
- Leveraging work to advance airborne lidar and coastal mapping and charting technology and applications and maintaining the National Shoreline



Examples of NOS-USACE Collaboration

Advancing resilience and natural infrastructure



- Supporting the development of the sea level and extreme water level technical letters.
- Providing input and extreme water level statistical analysis to support the development of the USACE Sea Level Change Curve Calculator

Coastal Intelligence Partnerships

Advancing resilience and natural infrastructure

- A growing need for common standards, particularly around water level information for use primarily for SLR and extreme events
- NOS has been fostering partnership with Federal Agencies, move forwards on outlining data standards and looking at monitoring through tiered data perspective
- USACE and NOAA have already made progress with sharing common standards.

Science Supporting Coastal Resilience and Natural and Nature-based Features

Mary Erickson
Director, National Centers for Coastal Ocean Science

USACE/NOAA-NOS Collaboration Workshop on Natural and Nature-Based Features
March 1-3, 2016

Overview

- NOS Science Approach
- Core NNBF Science Capabilities
- Emerging Opportunities

NOS Science Approach

- Science to inform coastal preparedness for coastal storms, hazards, and the effects of climate change
- Internal and External science capacity
  - Competitive science programs
  - National Estuarine Research Reserve System Science Collaborative

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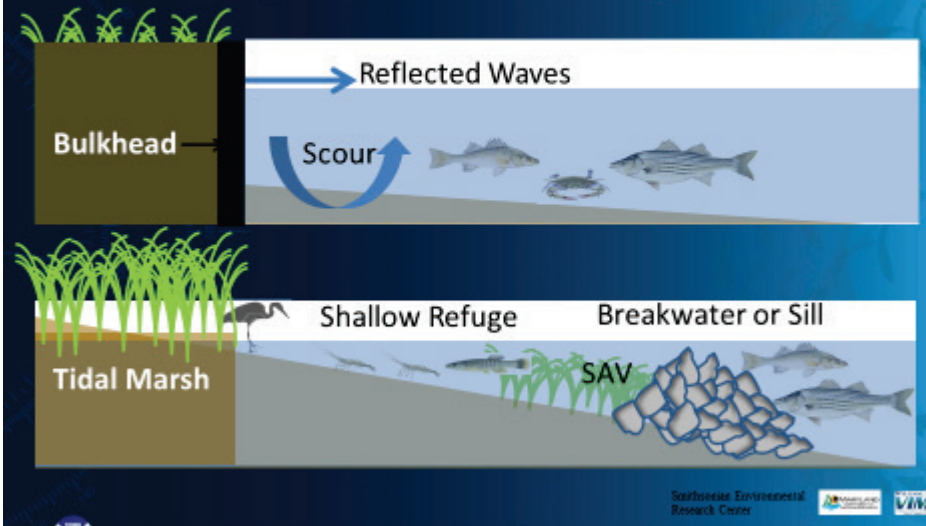
Applied Science

What are the impacts of shoreline hardening?



Southeast Environmental Research Center

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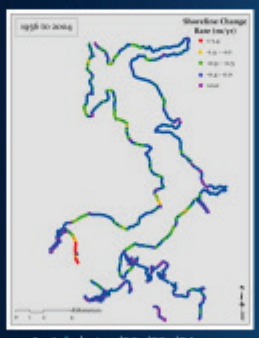
Applied Science

Where are marshes most resilient to erosion?

Estuary Shoreline

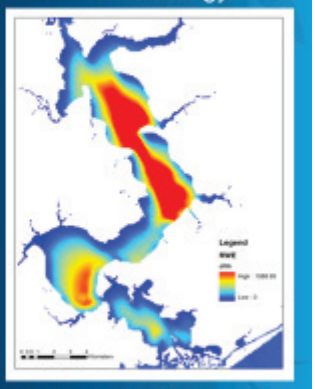
Mapped from small boat

Erosion Rate



Aerial photo. '56, '89, '04

Wave Energy



RWE from Wave Energy Model

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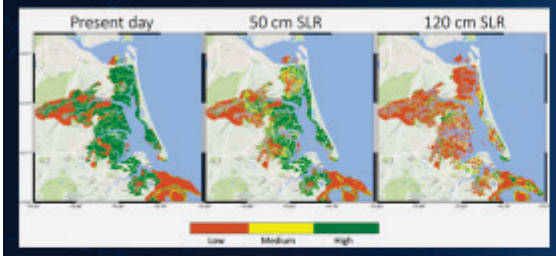
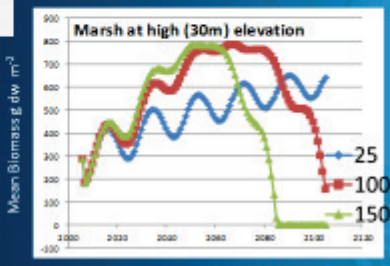
Models and Tools

Solutions to mitigate marsh vulnerability?



Vulnerability and risk
(Hydro-MEM model)

SLR and marsh elevation scenarios
(MEM model)



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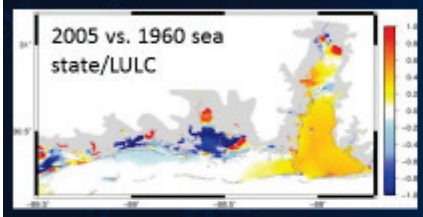
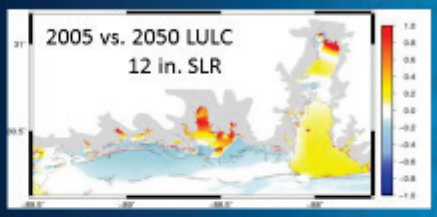
Models and Tools

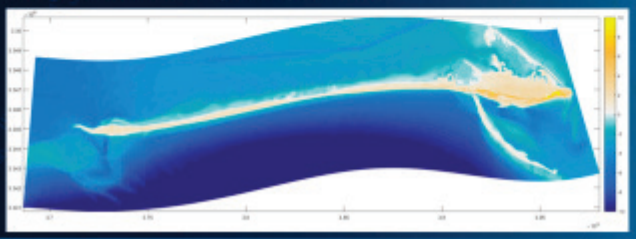
What if Hurricane Katrina struck in 2050?

Dynamic Storm Surge (*NGOM3*)





Over wash and breaching of Dauphin Island



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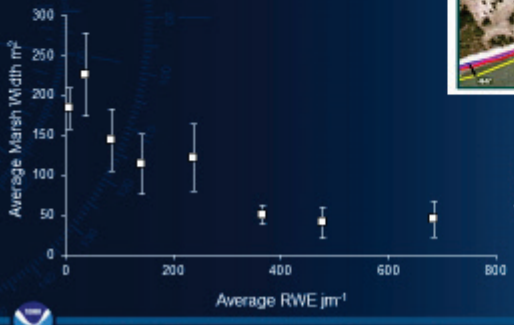
Guidance and Metrics

How much wave energy can living shorelines sustain?

Rachel Carson National Estuarine Research Reserve demonstration



Fringing marsh distribution versus wave energy

NOAA's National Ocean Service Positioning America for the Future

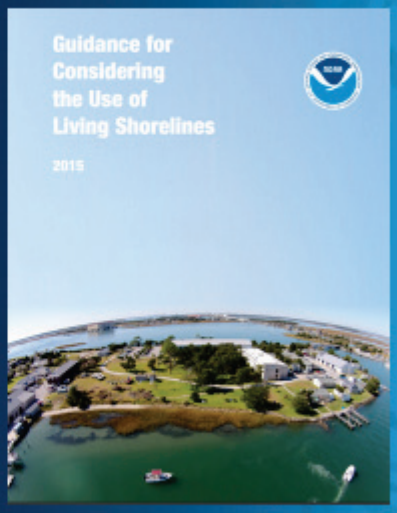
Guidance and Metrics

Guidance for installing a living shoreline?

Management & Policy

Engagement & Education

Science



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Ecosystem Services

What is the value of marshes for flood protection?

- Value ($$) of damages avoided by having natural habitats
- Value saved from reduced flood insurance costs
- Economic stimulus to the community

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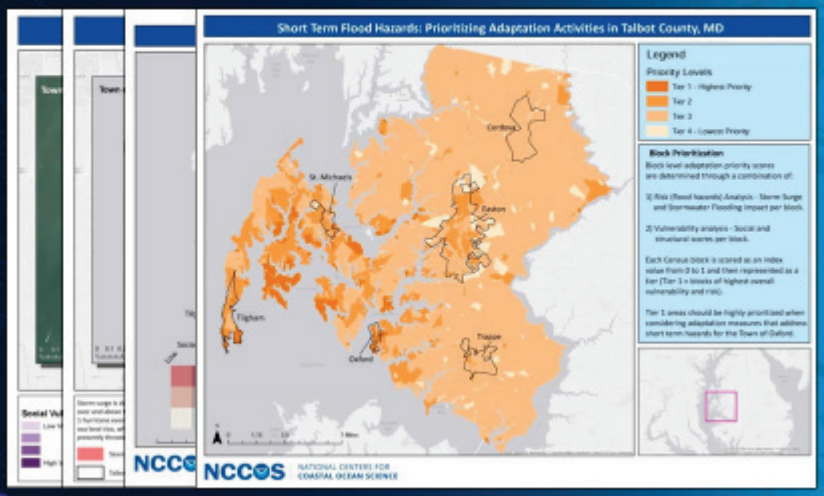
Ecosystem Services

How can our science inform adaptation?



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Emerging Opportunities

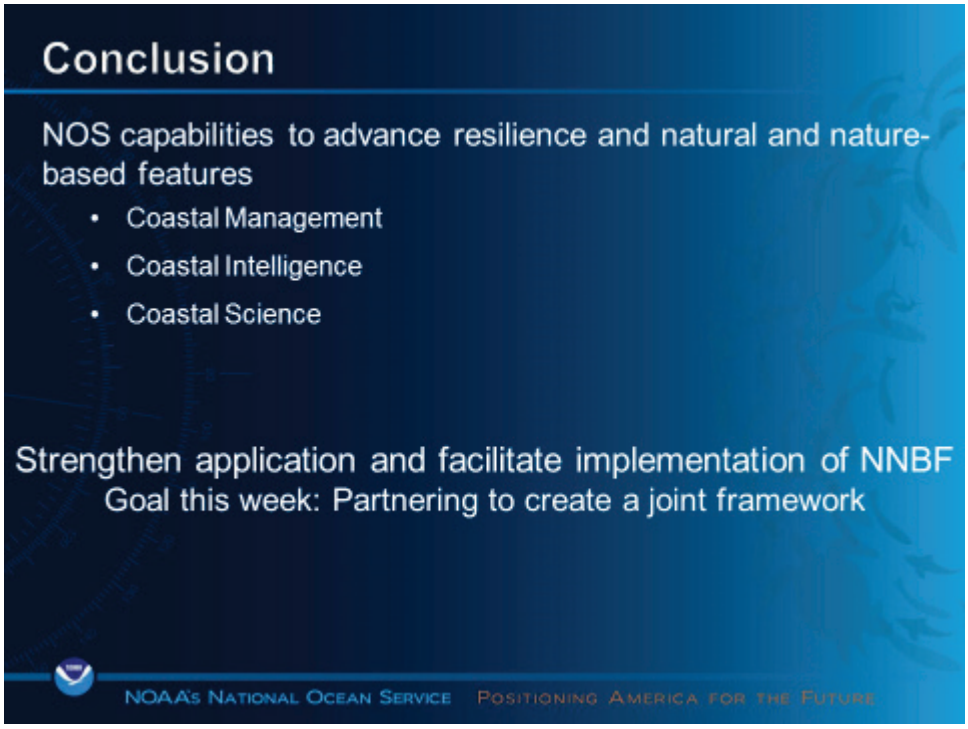
Enhanced emphasis on NNBF in new projects

- Tools and models for scenario evaluations (Gulf and CA)
- Valuing ecosystem services (OR)
- Thin layer disposal of dredge spoil at Camp Lejeune (NC)

NERRS Science Collaborative

- Living shorelines and erosion (FL)
- Performance of sustainable shorelines

NOAA's National Ocean Service Positioning America for the Future


Conclusion
NOS capabilities to advance resilience and natural and nature-based features
• Coastal Management
• Coastal Intelligence
• Coastal Science
Strengthen application and facilitate implementation of NNBF
Goal this week: Partnering to create a joint framework
NOAA's National Ocean Service
Positioning America for the Future

Appendix F: Breakout Session Worksheets

Participant Worksheet #1: NNBF Uncertainty, Ecosystem Services, Targets

What are the largest sources of uncertainty concerning NNBF design, performance, and management (including Operations & Maintenance)? How might an increased understanding of ecosystem services provided by NNBF be used in decision-making in coastal communities (for example, understanding performance of different features)? Please provide your rationale, succinctly. Given these levels of uncertainty, what specific physical, ecological, or social processes/science should be targeted and considered in order to advance the use and integration of NNBF into coastal infrastructure strategies?

Attendee Name: Agency: Small Group #:		Worksheet #1
What are the largest sources of NNBF Uncertainty?		
Design:	**Performance:**	**Management:**
How might an increased understanding of ecosystem services provided by NNBF be used in decision-making in coastal communities? (with rationale):		
Given uncertainty, what specific physical, ecological or social processes/science should be targeted to promote use of NNBF?		
Physical:	**Ecological:**	**Social:**

Participant Worksheet #2: Types of NNBF Collaborative Projects

What types of NNBF projects is your organization currently conducting? What types of NNBF projects present the best opportunities and biggest challenges for USACE and NOS going forward (considering research priorities, policy, planning, permitting issues, construction, operations, etc.)? With respect to your answer(s) above, what geographic settings present the best opportunities and biggest challenges? Please provide your rationale, succinctly.

<table>
<tr><td colspan="2">Attendee Name: Agency: Small Group #: Worksheet #2</td></tr>
<tr><td colspan="2">What types of NNBF projects is your organization currently conducting? Agency:</td></tr>
<tr><td>Name of Effort:
Location(s):
Description:

Entities Involved:</td><td>Name of Effort:
Location(s):
Description:

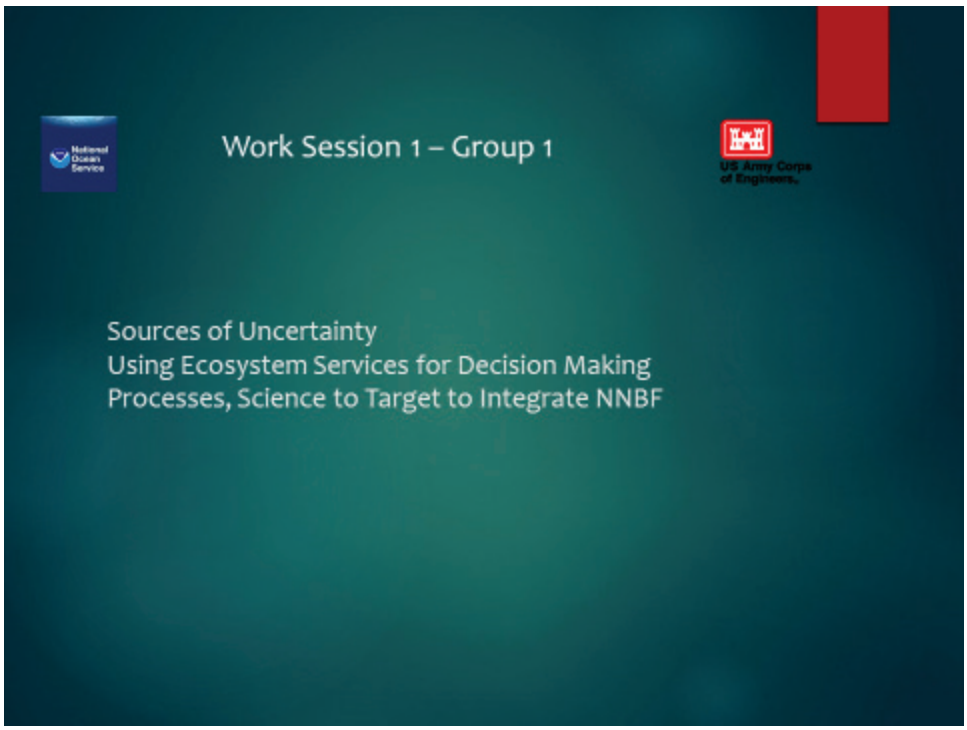
Entities Involved:</td></tr>
<tr><td colspan="2">What types of NNBF projects present the best opportunities and biggest challenges for USACE and NOS going forward (considering research priorities, policy, planning, permitting issues, construction, operations, etc.)?</td></tr>
<tr><td>Opportunities:</td><td>Challenges:</td></tr>
<tr><td colspan="2">With respect to your answer above, what geographic settings provide the best opportunities and biggest challenges (including your rationale)?</td></tr>
<tr><td>Geographic Opportunities: (include why)</td><td>Geographic Challenges: (include why)</td></tr>
</table>

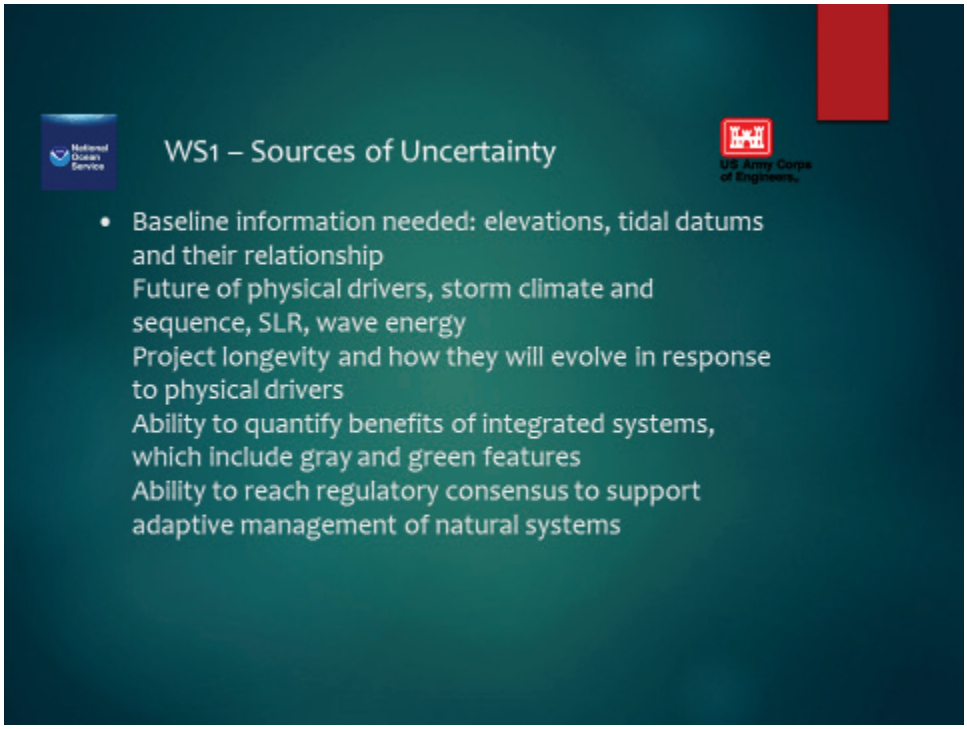
Participant Worksheet #3: Priority NNBF Collaborative Projects

What future NNBF projects would you prioritize for collaboration by USACE and NOS? Existing projects that can be leveraged should also be included. What do you consider to be the key aspects or elements of these collaboration projects? When considering your priority project(s), what key next steps should be taken to advance the collaborative efforts?

Attendee Name: Agency: Small Group #:	Worksheet #3
What future NNBF projects would you prioritize for collaboration by USACE and NOS?	
Name of Effort: Existing? ___Yes ___ No **Location(s):** **Entities Involved:** **Description of Key Aspects:** **Next Step(s):**	
Name of Effort: Existing? ___Yes ___ No **Location(s):** **Entities Involved:** **Description of Key Aspects:** **Next Step(s):**	
Name of Effort: Existing? ___Yes ___ No **Location(s):** **Entities Involved:** **Description of Key Aspects:** **Next Step(s):**	

Appendix G: Breakout Session I Results



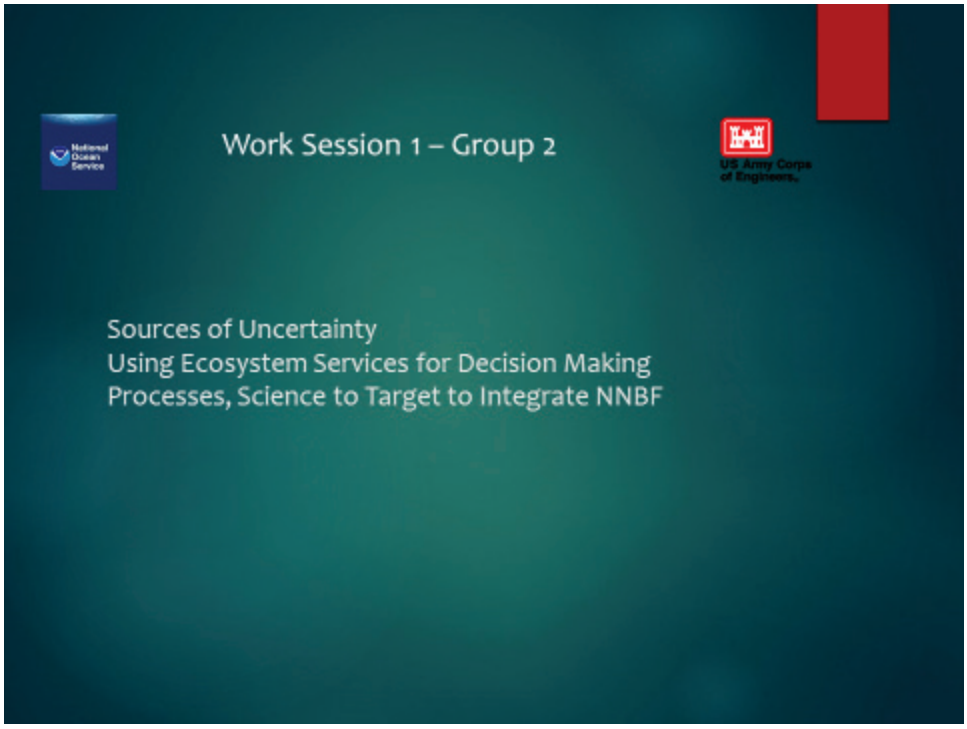


WS1 – Use of Ecosystem Services for Decision Making

- Understanding 'monetary' values of ecosystem services and importance people attach to them
- Improve ability to choose between different approaches
- Leverage resources and modify project to increase benefits
- Need inter agency support to incorporate into policy 'top down'

WS1 – Processes/Science to Target to Integrate NNBF

Need demonstration projects
Engage communities early to incorporate NNBF
Target life-cycle analysis tools
We want a 'true cost' approach
Uncertainty increases costs
Protocols to measure performance and benefits
Support private sector involvement
Opportunities for agencies to coordinate financing at the higher levels.


Work Session 1 – Group 2
Sources of Uncertainty
Using Ecosystem Services for Decision Making
Processes, Science to Target to Integrate NNBF


WS1 Group 2 – Sources of Uncertainty
Monitoring for evaluating NNBF project s - we don't have enough
Talking about "uncertainty" at times makes traditional solutions sound safer/secure than NNBF solutions – when it is really just dynamic
Sea level rise and/or local development and land use patterns
Don't have a full understanding of the system

WS1 Group 2– Use of Ecosystem Services for Decision Making

Need to quantify the value/benefits of ecosystem services, and monitor

- – how NNBF as the preferred alternative to traditional
- - Would give you perspective on the transferability to different locations
- - Could help communities get more dollars in the Community Rating System, flood premiums, insurance rates

Better understanding of how the public views, what they see as important vs. the experts

Focus more on the beneficial uses of Dredge Material over ocean disposal

Use of blended solutions (traditional and NNBF) – opportunity to educate decision makers

WS1 Group 2– Processes/Science to Target to Promote NNBF

Morphodynamics, elevation data

Sediment dynamics, use of sand as resource

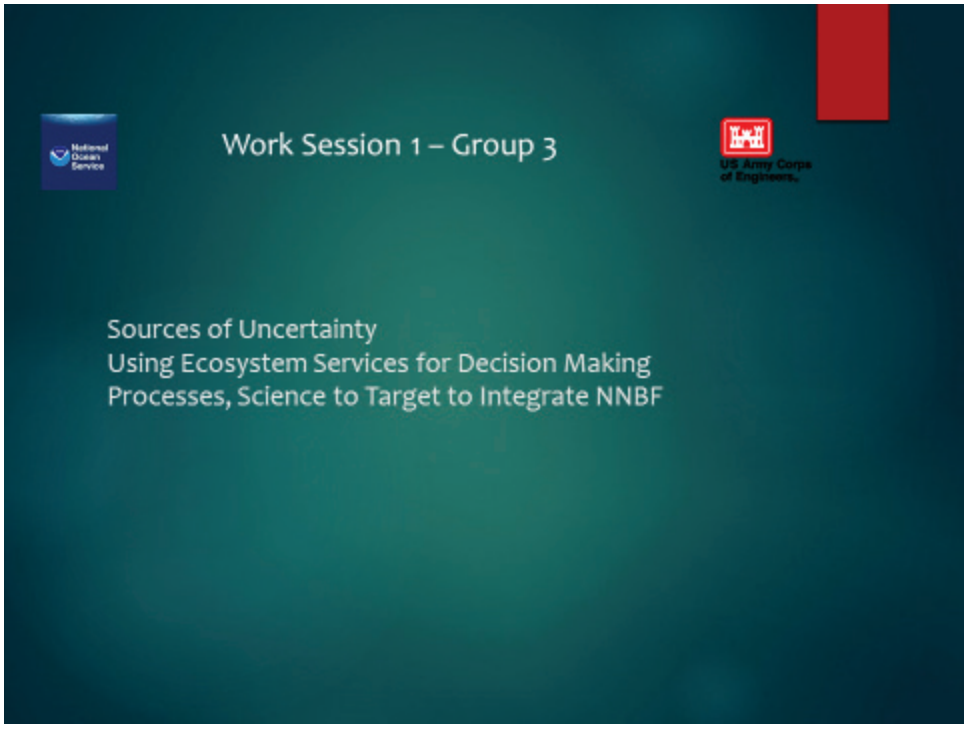
Climate change, species response, accepting new normal

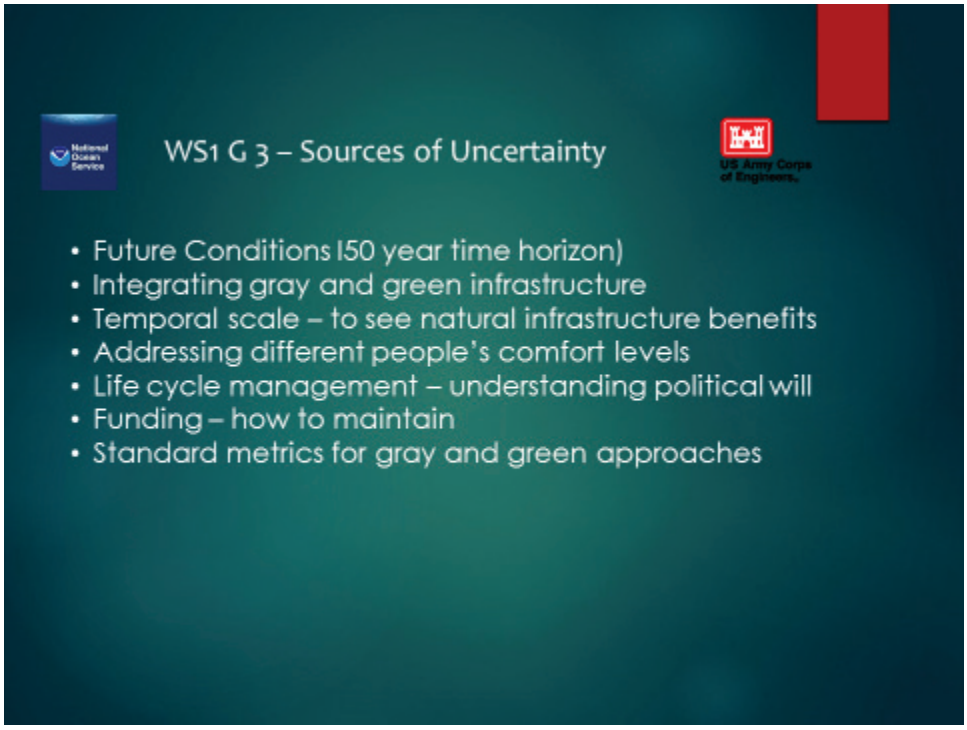
Ecosystem service valuation

Clearer NNBF project design criteria related to programmatic permitting processes (ESA)

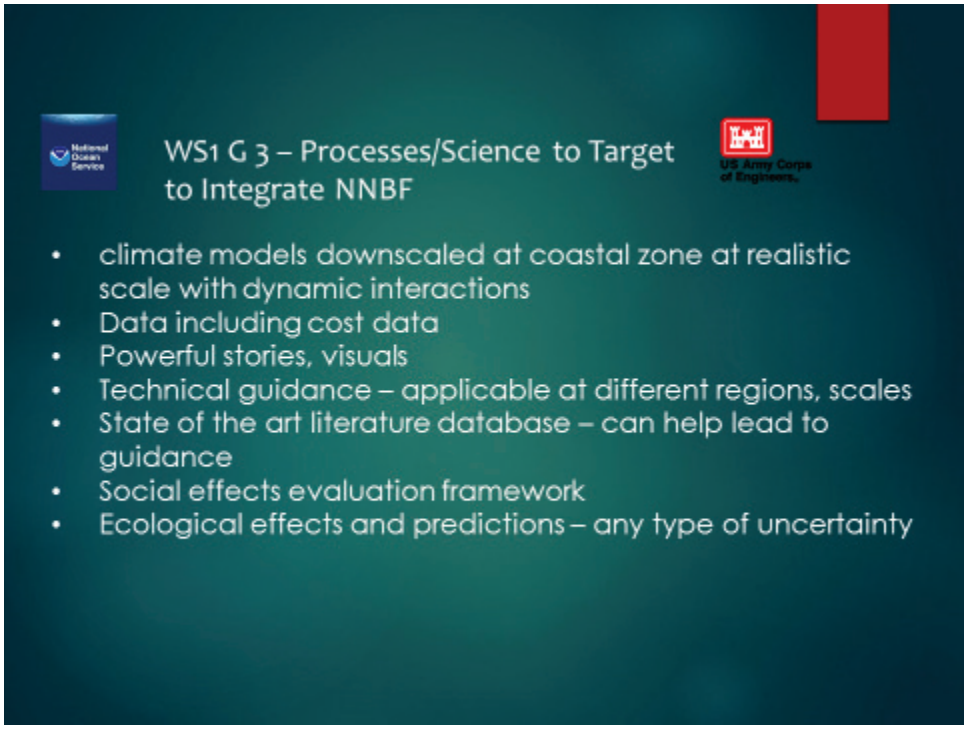
Attitude/social marketing

Multi-disciplinary – a must.


Work Session 1 – Group 3
Sources of Uncertainty
Using Ecosystem Services for Decision Making
Processes, Science to Target to Integrate NNBF


WS1 G 3 – Sources of Uncertainty
• Future Conditions I50 year time horizon)
• Integrating gray and green infrastructure
• Temporal scale – to see natural infrastructure benefits
• Addressing different people's comfort levels
• Life cycle management – understanding political will
• Funding – how to maintain
• Standard metrics for gray and green approaches


WS1 G 3 – Use of Ecosystem Services for Decision Making
US Army Corps of Engineers
• Standard method for monetization
• Understanding how different ES can be scaled up
• Better understanding of NNBF eliminates uncertainty
• Need advocates (NGOs, etc) to help with cost sharing, story telling
• Private industry or business case


WS1 G 3 – Processes/Science to Target to Integrate NNBF
US Army Corps of Engineers
• climate models downscaled at coastal zone at realistic scale with dynamic interactions
• Data including cost data
• Powerful stories, visuals
• Technical guidance – applicable at different regions, scales
• State of the art literature database – can help lead to guidance
• Social effects evaluation framework
• Ecological effects and predictions – any type of uncertainty

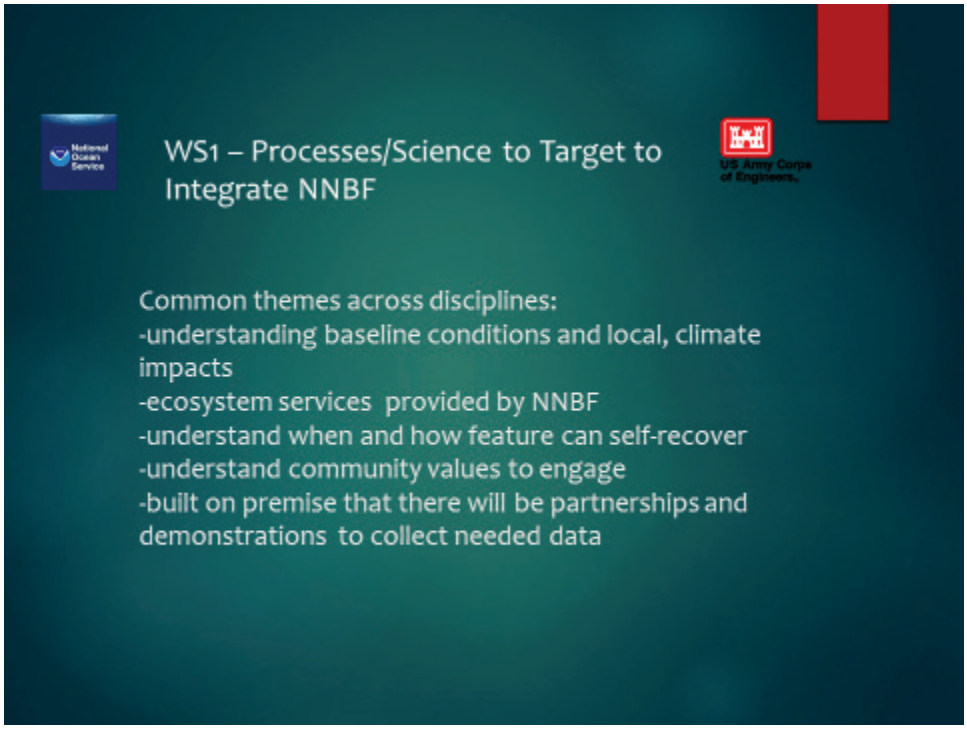
Work Session 1 – Group 4

Sources of Uncertainty
Using Ecosystem Services for Decision Making Processes, Science to Target to Integrate NNBF

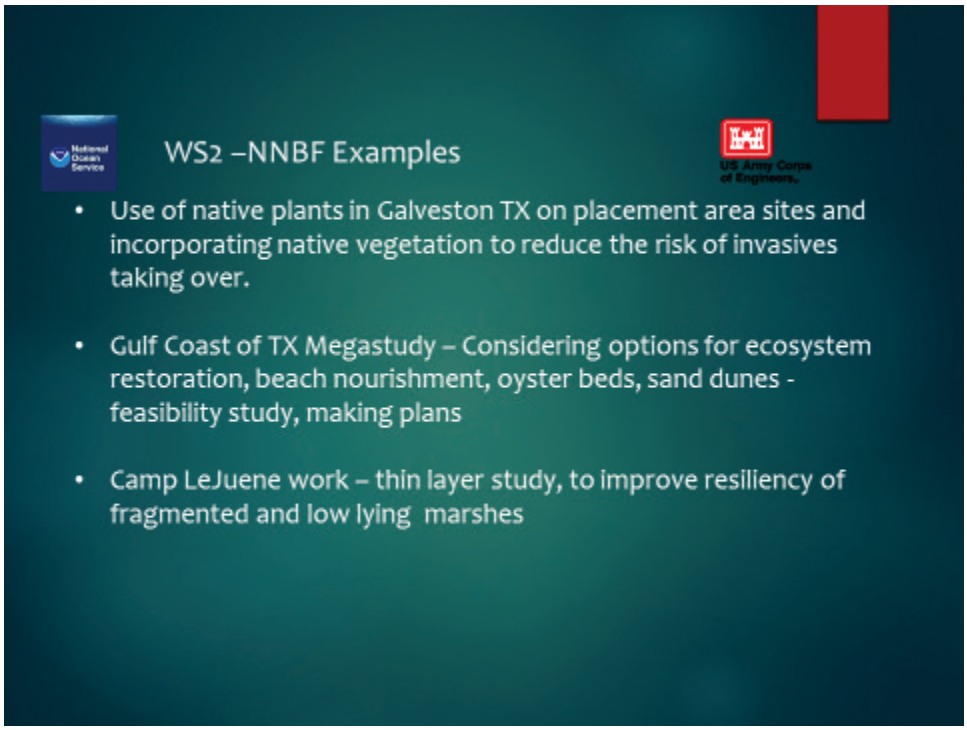
WS1 – Sources of Uncertainty

Continuum among planning, performance, and management:
-understanding the effectiveness of different NNBF under different scenarios (location, objectives, scale , climate variability, etc.)
    -how do they perform
    -how to capture benefits for decision making
-lifecycle management
    - long term operation and maintenance
-monitoring and adaptive management
-expertise in design
-understanding ecosystem services provided by different approaches


WS1 – Use of Ecosystem Services for Decision Making
Ecosystem service information allows for more informed decisions:
-to provide a framework to monitor and evaluate performance
-to justify investment
-to build community support
-partnerships
-managing expectations
-to conduct cost benefit analysis


WS1 – Processes/Science to Target to Integrate NNBF
Common themes across disciplines:
-understanding baseline conditions and local, climate impacts
-ecosystem services provided by NNBF
-understand when and how feature can self-recover
-understand community values to engage
-built on premise that there will be partnerships and demonstrations to collect needed data

Appendix H: Breakout Session II Results



WS2 –Examples

- Work on wave attenuation benefits of different species of salt marsh in NC – performance. External funding to academia.
- Performance of dune systems in managed and unmanaged environments.
- Ecosystem response to SLR in the northern GOM
- Generic ecological modeling in SF Bay.
- Deal Island - is MD's top opportunity – consistent permitting and design guidance needed
- Sharing information across the agencies,
  - NNBS guidelines for communities building from Great Lakes work
  - Incorporating NNBS considerations in GIS design
  - NOAA living shorelines (internal) guidance
  - NOAA Natural Infrastructure Strategy.
  - Geospatial Infrastructure for Sentinel Sites Guidelines
  - Surface Elevation Table Guidelines (NOAA, USGS, NPS)

WS2 –Other opportunities

- Develop an advocacy team across the two agencies that are committed to working NNBS issues and projects – practitioners communicating and engaging sustainably. Serve as a helpmate to the work to be done by those involved.
- Let's circle back on SAGE and look at its purpose, goals, and trajectory.
- Managing areas consistently regionally, scaled regional grids, develop strategy papers (Norfolk and NJ back bays)
- Engage NOAA as contributor now as the 9 papers are developed – look to collaborations
- Look to connections with NOAA sentinel sites.
- NOAA provide POCs to Corps now to ensure early participation.

WS2 – Best Opportunity Project Types (include rationale)

- Studies
  - Texas Mega study – coordinate with NERRS
  - Sandy Focus Areas (Norfolk, NJ Back Bays, NY/NJ Harbors and Bays, Nassau County, Washington, DC)
- Research
  - Wave attenuation benefits of different species of salt marsh
  - Ecosystem Response to SLR integrated modeling
  - Linking researchers / modelers / practioners
- On-the-Ground Project
  - Camp Lejune – Thin Layer Spraying
  - Deal Island Maryland – Living Shoreline & Dune Rebuild
  - Jamaica Bay / Rockaway – Spring Creek South (small effort that fits into bigger plan)

WS2 – Biggest Challenges Project Types (include rationale)

- Regional sediment management and where things are placed – Corps can't always do what is most cumulatively beneficial versus least cost.
- Could there be a pot of money to 1) compel the agencies to work together based on opportunities if $ are available, and 2) to consider how the whole system (landscape/regional) approach and cumulative effects analysis could help ensure success.
- Money and leveraging resources and talent.
- Variability across districts and states, including regulatory and permitting inconsistencies.
- Scale of things – geography and resources.

Work Session 2 – Group 2

NOAA/NOS NNBF Project Examples
USACE NNBF Project Examples
Best Opportunity Types
Biggest Challenge Types
Best Opportunity Location
Biggest Challenge Location

WS2 – Combined NNBF Examples

THERE ARE A LOT MORE! THESE ARE JUST A FEW EXAMPLES.

- Tech transfer:
  - Green infrastructure database (NOAA)
  - Guidance for incorporating habitat into beach nourishment (USACE)
- Modeling/science:
  - Gomex coastal modeling (NOAA)
  - Dune and marsh modeling in NC (NOAA)
- Science/application
  - Camp Lejeune thin layer (NOAA)
  - Hamilton and Sonoma Bay Lands wetland restoration (USACE)
  - Boston Harbor channel deepening (USACE)

WS2 –Opportunities

- Non-funded grants or tailor new funding opps to provide planning/recon and bring stakeholders together
  - NFWF
  - NOAA Resilience grants
- R&D Tech transfer - help people understand value of investment in R&D
  - NOS and ERDC share/talk more about models and tools being developed in both.
  - Then use OCM/Sea Grant to help get the sound science to community partners and other resource agencies.
  - Use this to inform/smooth perceived regulatory hurdles.
  - Also, USACE (e.g. RSM, ERDC) continue to transfer knowledge through Districts and public at large.
- Restoring natural floodplains, and 2014 flood assessment
- Work together on NNBF projects that encourage natural sedimentation as a project outcome

WS2 –Challenges

In-water work restrictions: to protect endangered species. Could delay the projects a year or two.

Beach nourishment: need project examples of nourishment efforts that incorporate NNBF features, to keep them from getting knocked down in storms/out of cycle.

NOS and NMFS communication (Cathy and her division working on this)

WS2 – Best Opportunity Locations (include rationale)

- Gulf of Mexico
  - Monitoring levees (post-Katrina)
  - RESTORE
  - Ecosystem Resilience Index
- SF Bay area – wetland restoration innovative techniques. Also a lot of money
- Something on the Missouri River – shoaling
- Louisiana – lots of money. USACE and interagency group very engaged.
- NC, Chesapeake, Northeast – already doing a lot of work that can be leveraged.

WS2 – Biggest Challenge Locations (include rationale)

SF Bay – so many entities with regulatory say (water board, FWS, BCDC, USACE, NOAA)

Rapid SLR cities (Miami, Outer Banks, Norfolk, SC Lowcountry) – giant drain on USACE to keep funding renourishment

Louisiana: complexity of political, environmental, and physical environment, and the timescale/pace

Gulf of Mexico (RESTORE and Deepwater Horizon (NRDA) and NFWF Gulf restoration work): not sure what is coming yet, but will be years of work that we need to get ready for.

Work Session 2 – Group 3

NOAA/NOS NNBF Project Examples
USACE NNBF Project Examples
Best Opportunity Types
Biggest Challenge Types
Best Opportunity Location
Biggest Challenge Location

WS2 – NOS/USACE NNBF Examples

- South Atlantic Regional Systems Management Strategy
- Mordecai Island – Beach haven, NJ
- Thin Layer
  - Avalon, NJ Thin layer placement (NJIWW, NJ Intracoastal Waterways)
  - Camp LeJeune thin layer project
- Port Everglades Harbor Mitigation project
- Green Infrastructure for flooding as part of Rochester, NY planning project

WS2 – Best Opportunity Project Types (include rationale)

- Synthesis of lessons learned from resilience/beneficial use projects. National guidance based on pilot projects.
  - Defined terminology, common language
- State of practice – building off what we know
- SA Regional Systems Mgt Strategy – brand new, planning phase, projects will occur at multiple levels, scales
- Partners or groups that are willing to take more risk and/or provide funding faster (NFWF, cooperative institutes)

WS2 – Biggest Challenges Project Types (include rationale)

- Synthesis project – platform issues and security
- General:
  - Risk - Risk of "failure" with multiple partners. Need to be clarified, defined. Social, technical, relational. Risk affects decisions.
  - Costs and constructability (efficiency)
  - Communication and coalition building
  - Funding (need to be cost effective)
  - Bandwidth for staff. Level of commitment
- SA RSMS – funding is a risk.
  - Buy in for what will be recommended. A lot of people need to buy in.
  - Communication will be critical

WS2 – Best Opportunity Locations (include rationale)

- Building or sustaining islands – ex. Chesapeake Bay
- What locations provide best opportunities of hybrid approaches?
- Target locations that were early adopter s of NNBF approach
- Opportunities where projects funded and progressive thinking exists – minimize social
- Focus on more needy areas.
- NOAA has special sites/locations – maybe target these

WS2 – Biggest Challenge Locations (include rationale)

- Each location different, what works in one place may not work in another
- West coast – less understanding, different dynamically
- Remote locations are difficult for data, site access. Sites closer toward the coast are easier
- Hard to know the local community interested – finding opportunities at local level can be challenging

Work Session 2 – Group 4

NOAA/NOS NNBF Project Examples
USACE NNBF Project Examples
Best Opportunity Types
Biggest Challenge Types
Best Opportunity Location
Biggest Challenge Location

WS2 – NOAA/NOS NNBF Examples

Wave Attenuation throug Vegetation	ERDC lab
Vegetative Dune Erosion	ERDC lab
Ecosystem Service Valuation of Natural Infrastucture	Oregon State University
Thin Layer Dredge Placement	Camp Legune
Living Shoreline	Camp Legune, NC, NERRS
Ecological Effect of SLR	NC, E. Gulf of Mexico, San Francisco Bay, Hawaii?
Nearshore Berm Placement	ERDC lab, Field Research Facility (Duck, NC)
Introducing Native Plant Species on Dredge Placement Areas	ERDC Galveston, TX
Avalon Wetlands Restoration	Avalon, NJ
Forsythe National Refuge	NJ
Forsythe National Refuge	NJ
Public Database of Resources on Effective of Green and Natural Infrastucture Approaches	www.
Thin Layer Placement Website	www. Soon
NOAA Sentinal Sites	NC, MD, HI, CA (San fran Bay), N Gulf of Mexico
San Francisco Bay Salt Pond Restoration Project	CA

WS2 – Best Opportunity Project Types (include rationale)

- Coastal/ Storm Damage Prevention (beach nourishment)
- Navigation Projects
- Regional Sediment Management Projects
- Ocean/Coastal Monitoring
- Guidance/Resource Development (rebuilding principles after Sandy, shoreline stabilization
- Tools for planning and development of projects (i.e. Digital Coast, Models, environmental intelligence
- Larger Scale Projects (NOAA regional capacity/stakeholders with USACE current capabilities

WS2 – Biggest Challenges Project Types (include rationale)

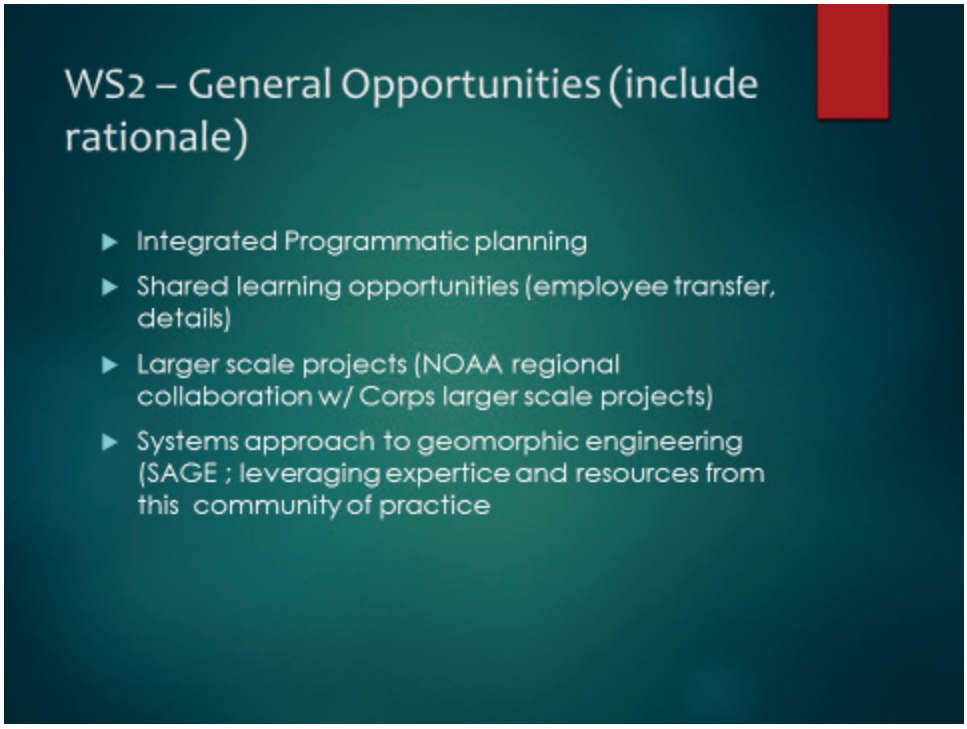
- Thin Layer placement (regulatory & technical)
- Beach (grain size, color, species, thickness)
- Modelling (availability of data, eg bathy, sediment consolidation)
- Project with partners (getting buy-in)
- Small scale (NOAA has smaller scale projects where USACE works on larger scales)
- Near-shore berm (regulatory & technical, environmental impacts)

WS2 Biggest Challenges are best opportunities (include rationale)

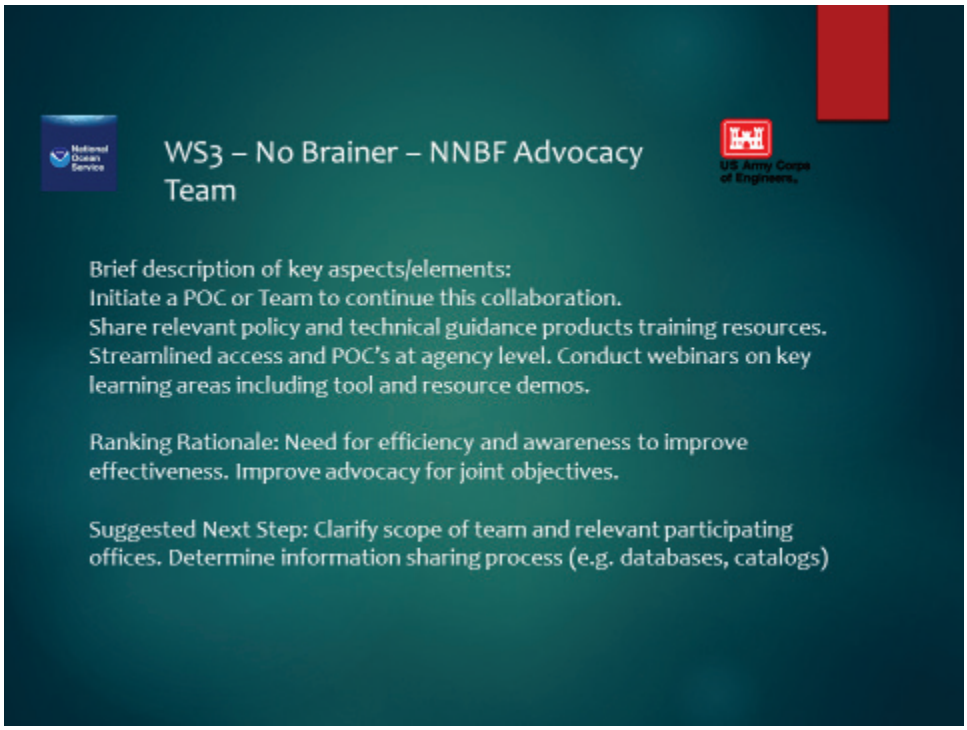
- Cities (C: limited space O: protect people and infrastructure)
- Developed Beaches (C: asthetics O: protects people and property, NOAA builds relationships, awareness, buy-in and Corps builds beaches)
- Endangered species habitats (C: implementation of regulations O: collaborate and streamline)
- High energy environments (C: design and cost O: innovation of methods)

WS2 – Geographic challenges are opportunities (include rationale)

- Field Research Facility, NC NOAA labs and estuarine reserves
- Sandy Impacted areas
- Gulf Coast (e.g. Texas Refineries)
- Columbia River (NOAA and Corps investments)
- Chesapeake Bay (NOAA and Corps investments, close partners, and political will)
- San Francisco Bay (NOAA and Corps investment, salt ponds)


WS2 – General Opportunities (include rationale)
Integrated Programmatic planning
Shared learning opportunities (employee transfer, details)
Larger scale projects (NOAA regional collaboration w/ Corps larger scale projects)
Systems approach to geomorphic engineering (SAGE ; leveraging expertice and resources from this community of practice

Appendix I: Breakout Session III Results



WS3 – Idea 1 – Sandy Focus Areas Collaboration

Brief description of key aspects/elements: Participate in development of strategic direction for NOAA/USACE collaboration and subsequent planning activities

NERRS Location(s): New Jersey Back Bays (Barnagett Bay): Norfolk (York R.); New York-New Jersey Harbor and Tribs (Hudson River)

Ranking Rationale: These location are of common emphasis and suitable for the NNBF approach. This is the next phase of our on-going collaboration and funding for on-the-ground implementation is available.

Suggested Next Step: Identify NOAA roles and participants.

WS3 – Idea 2 – Coastal TX Megastudy

Brief description of key aspects/elements: Feasibility study to identify data for strategy for reducing coastal storm flood risk through structural and nonstructural measures that take advantage of Natural Based Features.

Location(s):Sabine Pass to Galveston Bay, Matagorda Bay, Corpus Christi Bay, Padre Island

Ranking Rationale: Approved and funded!!!

Suggested Next Step: Ideas for NBF

WS3 – Idea 3 – Camp Lejuene Thin Layer

Brief description of key aspects/elements: Thin layer application of dredged material to improve marsh resilience on Marine Corps Base Camp Lejuene

Location(s): North Carolina

Ranking Rationale: Funded project provides opportunity for USACE NOAA collaboration to build regulatory framework in Southeast (Aligns with SACS), test logisitics for application, develop monitoring protocols. Leverage NOAA and DOD-funded research, use NC Sentinel Site outreach and ecosystem service valuation opportunities

Suggested Next Step : Form a working group

WS3 – Idea 4 - Jamaica Bay Rocks

Brief description of key aspects/elements: Sandy-Funded Project to provide coastal storm risk management benefits. Alternatives including NNBF are being developed. The Spring Creek South II Project is a NYC-TNC (FEMA funded) NNBF within Jamaica Bay which could pilot NNBFs for the larger project.

Location(s): Jamaica Bay-Rockaway Peninsula, NY City, NY.

Ranking Rationale: Construction funds in place through Sandy legislation.

Suggested Next Step: Evaluate the Spring Creek project and alternatives proposed for the JB/R project.

WS3 – Idea 5 - Chesapeake Bay -It's Not Just Islands

Brief description of key aspects/elements: Design and construction approaches for NNBF in salt marsh and dune systems

Location(s): Deal Island, Tangier, Franklin Point Park

Ranking Rationale: Communities at risk, identified partners (Maryland DNR, Ches Bay Sentinal Cooperative, Monie Bay, USACE Baltimore and Norfolk Districts). There are identified needs and stakeholders have been engaged.

Suggested Next Step: 1) Obtain funding 2) USACE - Floodplain Management, Planning Assistance to States, and Continuing Authority programs 3) NOAA - Community Based Restoration program 4) connect to lessons learned and partners from Choptank Habitat Focus Area

Work Session 3 – Group 2

PROJECT IDEAS

1. Improve the collaborative transfer of tech and R&D
2. Development of beach nourishment habitat guidance
3. Mature the opportunities from the Boston Harbor beneficial use project
4. Leveraging science and partnerships from Mobile Bay
5. Maximize the collaboration on Texas mega-project

PROCESS NOTES ON COLLABORATING TOGETHER:

→ for any project, consider implementing through a detail or more consistent staff relationship

→ Five-year management plans from each coastal zone mgt program: some of them include looking at NNBF. Look to see which states and if they align with the project ideas.

NOS

- NCCOS – David *(the ERDC and HEC)*
- OCM – Nancy and Jeff P and Sandy and Kim and Lori
- NGS – Galen
- CO-OPS – Audra and Rich (Tides and Currents)
- OR&R –

Project – Improve the collaborative transfer of tech and R&D

Brief description of key aspects/elements:

- A sub-group that would meet and continue to encourage this momentum and collaboration across offices.
  - Where projects have been completed – share the results! Have it available when and where people need it.
  - Science-to-management: OCM and Sea Grant can help get the science/info out to community partners and other resource agencies.
  - Science-to-science: NCCOS/ERDC sharing models and science each are developing/working on

Rationale:

- Low hanging fruit
- Improves staff-level collaboration (keeping NOAA in the loop when planning projects, because NOAA has state partners who will be interested in beneficial use)
- Can be transferred to other projects

Suggested Next Step:

- Get people together to plan it out, what it looks like.
- Share out the tech transfer USACE/NOAA/FWS doc.
- Include USACE completed NNBF projects in NOS database

Project – Development of beach nourishment habitat guidance

Brief description of key aspects/elements:
- Make the habitat component stronger in beach nourishment projects
- USACE developing the guidance, NOAA could contribute technical expertise, not only from beach erosion perspective but also protected species perspective (grain size, slope)

Rationale:
- Relationship building with USACE/NOAA
- As guidance is implemented, NOAA can help with monitoring using marine spatial ecology expertise

Suggested Next Step:
- Talk to Craig

Project – Mature the opportunities associated with the Boston Harbor beneficial use (dredging/deepening) project

Brief description of key aspects/elements:
- Opportunity to identify the uses of rock to create habitat
- Share NOAA/NMFS experience and knowledge about the possible beneficial uses of rock

Rationale:
- Uses a new kind of material that gives opportunity to transfer to other projects

Suggested Next Step:
- Talk to New England District to see if there is an opportunity to get involved

Project – Leveraging science and partnerships from Mobile Bay (beneficial use)

Brief description of key aspects/elements:
- Leveraging science to identify beneficial uses of placement
- Ideas for how to do it economically
- Working together to decide the best placement sites
- Showcase nationally what's going on in Mobile Bay

Rationale:
- It's a large deepening project, with large volume material (could be used beneficially)
- USACE/NOAA have mutual R&D, collaborative relationships on the ground already
- Lessons learned could have implications for a lot of other bays

Suggested Next Step:
- Work with Mobile District to see if there are opportunities to participate on the study team , for considering and identifying NNBF features as an element of this project.

Project – Maximize collaboration on TX mega-project

Brief description of key aspects/elements:
- Providing feedback and collaboration/ideas to the TX General Land Office/Galveston USACE District

Rationale:
- Getting in early.
- Good regional large-scale type project.
- Opps for traditional and NNBF
- Have NOAA-supported National Estuarine Research Reserves (NERRs) local/nearby that we could tap into

Suggested Next Step:
- Talk to Eddie

Work Session 3 – Group 3

Top 3-5 Group Ideas for Collaborative Projects with
- Title
- Key Aspects/Elements
- Location
- Rationale for Priority Ranking
- Suggested Next Step

•WS3 – Idea 1 - South Atlantic Regional Systems Management Strategy

Brief description of key aspects/elements:
Planning to identify coastal vulnerability and risk. NNBF features incorporated into future plans

Location(s): Coasts of NC, SC, GA, FL (Atlantic)

Ranking Rationale: Could have impact on large # O&M projects. Will lead to future projects. In Early stage. Leveraging NACCS tools and lessons. Diversity and scale of NNBF projects.

Suggested Next Step: Name a NOAA POC. Very early, stakeholder groups will be included - NOAA can help with this.

•WS3 – Idea 2 – Delaware and Barnegat Bay Integrated Test bed

Brief description of key aspects/elements:

- **Using monitoring data, Common language, NOAA could do an R&D**
- **Mordecai Island**
- **Island creation**
- **SAGE Community of practice**
- **Thin layer wetland restoration**
- **JC NERR**

Location(s): New Jersey

Ranking Rationale: Critical mass of active work in the area – makes sense. Would be lost opportunity to not link together. Low technical and social risks. Opportunity to work through regulatory issues. Can start to make connections that need to be made. This effort could spark action.

Suggested Next Step: meeting with key parties

•WS3 – Idea 3 - Advancing Thin Layer placement for resilience

Brief description of key aspects/elements:

- **Methodologies, building resilience**
- **Avalon, NJ Thin layer placement (NJIWW, NJ Intracoastal Waterways)**
- **Camp LeJeune thin layer project**
- **Pepper Creek, Delaware**

Location(s): New Jersey, North Carolina, Delaware

Ranking Rationale: Reduce uncertainty of this technique through combination of R&D and pilot projects to compete more favorably. Make it more cost effective, reduce inefficiencies. Improving comfort level with technology. Science-based approach. Clear common ground

Suggested Next Step: Identifying POCs from USACE and NOAA to work on this. 1 – 2 day long working meeting. Beaufort, NC???

•WS3 – Idea 4 - Port Everglades Harbor Mitigation project

Brief description of key aspects/elements:

- **reef tract enhancement (collecting, propagating, and planting coral)**
- **Seagrasses & mangroves & coral reef**
- **Plan developed jointly with NMFS**

Location(s): Broward County, Florida

Ranking Rationale: design phase, interagency team a requirement, spans ecosystems of interest, expands geography (more northern), addresses regional approach, and demonstrated success by NFMS, low hanging fruit. Bigger scale than previous work. Opportunity to incorporate research (ex. blue carbon). Impacts of SLR – research opportunity.

Suggested Next Step: Need NOAA POC . Already underway

•WS3 – Idea 5 - Synthesis of approaches for resilience/beneficial use projects to advance NNBF and NNBS.

Brief description of key aspects/elements:

- **National guidance based on pilot projects.**
- **Defined terminology, common language**
- **Ex. lesson learned Green Infrastructure for flooding as part of Rochester, NY planning project (and other related Digital Coast resources)**
- **Green and natural infrastructure literature search**
- **Natural and nature based features engineering guidance development**

Location(s): national with local case studies

Ranking Rationale: There is a clear need to curate information to show benefit and successes of these techniques. May need to focus (may be different places, that's ok). Balance of different types of projects, would be good to have common messaging. Joint desire to advance NNBF.

Suggested Next Step: meeting to map out what different agencies are doing (focused workshop)

Work Session 3 – Group 4

Top 3-5 Group Ideas for Collaborative Projects with
- Title
- Key Aspects/Elements
- Location
  -Type: studies, research, on the ground
- Rationale for Priority Ranking
- Suggested Next Step

WS3 – Idea 1 – Development of Strategic Collaboration Framework

Brief description of key aspects/elements:
Collaboration across agencies and programs to research, plan, design and share information for NNBF. Identify mechanisms to form and facilitate the exchange of technical information, communication & outreach and planning.
Location(s): N/A
Rationale: Improve and sustain collaborations to advance state of the art NNBF, so that our approach is less opportunistic and more strategic
Suggested Next Steps: near term: identify leadership and technical team, build framework, designate a champion on each side, strategic communication plan to agency leadership, inclusion of core technical documents in to natural infrastructure database used by collaborators, creation of inter-agency employee exchange program, revisiting role/use of SAGE, Test metrics (ie. Wave attenuation of wetlands) to inform effective ness of NNBF

WS3 – Idea 2 – Investigation of dune management approaches

Brief description of key aspects/elements:
Investigation of dune building methods (e.g. conventional, hybrid vs. natural core)
Managed vs. unmanaged dunes
Location(s): North Carolina, South Padre, Texas
Type: Applied Research
Rationale: Dune building techniques are in their infancy and coastal managers are faced with challenges in their utilization. Broad application and NOAA and USACE have investments and infrastructure here
Suggested Next Step: build project teams (NOAA's National Estuarine Reserves, and Ecological Effects of SLR Team), literature review, model protoype

WS3 – Idea 3 – Vegetation on dredge material placement areas

Brief description of key aspects/elements:
Using native plants as engineering materials while exploring potential engineering, ecological, socioeconomic and environmental benefits

Location(s): Galveston, TX Great Lakes, Philadelphia, PA

Rationale: Broad application, vegetating these DMPs provide multiple ecosystem services (e.g. habitat provision, erosion control), improved perception of dredging operation and cost savings.

Suggested Next Steps: identifying partners, demonstration projects in these location, identifying lessons learned and identifying applicability in other regions

WS3 – Idea 4 – Greening Grey Infrastructure

Brief description of key aspects/elements: Redesigning grey infrastructure to provide environmental benefits

Location(s): various, dependent on where work is already taking place

Rationale: Aligning research that is already being done in this area.

Suggested Next Steps: understanding existing infrastructure

- Research: Develop dune building techniques: lab pilot Texas A&M, Mission Aransas ecosystem service valuation, coastal
- Ecological Effects of Sea Level Rise: berm – can this connect with dune building techniques
- Gulf coast regional collaboration: research, planning design (RESTORE ACT)
- Natural Infrastructure Database- technical info and effectiveness
- Chesapeake Bay: sentinel site,
- Dredge sediment: dredged material placement areas (near-shore berm): their fate engineering and ecologically, native plant impacts, ecosystem and community resilience
- Test metrics (ie. Wave attenuation of wetlands) to inform effective ness of NNBF - monitoring and evaluation- could be done with any project
- Thin-layer placement
- Sediment migration through vegetation- in lab
- Strategic framework: technical teams, database infrastructure, employee
- Waterfront park for coastal protection: hybrid infrastructure

Appendix J: Results of Voting and Prioritization

Project Name	Score
Advancing Thin-Layer Placement	25.25
Coastal Texas Protection and Restoration Feasibility Study	21.0
Vegetation of Dredged Material Placement Areas	14.50
Sandy Focus Areas Collaboration	13.25
Investigation of Dune Management Approaches	10.25
Habitat Enhancement of Infrastructure	9.25
South Atlantic Regional Systems Management Strategy	8.75
Delaware and Barnegat Bay Integrated Testbed	6.0
Leveraging Science and Partnerships from Mobile Bay	5.75
Development of Beach Nourishment Habitat Guidance	3.0
Jamaica Bay Rocks	3.0
Port Everglades Harbor Mitigation Project	2.75
Boston Harbor Beneficial Use Project	1.25
Chesapeake Bay Project	0.75

Appendix K: List of NNBF Technical Documents and Resources

Please visit the NNBF webpage (https://ewn.el.erdc.dren.mil/nnbf.html), which is a living resource and currently houses the 26 USACE and NOAA publications and other resources related to NNBF shown below.

Videos

- Shoring Up: A Science Briefing on the Potential of Natural Infrastructure to Enhance the Resilience of our Nation's Coasts

US Army Engineer Research and Development Center (ERDC) Publications

- ERDC Special Report - Use of NNBF for Coastal Resilience
- ERDC Technical Note - Cleveland Breakwater
- ERDC Technical Note - Deer Island
- ERDC Technical Note - Wave Dissipation by Vegetation

Journal Articles

- Coastal Engineering - Wave Attenuation by Flexible, Idealized Salt Marsh Vegetation
- Environmental Science and Policy - Future of Our Coasts
- Journal of Coastal Research - Shoreline Change in the New River Estuary
- Nature Geoscience - Wave Attenuation Over Coastal Salt Marshes Under Storm Surge Conditions
- Port Technology International - A Winning Formula for Port Development
- Shore and Beach - Wave Dynamics in Coastal Wetlands
- Wetland Science and Practice - Horseshoe Bend

Other Technical Documents

- Natural and Nature-Based Features Brochure
- USACE Civil Works - Coastal Risk Reduction and Resilience

- Erasmus Centre for Sustainability and Management - Changing Estuaries, Changing Views
- Coastal Dynamics - The Sand Engine: A Solution For Vulnerable Deltas In The 21st Century?
- Galveston Bay Foundation - Living Shorelines: A Natural Approach to Erosion Control
- Int'l Conference on Coastal Management - Coastal Environmental Management and Enhancement
- Nat'l Science and Technology Council - Coastal Green Infrastructure
- NOAA - Guidance for Considering the Use of Living Shorelines
- Restore America's Estuaries - Living Shorelines: From Barriers to Opportunities
- Terra et Aqua - Horseshoe Bend
- Terra et Aqua - Engineering With Nature
- The Military Engineer - Engineering With Nature
- The Nature Conservancy - Communicating Nature-Based Solutions
- White House Memo - Incorporating Ecosystems Services into Federal Decision Making

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14. ABSTRACT

This proceedings report summarizes the activities of a collaborative workshop conducted on the topic of Natural and Nature-Based Features (NNBF) by the U.S. Army Corps of Engineers (USACE) and the National Oceanic Atmospheric Administration (NOAA). The workshop was held on March 01-03, 2016, in Charleston, South Carolina. NNBF refers to those features that define natural coastal landscapes and are either naturally occurring or engineered to mimic natural conditions. Some examples of NNBF are beaches and dunes, salt marshes, and barrier islands. Thirty-eight workshop participants represented USACE and NOAA. The objectives of the workshop included were to 1. identify high-priority, resilience-based NNBF projects of common interest to USACE and NOAA; 2. categorize and prioritize projects identified for future collaboration; and 3. form a USACE/NOAA Leadership and Implementation Group to provide advocacy and oversight. The workshop included a plenary session where USACE and NOAA senior leaders presented their respective organization's NNBF overviews. Interactive breakout sessions were also convened to gather input on uncertainty, opportunities, and challenges concerning NNBF. Over the course of the three-day workshop, fourteen short- and long-term opportunities emerged. It will be essential to capture and share lessons learned as the two organizations plan and implement selected NNBF projects.

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