NEW RESEARCH TO INFORM LIVING SHORELINE DESIGN, PLACEMENT AND MONITORING

WEBINAR SUMMARY REPORT | APRIL 11, 2019

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About the NERRS

The National Estuarine Research Reserve System (NERRS) is a network of 29 coastal reserves located in 22 states and Puerto Rico. Each site includes programs focused on land stewardship, research and scientific monitoring, training programs for the public and local officials, and education.

About the NERRS Science Collaborative

The NERRS Science Collaborative is a NOAA-funded program that provides grants and other support for user-driven collaborative research, assessment, and transfer activities that address critical coastal management needs identified by the reserves.

National Estuarine Research Reserve System Science Collaborative

BACKGROUND

Living shoreline techniques can be effective tools for bolstering coastal habitats, controlling erosion, and protecting coastal areas from the impacts of storms, sea level rise and boat wakes. Under the right conditions, they can provide a variety of services while being cost-competitive with traditional approaches, such as bulkheads. Despite their potential, sustainable shoreline designs are not applied as broadly or effectively as might be expected.

Members of the National Estuarine Research Reserve System (NERRS) and partners, in part supported by Science Collaborative resources, have been studying how different living shoreline designs perform in a variety of coastal locations from Mississippi to New York, and have been developing tools to enhance the use of these techniques.

On April 11, 2019, the NERRS Science Collaborative hosted a panel webinar highlighting these efforts and to encourage a dialogue around important next steps for living shorelines research and management. In addition to facilitating a panel discussion of lessons learned, management implications, and next steps related to a series of applied research projects, the webinar gave audience members the opportunity to engage and ask questions about opportunities and challenges associated with living shorelines.

This document is a comprehensive post-webinar report that includes a summary of the panel discussion, records of the Q&A session and comments submitted by attendees about next steps for living shorelines, the results of audience polls administered during the webinar, an account of who attended the webinar, and a list of participants who opted to list their contact information to foster connections among living shorelines practitioners and researchers.

A complementary living shorelines management brief is also available in the Science Collaborative Resource Library.

ABOUT THE SPEAKERS

Christine Angelini, Assistant Professor in Environmental Engineering Sciences, University of Florida

Christine's research and teaching focuses on community ecology and restoration engineering in a variety of coastal habitats. In partnership with GTM Reserve in Florida, she has been testing a hybrid design for protecting oyster and salt marsh habitats from boat wakes in the busy intercoastal waterway. Learn more about project

Stuart Findlay, Aquatic Ecologist, Cary Institute of Ecosystem Studies

Stuart has been conducting research on the Hudson River ecosystem for over eighteen years with an emphasis on carbon and nutrient cycling in freshwater and tidal habitats and watershed restoration issues. Stuart has led several Science Collaborative grants related to sustainable shoreline designs and monitoring approaches in the Hudson River Valley. Learn more about project

Jennifer Raulin, Manager, Chesapeake Bay-Maryland National Estuarine Research Reserve

Jenn oversees the Chesapeake Bay Reserve's research, training, stewardship, and education sectors. Her responsibilities include serving as the primary liaison with NOAA to manage grants and advancing coastal management practices with partners in and around the reserve's three protected areas. Jenn brings a management perspective to the panel discussion, helping explore the applications of shoreline research projects for other reserves and regions.

Denise Sanger, Research Coordinator, ACE Basin National Estuarine Research Reserve

Denise is a marine ecologist with expertise in benthic ecology, sediment chemistry, water quality, ecological risk assessment, and the application of science to management. She oversees long term monitoring and a range of applied research efforts at ACE Basin Reserve and has studied the performance of living shorelines all along the coast of South Carolina. Learn more about project

Eric Sparks, Assistant Extension Professor, Mississippi State University

Eric is the assistant director for outreach for Mississippi-Alabama Sea Grant and he focuses on estuarine and wetland issues, including coastal restoration and restoration research. He's worked on two Science Collaborative projects assessing living shoreline use along the Gulf Coast. Learn more about project

This session was moderated by Jennifer Read, program manager of the NERRS Science Collaborative and Director of the University of Michigan Water Center.

DISCUSSION SUMMARY

The session began with a set of three brief polling questions to provide a snapshot of audience demographics, gauge familiarity with the NERRS, and identify audience members' interest and involvement in the field of living shorelines. Following a quick analysis of polling results, moderator Jen Read asked each panelist to provide a personal perspective on why they became involved in living shorelines, and why the topic is a compelling management issue in their region. Polling results can be found on page 5. A summary of the discussion follows.

DISCUSSION SUMMARY

Discussion Prompt 1: **What is the most important lesson you have learned through your research that you want to share with practitioners?**

Stuart Findlay noted that nearly 20 years of shorelines research in the Hudson River reserve laid the groundwork for developing a rapid assessment protocol for evaluating ecological and physical protective function provided by living shorelines. As he explained it, a major research challenge was synthesizing two decades of research and calibrating it for local conditions relevant to shoreline managers.

Key lesson learned: Encouraging living shoreline modifications requires local, visible, and tangible demonstration of their ability to minimize erosion, protect infrastructure, and remain viable over years.

Christine Angelini agreed with Stuart, commenting that experiencing a living shoreline demonstration in person provides a significant boost to credibility. She further remarked on the value of performing smaller pilot-scale experiments to identify where and how materials should be placed to enhance the performance of larger-scale projects.

Key lessons learned: Build in time to test different factors - such as materials, elevations, and timing of deployment - at pilot scale if able to do so; and begin projects by figuring out what the shoreline is supposed to look like, which materials to use, and where to position components.

Denise Sanger shared a similar perspective, observing that experimental treatment types are valuable as a means of determining anticipated results and informing practice. As an example, she noted that testing coir logs helped them understand scenarios in which they are likely to work and differentiate from those in which they are unlikely to perform as desired.

Key lessons learned: Monitoring is vital to long-term success; and use experiments to help inform expectations for success, especially when communicating expectations to homeowners.

Eric Sparks gave a quick overview of his project, summarizing it as an evaluation of the cost effectiveness of large scale breakwaters in relation to other practices. He raised a challenge observed in the Mississippi-Alabama region; namely, the difficulty in finding a contractor trained in living shoreline techniques that can perform the

installation. Eric noted that one of the focus areas of his project was to provide workshops aimed at training a contractor base so that they can confidently recommend living shoreline approaches when appropriate.

Key lessons learned: The Gulf region needs a contractor base familiar with living shorelines; when working with highly dynamic sites, understanding the geologic history of a site can help inform results and future designs.

Jennifer Raulin then provided a reserve perspective, emphasizing the value of using NERRS sites as reference sites or controls in research. She agreed on the value of providing training, and remarked that this is an activity in which the Reserve system engaged in the past.

Key lessons or insights: Explore pilot projects together with a team; engage with landowners and regulatory agencies from the beginning of the project onward; implementing smaller pilot projects tends to lead to more projects; designs may vary by region, but challenges are similar across the Reserve system; and NERRS sites serve as excellent reference sites or controls in research.

Discussion Prompt 2: **What do you see as the next steps, opportunities, and needs for management and research?**

Jennifer Raulin identified three major misconceptions common to living shorelines against traditional armored shorelines: cost, efficacy, and maintenance. She remarked that living shorelines make people nervous because they may not have the same outward appearance of strength that a bulkhead does, but went on to say that photographic evidence showing how living shorelines survive major storms provides a compelling case for their strength.

Opportunities and Needs: Explore more social science, or more discussion on how other reserves have overcome barriers to implementation; and perform a cost-benefit analysis for ecosystem services and protective function offered by living shorelines approaches.

Denise Sanger spoke to the need for approved guidance documents to encourage state-level support and provide evidence of living shoreline efficacy and cost-effectiveness. From a research perspective, Denise identified materials testing as an ongoing focus of shoreline research and application in South Carolina.

Next steps: Explore material combinations that optimize the efficacy and longevity of living shorelines.

Stuart Findlay commented that the Sustainable Shorelines project team identified both short-term and long-term goals. In the short term, he noted that the team's advisory committee was eager to see projects on the ground, functioning as intended and providing ecological benefits. For long-term goals, Stuart indicated that a change in landscape and coastal design practice motivated by client needs would be the likely driver behind wider adoption of living shorelines.

Next steps: Understand and bridge gaps between engineer or contractor recommendations and client understanding; change the types of educational materials people encounter when exploring living shorelines; and shift the perspective of what clients and contractors view as feasible techniques for shoreline stabilization.

Christine Angelini identified two areas that need more attention from a research perspective: harmonizing natural and built environments; and quantifying the net benefits of collective action. For the former, she described a need to conceptually expand living shorelines approaches to existing armored shorelines to help stabilize eroding shorelines and improve their ecological benefits. In the latter area, Christine observed that communitywide efforts to implement living shorelines could provide crucial information as to whether there are any net benefits that can arise through collective action and implementation, such as seeing the greatest gains in water quality where many neighbors invest time and effort into oyster restoration.

Need: A study quantifying the collective benefits of whole-systems approaches versus individual approaches for living shorelines.

Eric Sparks commented on the high ratio of private to public landowners in coastal areas, identifying private property-scale evaluations as a target area for ongoing work. This perspective was reinforced by Jennifer Raulin, who agreed that targeting homeowners' associations and community groups to increase awareness about living shorelines was an effective way to build and finance larger projects.

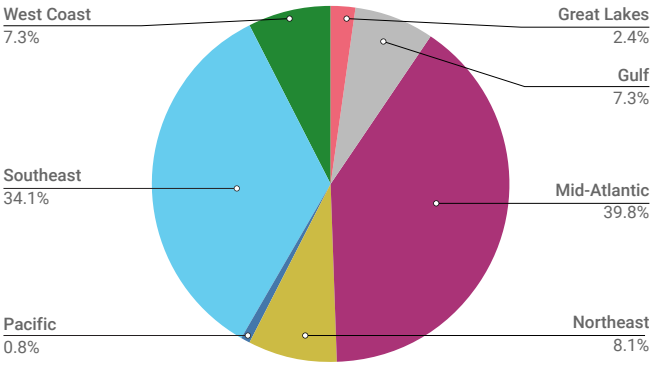
Need: Cost-sharing and assistance programs for private landowners to understand and finance living shorelines projects on their property.

SUMMARY STATISTICS

The graphs below illustrate audience demographics and polling results from the April 11 webinar.

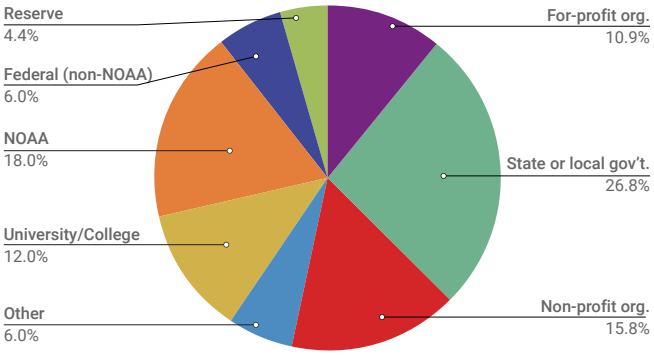
Attendance Breakdown by Region

n=123



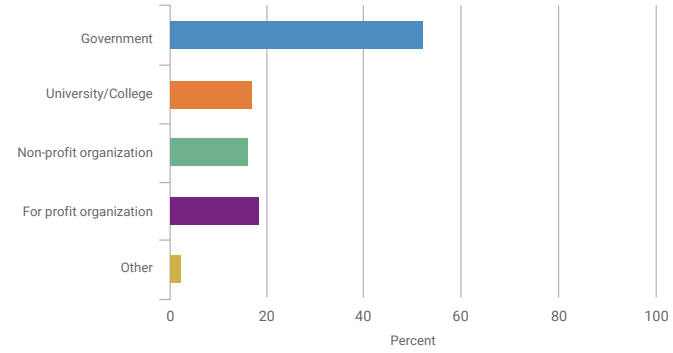
Attendance Breakdown by Sector

n=123



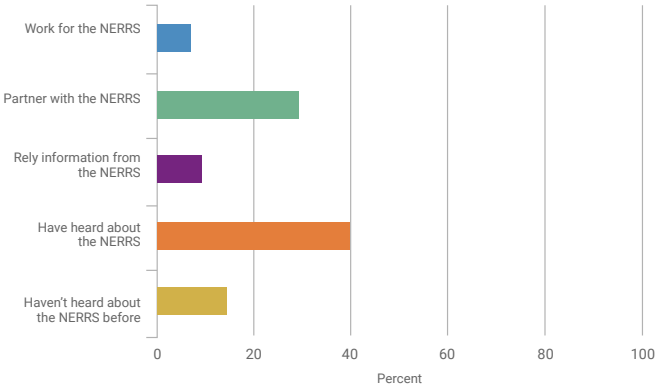
What kind of organization do you work for? Select all that apply.

n=184



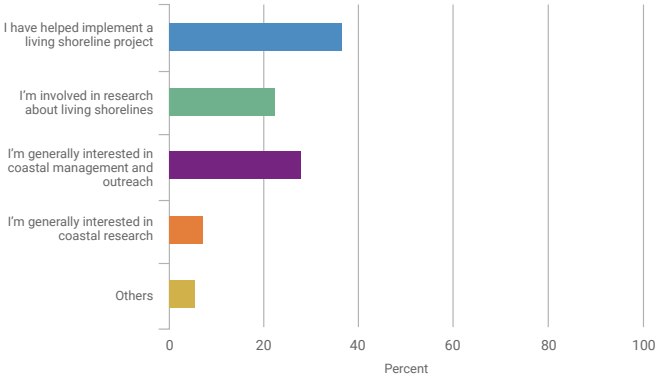
How familiar are you with the National Estuarine Research Reserve System?

n=130



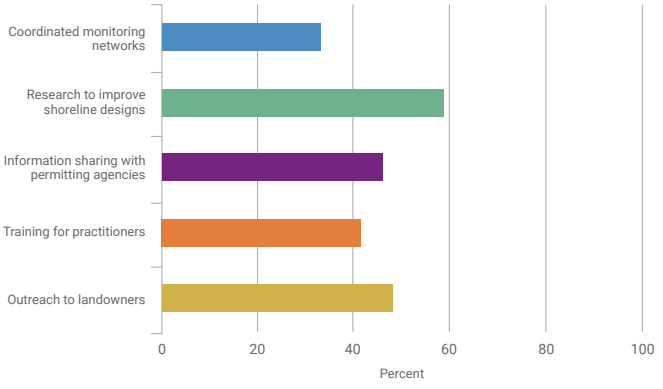
Which statement best describes your interest in living shorelines?

n=139



Which next steps seems most important for your work? Check any that apply.

n=93



QUESTION AND ANSWER SESSION

This section summarizes questions submitted by webinar participants during the webinar and responses provided by the panelists. Due to time constraints, not all questions were answered during the webinar. For questions not answered during the webinar, panelists helped to provide written responses, which are included here. For privacy purposes, the names of the individuals who submitted questions are not provided in this document. If you would like to follow up on any of the questions below, please contact us at nerrs-info@umich.edu.

QUESTION AND ANSWERS

Q: I'm curious as to what line of evidence or data has been the most effective in convincing either policy makers, government actors, or funding bodies that these living shorelines are worth funding and studying further?

A: South Carolina DNR has been implementing oyster-based projects. It really was the fact that communities were seeing how successful they were and how much marsh was filling in behind them - and protecting shorelines - that they started asking regulatory agencies how to pursue them; that elicited them coming to us and wanting to work with us. The beauty of the NERRS Science Collaborative as a funding source is the concept of developing research with management applications and having true interaction because we have this very direct connection. I think it goes back to the idea of those pictures and pilot projects to demonstrate that these projects do work and can be successful.

Q: Can you recommend living shorelines best practices for low-salinity, high wave energy environments where minimizing disturbance to submerged aquatic vegetation is a priority? Are there any online tools that allow you to enter parameters like these in order to find recommendations on most effective living shoreline approaches?

A: We have had great success with in a low-salinity, high wave energy environment at the Weeks Bay NERR. Knowing that wetland plant diversity is much higher in the lower salinity environments, planting a tolerant foundation species, such as black needlerush *(Juncus roemerianus)*, can be used as a method to stabilize the shoreline and allow for succession of stronger competitors in that environment, which is typically an assemblage of more freshwater associated plants. In other words, build a stable environment that is conducive for natural plant colonization and let nature determine the appropriate assemblage. Minimizing disturbance to submerged aquatic vegetation (SAV) is an issue that is difficult to navigate when considering living shoreline approaches, particularly where breakwaters, groins, etc. are desired. Those structures will inherently alter sediment deposition, which may lead to covering of SAV, or the ideal location for this structure might be on top of a SAV bed. Those types of projects just require a significant amount of coordination and discussion with permitting agencies to determine if the improved shoreline is worth the potential, and possibly temporary, loss of SAV. I'm not aware of any online tools where those types of parameters can be entered to determine a recommended design.

Q: We seem to see a focus on evaluating protection but assuming ecological benefits - can any panelists speak to their experience with the latter?

A: The ecological benefit question goes back to the point about having local verification that metrics are demonstrably linked to presumed ecological functions. We do this for the Hudson in the *Aquatic Sciences* paper where we show, for instance, that gentler slopes have higher fish richness. Such patterns have been widely reported but local validation seems key.

Q: How important is understanding boat wake interactions with living shorelines? Are panelists aware of interesting research in this field that is along the same lines as Dr. Angelini's work?

A: In estuaries that support moderate to high levels of boat traffic, it can be essential to understand how the energy created by boats are affecting shoreline processes and design living shorelines in such a way that they can can not only withstand that energy, but also dissipate it to enable coastal marsh and/or oyster reef to persist. And, as far as I know, Linda Walters, Ray Grizzle and Eric Sparks (another panelist) are other investigators who have been studying the performance of living shorelines under high boat energy conditions.

Q:Which species of salt marsh grass would be more successful in potentially seasonal high-velocity flow: Juncus roemeranius or Spartina alterniflora *(a.k.a. Sporobolus alterniflorus)*?

A: Assuming that these seasonally-higher flow velocities are driven by increases in freshwater input that would lower the prevailing salinity, of the two options, I would say that *J. roemerianus* would be a better alternative to *Sporobolus alterniflorus*. More broadly, though, a good rule of thumb would be to observe which species of vegetation predominate in the particular area of study and to investigate the use of those locally- and environmentally-appropriate species within living shoreline projects implemented at that same location.

Q: How can the regulatory agencies' rigidity toward living shorelines be overcome? For example, the concept of thin layer deposition runs counter to the mindset of absolutely no filling of tidal wetlands.

A: Little by little. It takes time and patience to work with the regulatory sector to implement new and innovative techniques such as living shorelines and marsh enhancement projects like thin layer placement. Start small - pilot and research projects are helpful to demonstrate proof of concept and get regulators on board. Include your regulatory colleagues as partners in the project - get them out to the site, do a pre-application meeting, and demonstrate why a traditional approach would not work as well as a natural approach. By including them as part of the project team up front you can address their concerns along the way. Look for willing landowners, like a Federal partner. Getting a demonstration project on federal property can be less burdensome on the permitting side, but if successful, can be the demonstration site you need to showcase the technique to state and local agencies.

Q: Do you find local jurisdiction streamlines living shoreline projects permits above traditional shoreline armoring?

A: For 11 years now, the state of Maryland has said that the preferred approach is the natural approach, but you can still apply for a waiver. We have a joint permitting process with federal and state permitting. The timeline for the living shoreline design process can be lengthy, which can be a disincentive for homeowners, and that may be an area which we can improve upon. There are FAQs on the MD DNR page that can take homeowners and contractors through the process.

Q: How do you balance the installation of a living shoreline with prohibitions on filling out into our waterways and potentially impacting other benthic habitat?

A: I think it's important to consider the objectives of the living shoreline installation in the first place. Is it meant to preserve the coastal wetlands that are behind it? Was that benthic habitat salt marsh three years ago that's eroded and become benthic habitat?

I think we should be a bit careful about where we're placing these materials. Are we managing against what's somewhat of a natural process, in which that mudflat was going to expand whether there were humans there or not? We're engineering nature in all of these situations, so we again need to consider the objectives; is property protection the main objective of your project? Is it preventing further habitat loss? You could potentially justify installing materials to take over some of that benthic habitat in the latter case, but if the ecological benefit of that benthic habitat is very high, and you don't have these other incidental ecosystem services generated by that living shoreline, then you may be doing the natural system the biggest favor by leaving it alone. Again, I think this is another example of the importance of local context and conditions.

Q: Are you all working with the same definition of a living shoreline? There's a spectrum of how "living" a living shoreline practice might be, so I'm interested in whether everyone's speaking the same language.

A: For this webinar, we used a broad definition of living shorelines in order to capture the diverse approaches used by the featured projects. For our purposes, the term living shoreline encompasses a range of techniques referred to as nature-based, ecologically enhanced or softer approaches. Projects incorporate features of the natural environment, including plantings, oyster reefs, breakwaters, natural fibers or rock amendments in order to stabilize the shoreline and protect coastal habitats.

Q: Is any work being done in this area for urban and industrial shipping channel areas?

A: There is certainly work being done by engineering firms to address and mitigate erosion associated with industrial ports and commercial shipping channels. However, most of the infrastructure put into place to reduce erosion from those sources is usually associated with the ports themselves, and does not address erosion to coastal wetlands and reefs that may be further from urban centers but still affected by these larger boats. In general, humans have extensively hardened urban coastlines where boating traffic is really high; thus, many of

our most vulnerable areas are those in nature reserves or more residential/rural areas where boats are directly interacting with natural shorelines.

Q: What do the panelists see as the potential or likelihood for the development of design standards and/or performance standards for living shorelines in their states?

A: I can't speak for the state, but it does relate back to a previous question as to whether there's some sort of fast-tracking for living shorelines. I'm a bit concerned that there's a risk, if a living shoreline design gets fast-tracked, then that will become a standard practice. Then, whether or not a specific design is appropriate for certain situations, it may be installed regardless and potentially fail. This in turn can lead people might to conclude "we tried it and it didn't work so we aren't going to consider this anymore."

The other potential problem is that universal application of a living shoreline design trades one kind of homogeneity for another. Given the range in attributes for natural shorelines along any coastline, the last thing you want to do is lose diversity; those natural shorelines have become different for a variety of reasons, and the idea that we're going to replace them with any single type of shoreline - hard and gray or green - is probably a bit optimistic. We need the knowledge base to be able to say "for your site, degree of protection, and conditions, these are your best three options," and hope that one of those options has nature-based features.

A: Every project is so different, and every shoreline is so different. A standardized approach may not be the best thing for this. We recently ran a contractor workshop in which we presented the basics of living shorelines, suggesting they contact us after the fact if they have specific projects they want to tackle. If we expanded that workshop to include every possible scenario, we'd have been there for a week. I don't think it's likely that there will be a standardized packet of living shoreline activities pushed forward in our region.

Q: What are the processes and/or metrics most commonly used for monitoring living shoreline installations? Are these sufficient, or are new or more metrics needed?

A: It depends on the goal to some extent - was it installed with habitat creation or shoreline protection as a priority? Since our project was centered on shoreline protection, our (SC) monitoring program reflects that. I'd say in the simplest sense sediment characteristics, sediment elevation, shoreline position, and oyster growth would be key metrics.

If it was for habitat creation then some of those parameters, plus some sort of nekton-type metric (e.g., drop-netting), would be needed.

A: The goal and context are important. Some caution is needed in this dialogue to avoid too much separation between shoreline protection services and, at least for oyster reef-based approaches, other associated ecosystem services. It is impractical to measure every type of ecological benefit for every restoration site we establish or living shoreline that we create. For our current project (SC), we were certainly focused on shoreline protection as our primary response, but for reefs that were successful in those functions, as supported by oyster settlement and growth, I do not think that it is a leap to assume that other benefits were occurring, even though we did not measure them (e.g., water filtration, associated fauna, etc.). Certainly, for the east coast, those benefits of oyster reefs are extremely well documented.

At least in terms of oyster based approaches to creating living shorelines, there are some standardized monitoring approaches that are encouraged and can be useful in determining the extent to which the establishment of oyster reef habitat has been successful. One such widely distributed handbook on those approaches can be found here.

Q: Can you please post the link for the management brief that was mentioned?

A: You can access the Draft Management Brief - distributed ahead of the April 11 webinar - from the Resource Library on the NERRS Science Collaborative website.

Q: Was this webinar recorded for later viewing?

A: The video recording for this webinar is available on the Science Collaborative's YouTube channel.

ATTENDEE THOUGHTS ON NEXT STEPS, OPPORTUNITIES, AND NEEDS

Following the webinar, attendees were prompted with a short, online survey to provide their thoughts on next steps, opportunities, and needs for management and research related to living shorelines. Science Collaborative staff then organized survey responses according to emergent themes as follows.

Prompt: **What do you see as next steps, opportunities, and needs for management or research related to living shorelines?**

Permitting and coastal management

- I would like to see a better feedback loop between practitioners and permitting agencies. The red tape can be so thick that the original intent of these restorations is lost. As a design consultant I would love the opportunity to give input on the actual installation results of these regulations.
- More focused and coordinated management of public lands (federal, state, local) with eroding shorelines.
- Elevate living shorelines from piecemeal, erosion protection projects to a larger scale, multiple-benefits coastal resilience framework.
- Shifting management from a private owner or household level to a shoreline approach.
- Develop regulatory flexibility when reviewing permit applications to assess ecological functionality and account for ecological uplift.

Financing and incentives

- We need cost-share programs and monetary incentives, as well as more education and greater awareness among homeowners.
- I would really like to learn more about, and see greater application of, Maryland financing options - or financing mechanisms from anywhere really.
- Get local governments to provide incentives for living shorelines.
- Research on how local governments can incentivize nature-based solutions for shoreline protection.
- The permitting process on its own becomes cost prohibitive, and I like the idea of cost-sharing grants for private homeowners.

Shoreline designs and materials

- One of the next steps for research is to evaluate hybrid options and/or ecologically beneficial enhancements to hardened shorelines.
- I know examples on West Coast are scarce but this discussion was very low-energy environment centric and had less utility for someone from the West Coast. In particular I would really like Maryland financing options - or financing mechanisms from anywhere really.
- A big need that we have as restoration practitioners is the development of a biodegradable mesh that can hold recycled oyster shells long enough for new oysters to attach to and grow, ideally 3-5 years. The plastic mesh is very effective

for living shoreline construction, however, we would like to get away from the plastic since marine debris removal and prevention is another one of our goals.

- Salt marsh grass cultivation and best planting techniques.
- Intertidal reef construction methods using oyster shells without plastic.

Understanding decision making related to living shorelines

- Socioeconomic research capturing stakeholders' motivations.
- More social science understanding to reveal how property owners perceive risk and make their choices.
- As Christine Angelini said during the webinar, we need to elevate living shorelines from piecemeal, erosion protection projects to a larger scale, multiple-benefits coastal resilience framework. This certainly requires more social science understanding to reveal how property owners perceive risk and make their choices. We are working on this approach now in coastal Virginia.
- People generally don't want to lose their property and would rather use the tidal areas to install the living shoreline.

Outreach and communications

- As a member of Fairfax County Wetlands Board and an environmental professional working on natural and nature-based flood management training, I think we need more work on innovative communication and awareness raising for living shorelines and training with contractors and engineers.
- We need more focus on property owner buy-in; greater diplomacy and/or outreach to homeowners about ecological practices.
- Discussions on how to get consultants on board convincing their clients to try living shorelines rather than hardened shorelines.
- More of this type of webinar highlighting what is going on across the nation. I'd like to discuss Virginia; many of the next steps and needs that the presenters suggested are being implemented in Virginia.
- I would love to have access to easy reference materials that cite examples of living shorelines and their ability to withstand harsh physical conditions just as well, if not better, than hardened shorelines. It would be great to be able to easily provide this information to landowners in a clear and concise way.
- To increase demand for living shorelines in North Carolina, the NC Coastal Federation and its partners have been training contractors through hands-on hired work in the field rather than indoors through powerpoint presentations, etc. This way they do not lose workdays by attending day long training. These contractors are now promoting and implementing living shorelines on their own. We also work closely with the state's Division of Coastal Management, the regulatory/permitting agency, to promote living shorelines over bulkheads to property owners. We also have then conducted Living Shoreline Open Houses to link waterfront property owners to these contractors and permit representatives. We have also found that when one neighbor gets a living shoreline in a neighborhood, others in the neighborhood want to implement one too. These efforts have been really successful in

increasing the number of living shorelines being implemented in North Carolina. This work was done through funding from NOAA's Community Ecosystem Resiliency Grant Program.

- Another lesson learned in Virginia was mentioned in the webinar. Gray infrastructure is likely here to stay, at least in some locations with high risk. Shoreline enhancements to 'soften' armored shorelines with vegetation or other habitat features are gaining in popularity. While they are not considered living shorelines per se, collectively these enhancements can have significant, local positive effects especially if the accepted shoreline landscape aesthetic is shifted away from bulkheads with lawns. Property owners not willing to remove existing defense structures to replace them with living shorelines should be informed about shoreline enhancement options and then be supported if they choose this approach.

Technical guidance and training

- Another lesson learned in Virginia was mentioned in the webinar. Gray infrastructure is likely here to stay, at least in some locations with high risk. Shoreline enhancements to 'soften' armored shorelines with vegetation or other habitat features are gaining in popularity. While they are not considered living shorelines per se, collectively these enhancements can have significant, local positive effects especially if the accepted shoreline landscape aesthetic is shifted away from bulkheads with lawns. Property owners not willing to remove existing defense structures to replace them with living shorelines should be informed about shoreline enhancement options and then be supported if they choose this approach.
- Ongoing development of best management practices for living shorelines techniques. Ongoing development of training tools for contractors, and availability of training opportunities. Ongoing translation of regulatory requirements for contractors and private property owners. Ongoing avoidance of "greenwashing," ensuring that we keep the "living" in living shorelines -- the SAGE diagram showing continuum of green-gray stabilization options helps keep us honest.
- One of the next steps for management is to train and mentor marine contractors in the implementation of living shorelines and hybrid solutions.
- In New England, at the state and regional scales, we need more training material development and outreach, education, and capacity development with coastal engineers, landscape architects, permitting staff, municipal staff, and private coastal property owners.
- I think that there is a real need for design guidance on living shorelines. There are a lot of different options available but, as an engineer, it's difficult to be confident sometimes that less "hardened" approaches are adequate to appropriately stabilize a shoreline.
- We need more industry training and development of best management practices for living shoreline practice.
- Consideration of habitat tradeoffs in construction of living shorelines - for example, submerged aquatic vegetation is often growing along shorelines that would be filled in the construction of a living shoreline. How is the existing habitat function taken into consideration in design?
- Stuart Findlay made a valid point about fast-tracking with expedited permits & review processes. He rightly expressed concern for under-designed or inappropriate design choices

made for fast-track permits that lead to project failures or underperformance, which increases skepticism for living shorelines in general. Regulatory agencies may not be able or allowed to question whether a project design will perform adequately, although the regulated public might assume that permit issuance is also a performance guarantee. This responsibility actually falls to the designers & installers, and property owners. This is just one reason why more training for living shoreline professionals is imperative.

Demonstration and monitoring

- What are the processes and/or metrics most commonly used for monitoring living shoreline installations? Are these sufficient, or are new or more metrics needed?
- More tracking and monitoring of living shoreline projects is absolutely necessary. At the very least, simple observational performance assessments are needed to document and track where and why projects work and don't work. The post-storm forensic analyses and Rapid Assessment Protocol from New York should be very useful for other regions to adopt similar efforts.
- Establishing demonstration sites, monitoring, developing the professional network.
- Continuation of research on projects installed.
- In New England, at the state and regional scales:
  - More demonstration projects;
  - Standardized monitoring to evaluate performance (ecological and physical), including ice impacts, storm-event impacts (especially winter nor'easter storms), and long term monitoring;
  - Better understanding of monitoring and maintenance costs, and comparison to traditional gray infrastructure costs in New England;
  - Regional database of monitoring data to share data and inform the designs of future projects; and
  - Local, state, federal policy guidance for living shoreline project design and implementation, and parity between living shorelines and gray infrastructure in terms of baseline site characterization and performance monitoring requirements to evaluate impacts on the both the project site and adjacent properties/resource areas.
- It's important to demonstrate that living and nature-based shoreline treatments work in three ways: 1) they are structurally successful, especially in the context of impacts of the changing climate; 2) their cost is comparable to conventional treatments over the life of the project; and 3) they provide good ecosystem services. Monitoring and demonstration sites are key ways to accomplish this. The most important audiences for this information are regulators, designers, and land-owners. I'd also like to see this topic linked to long-term adaptation of coastal wetlands to climate change, especially wetland migration up-slope as sea level rises.
- More consistent and/or standardized monitoring to demonstrate effectiveness, appropriate locations, and designs of living shorelines.
- Monitoring techniques for accretion, especially at publicly accessible sites where people may interfere with placed reference markers.

SURVEY RESPONDENTS

To help support ongoing efforts and foster connections among living shorelines practitioners and researchers, attendees were encouraged to consider providing their contact information and a summary of how their work intersects with living shorelines. 183 people attended the webinar, and the following opted to provide their information.

Betsy Blair

Director, Blair Environmental Consulting; Research Affiliate, National Estuarine Research Reserve Association

Betsy@BlairEnvironmental.com

About my work: My work is dedicated to fostering adaptation of natural coastal communities to climate change.

Marina Cazorla

Program Manager, Coastal Habitat Restoration, California Ocean Protection Council

marina.cazorla@resources.ca.gov

About my work: I implement public bond-funded coastal habitat restoration grant programs, with a particular focus on sea level rise coastal adaptation.

Justina Dacey

Extension Agent II, University of Florida Institute of Food and Agricultural Sciences Extension

jdacey@ufl.edu

About my work: I work on education pertaining to natural resources in Florida.

Karen Duhring

Coastal Scientist, Virginia Institute of Marine Science

karend@vims.edu

About my work: My group at VIMS provides shoreline mapping tools and models, plus living shoreline outreach and training for local governments, extension agents, NGOs and design-construction professionals.

Vincent Encomio

Extension Agent, Florida Sea Grant

vencomio@ufl.edu

About my work: I have been involved in living shoreline installations on public and private sites.

Allison Fitzgerald

Assistant Professor, New Jersey City University

afitzgerald@njcu.edu

About my work: I work on oyster restoration, living shorelines, and ecotoxicology in the Hudson-Raritan Estuary. My specialities are invertebrates and marine ecology.

Carolyn Fraioli

Coastal Resources Specialist, New York Department of State

carolyn.fraioli@dos.ny.gov

About my work: I implement the NY Coastal Management Program, with a focus on alternative shoreline management measures.

Marina French

Landscape Architect/Restoration Designer, The Watershed Company

mfrench@watershedco.com

About my work: I work on restoration design in public and private spaces of critical areas, including shorelines.

Barbara Gavin

River Star Homes Program Manager, Elizabeth River Project

bgavin@elizabethriver.org

About my work: I am manager of a homeowner cost-share program in Virginia implementing residential best management practices.

Jana Haddad

PhD Student, University of North Carolina Institute of Marine Sciences

jhaddad2@live.unc.edu

About my work: I conduct research on wave attenuation due to coastal marsh vegetation, with an interest in boat wake attenuation.

Keith Hanson

Habitat Specialist, National Oceanic and Atmospheric Administration-National Marine Fisheries Service

keith.hanson@noaa.gov

About my work: I review and provide recommendations on coastal development projects.

Jane Hart

Environmental scientist, Brevard County Natural Resources

jane.hart@brevardfl.gov

Fara Ilami

Biological Scientist, Florida Fish and Wildlife Conservation Commission

fara.ilami@myfwc.com

About my work: I coordinate a coastal conservation program.

Tim Judge

Adjunct Professor, Ramapo College of New Jersey; EcoAssessment, LLC

judget@alum.rpi.edu

About my work: I am an Adjunct Professor of Environmental Studies and a practitioner of applied ecology.

Wendy Kordesch

Geological Oceanographer, National Oceanic and Atmospheric Administration-Greater Farallones National Marine Sanctuary

wendy.kordesch@noaa.gov

About my work: I work on living shorelines on the West Coast.

Steve Miller

Coastal Training Program Coordinator, Great Bay National Estuarine Research Reserve

steve.miller@wildlife.nh.gov

About my work: I provide outreach and training for decision makers.

Amy Picotte

Lakeshore Manager, Vermont Department of Environmental Conservation

Amy.Picotte@vermont.gov

About my work: I work on lakeshore restoration and protection.

Melody Ray-Culp

Coastal Program Coordinator, U.S. Fish and Wildlife Service

melody_ray-culp@fws.gov

About my work: I work on coastal restoration for the benefit of federally-protected species.

Eric Roberts

Coastal Resilience Specialist, The Nature Conservancy

eric.roberts@tnc.org

About my work: I facilitate collaboration to advance coastal resilience science and policy at the local, state, and federal levels.

Angela Schimizzi

Marine Biologist, New York State Department of Environmental Conservation

angela.schimizzi@dec.ny.gov

About my work: I review project proposals on the Hudson River and a portion of the Long Island Sound.

Samantha Schneider

Environmental EIT, ASA Analysis & Communications, Inc.

sschneider@asaac.com

About my work: I provide environmental and engineering services.

Andrew Tiefenback

EIT, Stantec

andrew.tiefenback@stantec.com

About my work: I am working on designing a number of different hybrid living shoreline projects around the Chesapeake Bay in Virginia.

Jennifer Ukeritis

Assistant Regional Attorney, New York State Department of Environmental Conservation

jennifer.ukeritis@dec.ny.gov

About my work: I handle enforcement and permitting matters for the agency, and I previously assisted in creating the NYS Living Shoreline Guidance document.

Anita van Breda

Senior Director, World Wildlife Fund

anita.vanbreda@wwfus.org

About my work: I work on environment and disaster management, including flood management, using natural and nature-based flood management methods.

Lexia Weaver

Coastal Scientist, North Carolina Coastal Federation

lexiaw@nccoast.org

About my work: I design, permit and implement living shorelines in North Carolina.

Aaron Wendt

Shoreline Engineer, Virginia Department of Conservation and Recreation

aaron.wendt@dcr.virginia.gov

About my work: I provide free technical assistance to landowners experiencing shoreline erosion and assist them in choosing, designing, and implementing solutions (including living shorelines).