Living Shorelines Workshop: Habitat tradeoff considerations for design and permit review

Workshop planning and facilitation by NCDMF and NCDCM

NOAA Beaufort Lab Auditorium

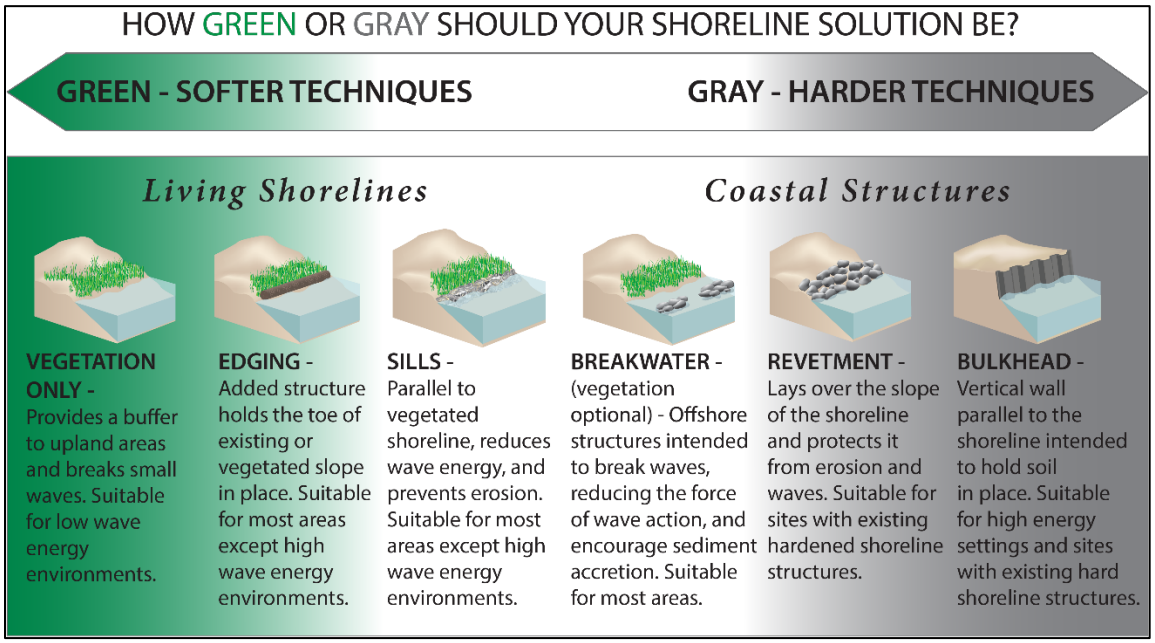
October 12, 2023, 9:00am - 3:00pm

Introduction and meeting objectives

The meeting was held by the Division of Marine Fisheries (DMF) and Division of Coastal Management (DCM). Increasing numbers of large living shoreline applications have resulted in questions from resource and regulatory agencies reviewing the projects and restoration professionals designing and constructing projects. With updates on what is currently known about living shoreline from researchers and group discussions, the meeting objectives are to:

- Improve understanding of maintaining and enhancing coastal habitat resilience
- Improve understanding of regulatory considerations for the permitting process
- Consider the latest science on habitat tradeoffs when designing living shorelines to facilitate successful permitting
- Develop habitat tradeoff research needs

There is a wide range of shoreline stabilization designs that are referred to as a living shoreline, ranging from marsh plantings to breakwaters. For the purposes of this meeting, living shorelines were defined as ***"a suite of options for shoreline erosion control that maintain connections between upland, intertidal, and aquatic areas essential for water quality, ecosystem services, and habitat values. Unlike vertical stabilization measures such as bulkheads, living shoreline techniques typically use native materials such as marsh plants and oyster shells and sometimes, minimal amounts of structural materials (e.g. stone), to stabilize estuarine shorelines, minimize erosion, and enhance habitats." (NC Living Shoreline Steering Committee)***



Source: https://www.habitatblueprint.noaa.gov/living-shorelines/

Living shoreline history – where we started

Daniel Govoni (DCM), Anne Deaton (DMF), and Dr. Lexia Weaver (NC Coastal Federation) gave presentations on the history of living shoreline use in NC. Govoni began by discussing changes in the permit process since 2005. Due to legislation, DCM developed a General Permit (GP) (15A NCAC 7H .2700) for marsh sills in 2005 that included 29 specific conditions, including coordination with the DMF, the NC Division of Water Resources (DWR), and the US Army Corps of Engineers (USACE). Conditions were included due to input/concerns about distance appropriate for the sill structures to be built, habitat tradeoffs, navigational and public trust concerns, suitability of different structures on different shoreline types, and permitting requirements of other agencies. However, there were concerns from applicants that the conditions were slowing down the permit process and acting as a disincentive to applying for a marsh sill rather than a bulkhead.

Deaton explained that discussions at the Coastal Habitat Protection Plan Steering Committee (CHPP SC) meetings on the issue led to the 2005 CHPP recommendation to protect fish habitat by revising estuarine and public trust shoreline stabilization rules and consider the development and promotion of incentives for use of alternatives to vertical shoreline stabilization measures. Through discussions with the CHPP SC and DEQ agencies, several actions were taken that assisted with this, including agency field visits to existing marsh sills (~25) to assess effectiveness for erosion control and any evident resource concerns. The visits resulted in almost all of agency concerns being alleviated except effectiveness during large storm events and comparison of ecological effect of marsh sills in contrast to bulkheads and natural marsh. These were noted as research gaps. Following the survey, conditions to GP .2700 were modified and coordination with DMF, DWR, and National Marine Fisheries Service (NMFS) was removed. For the GP, fill was not allowed, and sills couldn't be constructed within 10' of shell bottom, and SAV.

While the GP was simplified, it didn't align with an existing USACE's Regional General Permit (RGP) or Nationwide Permit (NWP). After discussions between DCM and USACE, a USACE RGP was authorized in 2018, and CRC adopted the revised GP .2700 in 2019. Govoni reviewed other actions taken as part of DCM's Living Shoreline Strategy (2014) to encourage and promote living shorelines. This included encouraging field reps to provide outreach to property owners, reprinting of the publication "Weighing your Options", training workshops for property owners, contractors, landscapers, and realtors, informational signage at demonstration sites, and marsh sill monitoring and research. Deaton noted that multiple research projects were conducted around 2008-2010 timeframe examining the differences in fish, wetlands, and erosion control among bulkheads, marsh sills, and natural marsh.

Weaver reviewed how living shoreline designs have changed over time and reviewed the different materials available. She summarized the benefits of living shorelines and how the Living Shoreline Steering Committee was formed in 2018 to build on momentum of ongoing efforts. In 2019 there were 16 sites (0.5 mi) of living shoreline permitted, and in 2023 there were 58 sites (2.1mi) permitted. She provided visual examples of small and large-scale projects. Use of living shorelines has increased not only due to the streamlined permitting process, but increased availability of cost-share funding. The goal is to make living shorelines a more common method for shoreline stabilization, rather than bulkheads so that marsh and oyster habitat is restored and water quality is improved while also providing shoreline protection.

What have we learned about living shorelines?

Dr. Rachel Gittman reviewed some of the research completed by her and other colleagues in NC. Data and citations are included on the powerpoint slides. She focused primarily on comparing living shorelines to natural marsh shorelines. One study examined the difference in fish and crustacean use at natural (control) and marsh sill sites, both in the marsh and nearshore subtidal waters (Gittman et al. 2016). Within the marsh, catch per unit effort (CPUE) and biomass was higher at marsh sill sites. There was no statistical differences in the fish and crustacean use of the nearshore subtidal mudflat and seagrass habitats between sites with marsh sills and natural marsh shorelines. However, change in CPUE varied over time, with minimal difference in fish and crustacean CPUE noted one year after construction, and moderate but variable increases after three or more years. Other studies have found living shoreline and natural marsh supported similar nekton abundance and richness (Smith et al. *In prep*). Similarly Currin et al. (2008) compared fish, crabs, and shrimp at natural fringing and restored wetlands (marsh sill) and found differences in the mean number captured between the natural and restored marshes were not statistically significant. Only the abundance of *Palaemonetes vulgaris* (grass shrimp) was significantly greater in the natural marshes than in the restored ones. Sediment accretion during the study was up to two times greater at the sill than at the natural marsh, and after three years, *S. alterniflora* at the restored sites was increasing but not greater than the natural marsh. Scyphers et al. (2011) compared a natural marsh shoreline with oyster shell breakwaters for erosion control and effect on aquatic organisms. They found enhanced abundance of several fishery species between the breakwater site and the marsh, particularly blue crab and sciaenids.

A common finding across the studies mentioned was that living shorelines, based on a variety of fish and invertebrate metrics were ecologically equivalent to natural marshes. Additionally, the fish use varied over time. Additional studies are looking at fish habitat use with different types of structures (Geesin et al, in prep). In terms of the effect of living shorelines on seagrass habitat, a few modeling studies have been conducted (Vona et al. 2021; Palinkas et al 2023), but field data are lacking because permits usually require a buffer between living shorelines and SAV.

Dr. Brandon Puckett provided an update on research regarding effectiveness of living shorelines for erosion control and hurricane resilience. He reviewed known erosion rates in different regions of NC and noted that wetland vegetation reduces shoreline erosion, but does not prevent it, as evident by the prevalent erosion rates. Rather than extreme storm events, Leonardi et al. (2015) found that more than 85% of salt marsh erosion was attributed to frequent regular wind events (8-30mph). Puckett reviewed statistics on the extent of different shoreline stabilization structures, noting that there are 590 mi of bulkhead, 210 mi of revetment, and 4.25 mi of marsh sill. As of 2018, marsh sills occur in 12 coastal counties, with the majority constructed using granite. Research has been done before and after several Category 1 hurricanes (Irene, Matthew, Florence) to assess resilience of natural and stabilized shorelines to storms. Waterward of structures, results indicated a general pattern of some scour in front of bulkheads following a storm (although on the order of ~0.1m), whereas rock sills tended to gain sediment, oyster sills tended to have no effect, and natural marsh edge generally lost elevation (Smith et al. 2018). Landward of a rock sill, elevation generally increased following a storm, as did oyster sills to a lesser extent. Marshes generally lost a small amount of elevation. Some hurricanes reduced the marsh density at both sill and natural sites but were able to rebound, however sills appeared more resilient to vegetation loss and increased in density quickly (Gittman et al. 2014).

Several studies have evaluated marsh edge erosion, elevation change, and vegetation cover over time between sills and natural marsh. Over a 15-year period the elevation landward of the sills increased over time (~ 0.07- 0.13 m) in contrast to natural marsh that remained at or below 0.0 m. *S. alterniflora* stem density tended to be denser at the waterward edge of vegetation at sills compared to natural marshes, and less dense about 15 m landward. The upper area of the *S. alterniflora* transitioned to high marsh, increasing resilience to sea level rise. Sills reduced horizontal marsh edge erosion and resulted in accreting marsh edges within five years of installation in most cases.

Puckett noted that since surface elevation and plant distribution drive ecosystems services (wave attenuation, fish use, water quality, carbon burial), and years of fish monitoring have shown that fish will come to a healthy marsh, it is likely more valuable at this point to spend monitoring time on elevation and marsh plant success. Property owner surveys have also been conducted regarding shoreline stabilization and found that effectiveness of structure was the highest rank criteria, followed by cost, durability and ecological benefits (Smith et al. 2017). The studies on structure effectiveness are therefore very important in promoting living shorelines.

Climate change and increasing need for coastal resilience

Dr. Carolyn Currin presented on climate change implications for living shoreline design and permitting. Sea level along the U.S. coastline is projected to rise, on average, 10 - 12 inches (0.25 - 0.30 m) in the next 30 years (2020 - 2050). The long-term (1953-2022) relative sea level rise (SLR) based on the Beaufort NC tide gauge is 3.4 mm/yr. However, a salt marsh SLR study in Carteret County (2004-2008) reports 7.5 mm/yr and South Atlantic acceleration (2011-2015) is reported as 10-14 mm/yr. Due to suspended sediment concentrations and tide range in NC, the salt marshes are highly vulnerable to SLR. Currin went over how and where surface elevation tables (SET) are in NC and that the majority of the SETs failed to keep up with long-term relative SLR. Salt marsh meadows maintained elevation better than fringing marsh. Optimal elevation for marsh growth is near mean sea level and that is also where the greatest amount of sediment accretion occurs. Marsh that is submerged too long due to flooding is at risk to hypoxia stress, and when submerged too short of a time, is at risk to salinity stress. Warnell et al. (2022) modeled habitat change expected with an intermediate increase in SLR. Currin explained that the impacts of wetland loss will include reductions in nutrient uptake, pathogen immobilization, and fish and shellfish nursery and refuge habitat. Sediment erosion and resuspension, and shoreline wave energy will increase due to wetland loss, and reduced light from that will reduce seagrass and phytoplankton productivity. While sills and breakwaters can preserve marsh, they can also lead to loss of intertidal and shallow soft bottom habitat, hard substrate for invasive species, and altered marsh accretion rates. She noted that living shorelines, if not overbuilt, are a viable means of protecting property and infrastructure, but may only be buying time as SLR continues to accelerate. Higher elevation marshes are more resilient to SLR, but lower elevation marshes are better fishery habitat, so the distribution of marsh elevations is an important tradeoff in ecosystem services to consider.

Clair Rapp, NC Coastal Federation, reviewed regional and statewide salt marsh conservation efforts. The South Atlantic Salt Marsh Initiative (SASMI) is a coalition of partners, led by SERPPAS and including multiple local, state, and federal partners and NGOS from the south Atlantic states. The NC Coastal Federation completed a regional salt marsh plan in May 2023 (https://marshforward.org/). From that, states are developing more specific action plans. In NC, the NCCF took the lead to develop a NC salt

marsh action plan. They selected priority areas based on GIS analysis of predicted loss or gain of salt marsh by 2050, based on modelling by Warnell et al. (2022). The actions are focused around conservation of existing salt marsh (including by use of living shorelines) or facilitation of marsh migration. The NC Coastal Federation has established a Salt Marsh Steering Committee to assist with these efforts.

Refer to copies of the presentations and citations noted on the slides for more details.

Panel Discussion 1: Purpose and subsequent design of living shorelines – maximizing the ecosystem benefits while achieving effective erosion control

Panelists: Gregg Bodnar (DCM), Lexia Weaver (NC Coastal Federation), Mariko Polk (NC Sea Grant), Brandon Puckett (NOAA)

Panel members gave brief comments on their thoughts regarding the purpose and design of living shorelines, and discussion followed. Panelists noted knowledge gaps on how to site and design living shorelines, including: whether to design for future SLR or to plan to modify/add protection in future as SLR increases; how to address bluffs as tides increase; and minimum gap size and spacing recommendations. Further comments from panelists included that overlaps are better than gaps, that salt marsh plantings alone are not effective now, and that it will take time to see how well novel materials work.

Regarding the application process for living shorelines, regulatory staff noted that explaining the purpose and need is important for considering habitat tradeoffs and why the applicants need that specific design. Todd Miller asked if the same standards apply during permitting for bulkheads. Gregg Bodnar responded that they do not, and that resource agency review is not required for bulkheads. It was also mentioned that the USACE RGP includes coastal wetland considerations/restrictions. Rachel Gittman mentioned that she'd like to see what a permit looks like for a large bulkhead (i.e., for an entire housing community). Cameron Luck noted that a lot of the bulkhead permit applications received are for replacement bulkheads as opposed to new bulkheads. Gregg Bodnar mentioned that bulkheads also tend to be for individual residences, whereas a lot of extended community shoreline projects are living shorelines or revetments. Stephen Lane noted that when he receives an application for bulkheads, he lets the applicant know that riprap is more durable. Carolyn Currin noted that marsh wouldn't survive with a bulkhead landward, as that would prevent landward migration of the marsh.

Other suggested research needs included full assessment of functionality between natural and living shorelines with various amounts of "gray" components; assessment of cumulative impacts to shorelines; guidance for practitioners; and how to prioritize shorelines for protection and restoration activities.

Panel 1 breakout group discussions related to purpose and design

During the roving breakout session, participants were asked to discuss several questions. Responses are summarized below.

1. *Should living shorelines be designed for current or future conditions? If future, how far out?*

2. *How do restoration planners determine the type and size of structure and how do they prevent being overly hardened – height, width, length*
3. *What is the importance of the living part of living shorelines? I.e., must a living shoreline have plantings? Does research show the need for fill in living shoreline design?*
4. *What are the research needs related to living shorelines maximizing ecosystem benefits while providing effective erosion control [responses summarized in Research Needs section]*

P1.1. Should living shorelines be designed for current or future conditions? If planning for future conditions, how far into the future?

There was general consensus across groups that the focus should be planning for future conditions and looking as far as 30 years, but this is also dependent on the type of structure and expected life expectancy of the materials. To help determine the most appropriate design and size, given expected shoreline change, one idea was that additional resources could be utilized (i.e., CRC Science Advisory Panel, NOAA, Living Shoreline siting tools). Planning for future conditions may result in planning structures that are higher, wider, and closer to the shoreline. Another design consideration is the structure's purpose – is it for protecting infrastructure or habitat? When the goal is primarily protection of critical infrastructure such as roads, applicants are more likely to need a structure that is highly resilient over a greater time period and more extreme conditions.

One regulatory agency staff mentioned that ideally we need to plan for both current and future conditions. However, the permitting agency needs to be more reactive to new structures/methods, rather than proactive until there are enough study results indicating effectiveness and addressing concerns. In other words, they need to be conservative on how far in the future to plan for, and that can increase over time with increasing confidence as monitoring verifies effectiveness. One attendee noted that when planning for the future, it's important to remember that predictions are just that – predictions. The future may be different (better or worse) than what's being predicted.

All groups agreed that it would be ideal for the project to be adaptive, modifying in the future as needed. There was a suggestion to have a project management plan that includes guidelines and success criteria over time to aid in when adaptive modifications are needed. One person noted that this can be expensive due to remobilizing, although others disagreed, depending on the structure type and methodology.

Several agreed that living shorelines should be designed to have a broad continuum from upland to intertidal to subtidal habitats so the living component (low and high marsh, oysters) will persist longer with sea level rise. Someone also noted that we should be planning for the future when it comes to all shoreline stabilization structures, not just living shorelines.

P1.2. How do restoration planners determine the type and size of structures, and how do they prevent overly hardened structures (i.e., height, width, length)?

Participants all agreed that each living shoreline should be designed for the purpose and need of the shoreline protection while considering the specific local conditions of the site. Some suggested

characterizing the surrounding water body was important. The type and amount of adjacent hardened shorelines should be considered. If there are natural oyster reefs in the area, the living shoreline should be designed to incorporate and mimic the natural shoreline protection.

Purpose and need examples were listed as: restoration, protection, level and time of protection, use (function) of property, access through or over, infrastructure protection vs residential, protection of man-made spoil islands, habitat enhancement for organisms in the area, and animal passage. An important factor to consider is the history of the site, especially if there have been different phases with different materials. Site-specific factors mentioned by participants that should be considered when determining the type and size of structures included wind fetch, level and time of protection, wave energy, erosion rate at site, condition of shoreline, salinity, sediment type, tidal range, condition of shoreline, salinity, sediment type, tidal range, amount of sediment in the marsh, and the Mean High Water (MHW) level. Additional factors included sea level rise, time and amount of protection needed, alternatives, use of upland property, need for access through or over the structure, shoreline condition adjacent to proposed project (hardened?), appropriate materials for site conditions, and history of stabilization at site. Examining unsuccessful projects can also be beneficial.

A few participants mentioned the importance of monitoring plans, especially public projects. Often projects must be prioritized due to limited funding opportunities and monitoring will be recommended. Success criteria must be clearly stated and created to the scale of the project.

Many property owners have the mindset that larger structures will give more protection from erosion. However, this workshop has shown many examples of how smaller structures are more than sufficient protection. Several participants mentioned that educating property owners was a way to prevent overengineering. For private property owners design aesthetics can be just as important as erosion control.

P1.3. What is the importance of the living part of living shorelines? I.e., must a living shoreline have plantings? Does research show the need for fill in living shoreline design?

The consensus was that there *is* a difference between a rock wall/revetment and a living shoreline, and that the “living” components are what distinguish living shorelines from other hardening structures. One of the immediate questions was the definition of the term “living” – does it refer to plants, animals, or both? Most mentioned that the definition of the living component depends on the design and the goal(s) of the project, as not all living components are applicable at all living shoreline sites. Most groups agreed that shoreline projects with living components have been found to provide numerous ecological benefits, including improved biodiversity, adaptability, and self-repair of habitat. The location/position of living components is important for success and having them near each other may be mutually beneficial. One question regarding the living/non-living design was if there is any known specific percentage of a living shoreline project or any ratio of living to non-living that provides ideal results. For example, does a living shoreline project with a specific percentage of shoreline featuring living components produce more favorable results than a site with percentages above or below that number?

The placement and applicability of living components was also discussed in multiple groups. The applicability was discussed because, as noted by multiple attendees, not every site is suitable for a living shoreline nor is every site suitable for the same design components. There should be areas nearby that feature natural shorelines, and similar living elements should be utilized to provide equivalent habitat

value compared to the surrounding area. A question was raised on how to prevent public use that causes negative impacts to living components (i.e., shellfish harvesting, vessel impacts, human impacts, etc.). Multiple groups also questioned the need for fill in addition to living components and there was agreement that it is site-specific. Some sites feature natural processes that can facilitate sufficient natural filling, whereas others would not meet goals without having fill added. This tied into another point regarding post-construction monitoring and the success of natural fill versus immediate fill and planting. Additionally, big bluffs, such as on Neuse River, need to consider management (planting, grading, etc.) that includes the area above mean high water.

A common discussion point is the follow-up to construction of living shorelines. Multiple groups noted that there should be management/contingency plans involved, especially for those with living components. A common response was that projects with living components should have some degree of monitoring that includes project criteria and a means of tracking the "success" of the project. With annual quantifiable goals, there is an easier means of addressing "failures" of the project. Another common comment along those lines was that projects specifically involving fill need to include management plans that have criteria/specifics for fill material, such as grain size and source. Multiple attendees agreed that projects without fill could include monitoring criteria that could trigger a modification to add fill if it's not occurring naturally at levels that are sufficient to meet project needs.

Panel Discussion 2: How to evaluate the conversion of one habitat to another and protect the public trust?

Panelists: Carolyn Currin (NOAA, retired), Lexia Weaver (NC Coastal Federation), Maria Dunn (NC WRC)

Panelist Dr. Carolyn Currin began by emphasizing that for regulators, figuring out when it's acceptable to permit the conversion of one habitat to another is a difficult question. Currin made the point that our salt marsh habitat is declining (and accelerated declines are expected), and that salt marsh is converting into soft bottom mudflats, resulting in an increasing area of soft bottom habitat across the state. Given the contrasting trends, regulators should favorably consider efforts to restore salt marsh that come at the expense of soft bottom habitat, as much of the current marsh-fringing mudflats were once salt marshes, and the area of salt marsh that can feasibly be restored via living shoreline construction pales in comparison to the area expected to convert from salt marsh to mudflats due to sea-level rise. In discussion with Fritz Rhode, Currin agreed that the ponds and fringing mudflats forming in and around salt marshes due to sea-level rise are important habitat for fish, but she also offered that the salt marsh itself is still important habitat for fish and other animals, and while it is tough to weigh the tradeoff, the opposite trends for the salt marsh and soft bottom habitat extents should be factored into tradeoff decisions.

Panelist Dr. Lexia Weaver highlighted some current knowledge gaps surrounding how to evaluate conversions from one habitat to another. Specifically, Weaver noted that we need a better understanding of how the installation of living shoreline sills may impact nearby SAV, discussing that not all SAV meadows are the same, and that the buffer distance between sills and SAV beds may not need to be the same if the SAV meadows are small and patchy, as opposed to extensive and densely vegetated. Weaver also noted that she had observed that SAV beds sometimes expand towards living shorelines in the long term, suggesting that the paradigm that sills negatively impact adjacent SAV may not always be accurate. Dr. Niels Lindquist added that regulators should consider that when living shorelines reduce erosion of

muddy sediments and salt marsh peat, they also reduce turbidity, improving water quality for adjacent habitats. Addressing the public trust concern, Weaver noted that most sills are constructed very close to shore, within 30 feet, but that with increasing requests to build sills farther offshore, especially in areas where salt marsh was documented to extend farther offshore, the public trust concern associated with extending sills farther offshore should be explored further. Weaver added that there is conclusive research demonstrating the negative impacts of bulkheads to the salt marsh in front of them.

Panelist Maria Dunn expressed that when evaluating habitat conversions, it is important to look at the motivation for building the living shoreline and the ecological impacts of the shoreline modification. Noting the need to minimize the area of habitat converted with sill construction, Dunn also emphasized that the amount of water column taken up by a sill is also an important habitat tradeoff to consider. For herons, diamondback terrapins, and other animals, it is important to ensure that there is enough water for passage through sill gaps at low water, and that allowing water to overtop sills at high tide is another important consideration for those animals. Sills that extend well above mean high water degrade the quality of habitat provided by the living shoreline for those animals, so it is important to minimize not only the footprint of sills, but their height as well, and reduced height also brings the benefit of reducing the needed footprint for the sill to be structurally stable. Dunn concluded by commending the workshop participants on the wide array of ideas and research topics that had been discussed.

Panel 2 breakout group discussions related to evaluating habitat tradeoffs

1. *How should the ecosystem services of different habitats (soft bottom or SAV vs. rock and marsh) be compared? How are existing adjacent habitats (especially SAV) going to respond to living shoreline construction?*
2. *How should impacts to public trust be weighed alongside habitat concerns? How should fishing access concerns be addressed (shoreline access, oystering/clamming/gigging access, navigation) when planning gaps, width, and length of a living shoreline?*
3. *Should living shorelines be permitted in front of estuarine beaches?*
4. *What are the research needs related to the conversion of one habitat to another and protecting the public trust. Do we need to monitor adjacent habitat effects? Do we know the ability of living shorelines to reduce nutrients and sediment? [responses summarized in Research Needs section]*

P2.1. How should the ecosystem services of different habitats (soft bottom or SAV vs. rock and marsh) be compared? How are existing adjacent habitats (especially SAV) going to respond to living shoreline construction?

a) *How should ecosystem services of different habitats be compared (i.e., soft bottom vs. marsh/rock)?*

It's difficult to determine an answer to this question, and this sentiment was repeated among various groups. One idea that was supported by other groups was the development of a table to compare the ecosystem services of the different habitat types. The table could include items such as species present, habitat use by aquatic and terrestrial organisms, endangered species use, habitat rarity, threats, and sensitivity. Another idea is to conduct or compile existing economic valuation studies of different habitats. One group felt that it was the applicant's responsibility to provide information.

b) *How are existing adjacent habitats going to respond to living shoreline construction?*

Living shorelines should help with adjacent habitats by providing cleaner, improved overall water quality and wave energy reduction. Marsh recruits in and becomes established behind the sill structure, oyster recruitment follows on the hard substrate. Additional information is needed on how living shorelines impact adjacent SAV and what buffer distance is needed between the structure and the SAV. The response can vary with time. For example, short-term sediment losses vs. long-term gains.

P2.2. How should impacts to public trust rights be weighed alongside habitat concerns? How should fishing access concerns be addressed (shoreline access, oystering/clamming/gigging access, navigation) when planning gaps, width, and length of a living shoreline?

Public trust rights have been in NC statutes since the 1800s and state that the public has the right to fishing, hunting, recreation, and navigation in public trust waters (below MHW). Since living shorelines are constructed beyond the MHW line, the balance between retaining public trust rights and living shoreline benefits must be considered during the application process.

The groups noted that to assess the tradeoff, one must consider the function of the property needing shoreline stabilization and whether it is a public or private entity. The project's purpose and need can determine how much access should be included - whether the structure is to restore, protect, or create habitat. It was also mentioned that it is important to include the purpose and need for the project in environmental assessments, for the agencies' consideration. Other considerations are the width of the waterbody, and extent of public use. The groups agreed that public property should include more public access than private property. Living shorelines, especially along public property, should include passage for recreational users to access the shoreline, particularly in areas of historical use. Because the public has the right to access areas below MHW and fishing is a public trust right, fishers have the right to access the shoreline. Discussions with NC Marine Patrol and state attorney determined that the public are allowed to harvest shellfish that recruit onto stabilization structures (in open harvest areas) as long as it does not impact the integrity of the structure. Participants gave examples of how living shoreline projects have increased access for fishers and recreational users. They stressed that living shoreline projects can be designed for mixed development areas.

Some participants had the opinion that living shoreline projects should not provide access to the shoreline behind the structure because the protection and restoration of coastal wetlands is a higher priority, and that providing access could continue the degradation of the habitat. However, a counter point to that idea was that blocked access could concentrate usage into adjacent areas creating different impacts.

A common theme during the workshop is that education on the importance and function of living shorelines will increase the support by the public. Living shorelines along public entities, especially public parks and state aquariums, are great opportunities to provide the public with outreach education and good sites to conduct research.

P2.3. Should living shorelines be permitted in front of estuarine beaches?

While answers to this question ranged from a hard "yes" to a hard "no," most answers fell into the "in certain situations" bucket. The primary concern expressed by participants was with issues surrounding public trust rights – given that estuarine beaches are a public trust resource and are popular for beachgoing, landing boats, and fishing, the placement of a living shoreline sill would negatively impact all of those uses. However, some participants noted that if ongoing erosion is threatening property behind the beach, or if the site was previously marsh or oyster habitat that had been converted to a beach, those situations could merit installing a living shoreline. Beaches in more remote areas may be more appropriate than beaches that receive lots of traffic. There could be conflict between user groups due to placing hardened materials in an area that receives foot traffic, fishing use, or vessel access. If the beach is highly utilized for recreation, it might not result in a successful project and not be a good location. Living shorelines should not be permitted in areas that would prevent the public trust usage of estuarine beaches to normal high water/normal water level. A living shoreline that includes creation of oyster reef habitat in front of a public estuarine beach would be a safety issue (cuts from dislodged oysters).

One should take into account if the beach actually requires protection. Some participants said that if the existing beach partially or completely protects developed property (e.g. island providing storm protection to developed mainland), justification to protect may exist. However, several said that should only be done if there is an erosion issue, the beach has been documented to be losing size, or the intent is to restore marsh and oyster habitat that was there originally. In some cases where shorelines are particularly vulnerable to erosion due to anthropogenic access, living shorelines may function as a deterrent for minimizing (without preventing) access to areas. This concept has potential to create major conflict within user groups and should generally not be considered the primary reason for placing living shorelines.

Whether the upland beach property is public or private affects beach use. The applicant should consider the extent that the public values the benefits of constructing a living shoreline to preserve the beach versus not valuing due to issues associated with beach access and use. If private, it is the same decision but made by individual property owner.

If constructing a sill at an estuarine beach, some participants suggested that a priority assessment should be conducted to determine if the living shoreline objective is to stabilize and promote waterward movement of the existing shoreline, or to protect existing upland property. The design may significantly vary depending on what the goals of the applicant are. Viable alternatives to minimize shoreline erosion that more effectively maintain the beach's access for public use should be considered (beach nourishment?). Participants noted that living shorelines also need to consider existing species use along estuarine beaches, included but not limited to bird, marine mammal, and/or other sessile organisms and vegetation species needs.

Research Needs

Research needs arising from both panel breakouts are summarized below.

What are the research needs related to conversion of one habitat to another? To protecting the public trust? To adjacent habitats? To nutrients and sediments? What are the research needs for maximizing ecosystem benefits of living shorelines while providing erosion control?

Participants expressed a need for a broad variety of research on living shorelines, but the most-discussed categories of research were (1) the ecosystem services of living shorelines, and (2) design/engineering questions. Ecosystem services research topics included quantifying water quality improvements from living shorelines, exploring how the provided ecosystem services are different for living shorelines in freshwater and low-salinity environments, and understanding how living shorelines influence the high marsh and upland transition habitats behind them. Design and engineering research topics included both technical questions, such as optimizing the number and size of sill gaps, and future-oriented questions, such as weighing the impacts to current habitats from designing sills for accelerating sea-level rise. Other categories of research discussed by participants included impacts of living shorelines on adjacent habitats, comparisons of negative impacts of living shorelines and bulkheads, statewide habitat trends and cumulative impacts of habitat conversions, public perspectives, and long-term monitoring needs.

Regulatory staff expressed interest in having existing research synthesized into a statewide living shoreline siting tool or suitability index that would make it easy for permitting agencies and the public to weigh the costs and benefits to easily assess the appropriateness of a living shoreline and potential sill substrate types, similar to the tool developed for Carteret and Onslow counties. It was also noted that improved input datasets (such as bathymetry and shoreline maps) would improve the usefulness of such a tool.

Specific research topics:

- Adjacent habitat impacts
    - How close can a living shoreline be built to SAV without damaging the SAV?
    - Monitoring of adjacent habitat interactions, both positive and negative.
    - Research into hydrodynamic flow around sills and sill gaps, specifically overtopping flows and cross- and along-shore flow.
- Ecosystem services
    - Water quality
        - Research on how water quality changes (especially nutrients) around living shorelines, including the impacts to water quality of habitat type conversions.
        - Research on ability of marshes to reduce nutrients and sediments that can be directly applied to living shorelines.
        - How do living shorelines affect water quality?
    - Fresh/low-salinity systems
        - Research into how ecosystem services provided by living shorelines are different in fresh tidal systems, and how living shoreline designs may need to be different in those systems (e.g. not suitable for oyster recruitment).
    - Adjacent upland habitats and species

        - Research into managing the high marsh and transitional upland habitat behind living shorelines for ecological functionality (e.g. seaside little bluestem as crystal skipper habitat).
        - How does changing a shoreline type affect protected bird species (e.g. piping plover)?
        - How will upland soil types affect marsh migration landward of living shorelines?
    - Is the ecological function of restored sills comparable to natural oyster reefs?
    - A better understanding of actual habitat function rather than just patterns of habitat abundance.
    - Research into how the ecosystem services provided by living shorelines will change over time.
    - Does living shoreline installation enhance the ecosystem services provided by surrounding habitat mosaics?
    - Do living shorelines have any impact on the ability of invasive and/or parasitic species to utilize/inhabit an area?
    - Is there any correlation between living shoreline usage by fish species and the absence of parasites in those fish (compared to fish that don't utilize living shorelines)?
- Comparing negative impacts of living shorelines and bulkheads
    - Research contrasting bulkheads and living shorelines with regards to habitat conversions, public trust issues, impacts to adjacent habitats, and changes in nutrients and sediments, and on how living shoreline retrofits (bulkheads with waterward living shorelines) differ with regards to those questions.
    - Research on the impacts of bulkhead erosion on adjacent properties with different types of shorelines, including the impacts of bulkhead tiebacks.
    - Research on the usefulness/relevancy of dredging moratoria in living shoreline permitting.
- Statewide habitat trends and cumulative impacts
    - Research on cumulative impacts (changes in ecosystem services and economic over time) of converting one habitat to another, and the cumulative impacts of such changes across different geographic scales.
    - Greater understanding of habitat abundance and trends to determine which tradeoffs are acceptable.
    - Better data on the statewide distribution and trends of structured habitats, including the historic distribution of those habitats.
    - Improved projections of habitat change, especially of fringing marsh loss.
- Public perspectives
    - Research on the perspectives and preferences of non-owner users of living shorelines and habitat conversions (fishers, beachgoers, others).
    - Social science research into what ecosystem benefits managers should be prioritizing protection for – what do members of the broader public prioritize? What does the public think of the aesthetics and costs of living shoreline projects?
    - The question of assessing habitat trade-offs is difficult and involves value judgements - we have enough information on the extent, importance to fish species, threats to each habitat, and other uses to support the development of priorities for different areas.

- Long-term monitoring
    - How long should success-evaluation criteria be monitored post-construction for living shorelines?
    - More research is needed looking into long-term management considerations.
    - How to evaluate the long-term benefits and impacts of new and emerging substrates as they are developed, since there are more hitting the market continually?
- Design/engineering
    - What design works best for the wave energy of a given environment?
    - How far offshore can a sill be built and still provide the desired erosion control?
    - Research into the design of sills, specifically the circumstances that necessitate taller sills, and the potential impacts that larger structures have.
    - How does tidal range affect the design of sills?
    - Research into the needed size and number of gaps in sills, both for fish passage and public access.
    - Research into designing living shorelines for sea level rise, and how to weigh impacts to current habitats against increased future protection.
    - Research into how the porosity of different living shoreline material types affects erosion control and ecosystem services provided.
    - What is the impact, if any, of living shoreline projects on local hydrology?

Summary and next steps

After the roving flipchart activities concluded, workshop participants offered some closing takeaways. Dr. Rachel Gittman expressed that it would be beneficial to send the meeting summary to the Living Shoreline Steering Committee to discuss, and for that committee to pass along the research needs to the appropriate subcommittee members. Mickey Suggs (USACE) recommended that permit applicants always come to regulatory agencies early on for scoping meetings about large projects coming down the pipeline, and that applicants provide more information than is required by the applications, as that can provide better support and justification to reviewers. Summarizing the day's discussion around tall sill structures, Holley Snider (DWR) pointed out that the use of tall sills detracts from the environmental benefits of living shorelines, given the ecological consequences highlighted by Maria Dunn and other participants. Rebecca Ellin (DCM) offered that the NC Coastal Reserve could enhance its living shoreline trainings for the contractors who are submitting permit applications to ensure that those applicants have access to the information discussed at this workshop.

Anne Deaton and Kim Harding brought the meeting to a close by reminding the participants of the purpose of the meeting: bringing participants together to share information across organizations and improve the permitting process, making living shoreline implementation better and easier going forward. DMF staff will compile the information presented in the presentations and discussions and share it with the participants, highlighting common themes and key insights.

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