Living Shorelines Strategy

North Carolina Division of Coastal Management
North Carolina Division of Marine Fisheries

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The N.C. Divisions of Coastal Management and Marine Fisheries acknowledge and thank the other N.C. Department of Environment and Natural Resources' Divisions and partners that contributed to the development of this strategy. Work accomplished on short- and long-term actions will be published in 2016 in a separate document.

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Introduction

"Living Shorelines" include a suite of options for shoreline erosion control that maintain existing connections between upland, intertidal, estuarine, and aquatic areas which are necessary for maintaining good 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. Non-vertical approaches to estuarine shoreline stabilization have been supported by the N.C. Coastal Resources Commission (CRC) and have also been included as a recommendation of the N.C. Coastal Habitat Protection Plan (CHPP, Deaton et al., 2010, 2015 Draft).

The Albemarle-Pamlico National Estuary Partnership's (APNEP) Comprehensive Conservation and Management Plan (CCMP) also identifies a number of objectives pertaining to living shorelines. For example, Objective B3 is to "utilize natural and constructed living shorelines to maintain estuarine and river ecosystem processes," and Objective C2 is to "restore hydrological processes in rivers and estuaries to support significant natural communities and ecosystem functions" (APNEP, 2012a).

Over the past several years, the CRC and N.C. Division of Coastal Management (DCM) have explored the use of living shorelines, and marsh sills in particular, as alternatives to vertical stabilization measures. Marsh sills are one type of living shoreline approach that has been utilized in North Carolina, with more than 60 such structures constructed along the state's estuarine shoreline (McVerry, 2012). Marsh sills are shore parallel structures sited in low to moderate wave energy environments to preserve, enhance, or create a marsh grass fringe between the sill and the upland (NRC, 2007). The offshore sill component, which is typically constructed of rock, oyster bags or loose shells, is designed to dissipate wave energy while the marsh component further reduces wave energy, minimizing erosion, improving water quality, and providing habitat for fish, birds, and other species (Figure 1).

Historically there has not been wide-spread use of living shorelines or marsh sills in North Carolina. Possible reasons include unfamiliarity on the part of marine contractors and property owners with the techniques and their efficacy; the cost of living shoreline projects compared to more traditional shoreline stabilization methods; and a more detailed permit review process, particularly for marsh sills. As a result, DCM has been undertaking substantial efforts to advance marsh sills and other living shoreline alternatives to vertical estuarine shoreline stabilization methods. These efforts have included coordinating the development of a General Permit (15A NCAC 7H .2700), hosting workshops for property owners and marine contractors, developing an Estuarine Shoreline Stabilization Guide for property owners, and conducting a multi-agency assessment of 27 permitted marsh sills in North Carolina. The N.C. Division of Marine Fisheries (DMF) has also compiled

information on the effects of bulkheads on fish habitat as part of the CHPP, funded living shoreline research through the Coastal Recreational Fishing License (CRFL) grant program, participated in interagency workgroups, and partnered in the multi-agency marsh sill assessment.

Based on continuing discussions among staff, the CRC, and the CHPP Steering Committee, the directors of DCM and DMF met to discuss additional opportunities to advance living shorelines through a broader Department-level effort. Following internal meetings with permitting, research, and policy staff, DCM coordinated an interagency meeting to discuss recent research and mapping projects, the offshore riprap sill General Permit, staff outreach and public awareness efforts, research needs, and short- and long-term actions for the Department to consider. Meeting participants included representatives from DCM, DMF, APNEP, Division of Water Resources (DWR), Wildlife Resources Commission (WRC), Ecosystem Enhancement Program (EEP), Community Conservation Assistance Program (CCAP), and the National Oceanographic and Atmospheric Administration (NOAA). The resulting discussions with agencies and partners led to the development of this Living Shorelines Strategy.

Figure 1. Riprap Marsh Sill at Pivers Island, NC.

It is important to note that not all living shoreline approaches take the form of a marsh sill. Other types of living shorelines include marsh vegetation plantings without structural components, or the creation of new oyster reefs. Marsh plantings alone may be successful in certain situations, but all living shorelines need to be designed according to the specific site conditions, shoreline type, erosion rate, fetch, tide range, and bank height and slope. In addition, timing is critical to take advantage of the full growing season, so marsh grasses should be planted during the spring and at a certain tidal elevation range. In estuarine areas with salty to brackish water, smooth cordgrass (*Spartina alterniflora*) is the preferred marsh grass species, but black needlerush (*Juncus roemerianus*) is an alternative for fresher water sites (Rogers and Skrabal, 2001). When sand fill is

required for a project, it may be placed in the fall to allow it to settle before planting during the subsequent growing season.

While more considerations are necessary in the design of a living shoreline than for a traditional erosion control structures, attention to specific site conditions can result in a successful project that provides erosion control benefits while also providing aesthetic and environmental benefits. The intent of this Strategy is to promote living shorelines, which include marsh vegetation plantings, oyster reefs, as well as marsh sills. This goal is also consistent with the existing CRC rules: Specific Use Standards for bulkheads, which state that "where possible, sloping rip-rap, gabions, or vegetation shall be used rather than bulkheads" (15A NCAC 7H .0208(b)(7)(E)).

Summary of Recent Research, Monitoring, and Mapping Projects

Recognizing that additional study was needed before promoting living shorelines as a preferred erosion control approach for certain estuarine shorelines, DCM and partners participated in several research and mapping projects. These projects provided significant information about the benefits of living shorelines and are summarized below.

N.C. DCM Estuarine Shoreline Mapping Project

Since successful living shoreline projects are dependent on site specific conditions, the Estuarine Shoreline Mapping Project (ESMP) is an important first step in characterizing and understanding the extents of various shoreline types in the state. DCM completed the ESMP digitizing methodology in June 2008 and began the mapping process in-house and through a contract with the East Carolina University (ECU) Department of Geological Sciences and the Institute for Coastal Science and Policy (Geis and Bendell, 2010). The methodology utilizes the most recent county-level orthophotographs at a viewing scale of about 1:500 to digitize the shoreline and related structures in ArcGIS®. DCM and ECU completed the ESMP in June of 2012 after mapping more than 12,000 miles of North Carolina's estuarine shoreline in the state's 20 coastal counties (McVerry, 2012). The estuarine shoreline data can be viewed[1] or downloaded[2] from DCM's website. The final product is a geospatial representation of the complete estuarine shoreline and structures (Figure 2).

These shoreline characterizations allow DCM to generate county-level statistics about the extents of swamp forest shorelines, marsh shorelines, sediment bank shorelines, and modified (stabilized) shorelines. Modified shorelines are subdivided further and attributed according to the type of erosion control structure present. According to a preliminary analysis of the mapping project data, 72% of the lengths of modified estuarine shorelines are stabilized by bulkheads and 23% are stabilized by revetments. The remaining 5% of stabilization structures are either marsh sills, groins, or breakwaters (McVerry, 2012). In addition to erosion control structures, the project has also mapped shoreline access structures such as bridges, piers, docks, and wharves. Statewide, there are over 28,000 such structures, and they cover approximately 880 acres of public trust waters (McVerry, 2012).

[1] Interactive Shoreline Mapping Site: http://ims.ncdenr.org/Website/ncshore/viewer.htm
[2] Data Download Page: http://dcm2.enr.state.nc.us/Maps/chdownload.htm

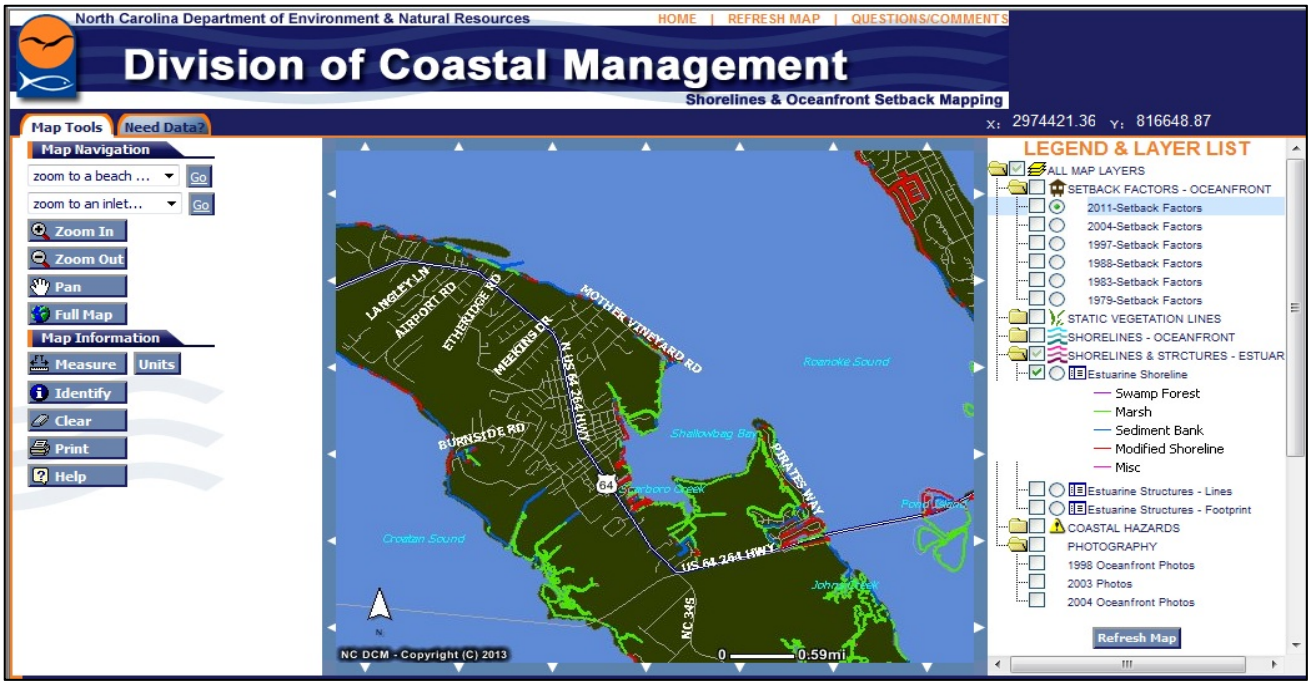


Figure 2. Estuarine Shoreline Types and Structures Mapped for Roanoke Island, NC.

DCM and ECU are now in the process of performing a detailed analysis of the ESMP data and attributing the shoreline segments by municipality and water body. The finer-scale attribution will allow for analysis of shoreline modifications along individual creeks. In addition, since the original mapping effort utilized aerial photos spanning the years 2004 to 2009, DCM intends to use new 2012 aerial photography to update the shoreline and structures inventory.

Sustainable Estuarine Shoreline Stabilization: Research, Education, and Public Policy in North Carolina (CICEET Bulkheads Study)

The N.C. National Estuarine Research Reserve and NOAA Center for Coastal Fisheries and Habitat Research began a project in 2009 to assess the effects of bulkheads on marsh habitats and the ecosystem services that they provide. The project was funded by the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), and the goal was to better understand the trade-offs between the land protection that stabilization structures provide and the potential loss of ecosystem services. Researchers selected six sites in each of three coastal regions in the state, for a total of 18 study sites. The sites represented different tide ranges and varying amounts of marsh, some with bulkheads and some without. The results indicate that wider marshes provide more ecosystem services than narrow marshes, but even narrow marshes still provide ecosystem services. In general, as marsh width increases at the study sites, the nekton abundance increases, the amount of nitrogen removed increases, and the ability to dissipate wave energy increases (Fear and Currin, 2012). The two-year project was not long enough to definitively determine that the presence of bulkheads leads to marsh loss, but the stem density and elevation data do show this correlation.

A second component of this study was to construct a demonstration site that effectively controls erosion of the shoreline while maintaining or enhancing the ecosystem services of the habitat. The demonstration site was built at the eastern tip of the Rachel Carson component of the N.C. National Estuarine Research Reserve. The shoreline in this area had experienced significant erosion over the last 15 years. Since the reserve is close to Beaufort, N.C. and adjacent to the Intracoastal Waterway

as well as several public boat ramps, it provided a good opportunity to educate the public and property owners about possible alternative estuarine shoreline stabilization options (Fear and Currin, 2012). The demonstration project consisted of an offshore sill made of oyster shells with marsh plantings behind the structure (Figure 3). Based on the monitoring to date, the study concluded that shoreline stabilization using oyster reefs and marsh plantings is a viable, cost-effective alternative to traditional shoreline stabilization structures.

Figure 3. Oyster Sill at the Rachel Carson Component of the N.C. National Estuarine Research Reserve.

The project also included an outreach component, whereby the results of a Homeowner Needs Assessment mail survey and a Contractor Needs Assessment email survey were compiled. The goal of the surveys was to assess the public's knowledge about estuarine shoreline stabilization options. The Homeowner Needs Assessment revealed that protecting property from future erosion and the cost of installation were two of the most important factors in determining which type of shoreline stabilization to pursue (Fear and Currin, 2012). The ease of permitting did not appear to be a major factor from a homeowner perspective. Additionally, there is no inherent bias of homeowners against the use of sills to stabilize their estuarine shorelines. Of the homeowners that currently have a shoreline stabilization structure, 68% of them have a bulkhead despite a high awareness of low-impact options and environmental benefits (Fear and Currin, 2012). The Contractor Needs Assessment revealed that they believe homeowners are primarily concerned about the cost when they are deciding which type of shoreline stabilization structure to construct. Bulkheads are most commonly recommended by 84% of the contractors identified in the survey, and riprap revetments are the second most commonly recommended type of structure (Fear and Currin, 2012). Fewer than 40% of the contractors are familiar with the performance and environmental pros and cons of marsh sills, but 89% of the respondents indicated that they would be interested in attending a training session on how to install living shorelines (Fear and Currin, 2012). Clearly, both homeowners and

marine contractors have important roles in deciding whether to pursue a living shoreline. Future outreach efforts will be targeted towards both groups as the Department seeks to promote living shorelines when appropriate site conditions allow.

Finally, a handbook was developed to guide property owners through the different types of shoreline stabilization options that are available and which is right for their situation. The handbook, "Weighing Your Options: How to Protect Your Property from Shoreline Erosion," provides information regarding the economic and environmental costs and benefits of vegetation plantings, oyster reefs, marsh sills, riprap revetments, breakwaters, and bulkheads (Seachange Consulting, 2011). Additional details of the handbook are described in the "Staff Engagement and Public Awareness" section of the Strategy.

Assessment of 27 Marsh Sills

At the request of the CRC, DCM conducted a performance assessment of existing marsh sills in the state. Sills were evaluated on two criteria: 1) Are the marsh sills performing their function as expected? and 2) What are the landowner and adjacent property owners' (where marsh sills are located) perceptions of the marsh sill shoreline stabilization option? (Fear and Bendell, 2011). Questions associated with the first criterion were assessed by field teams of 10 to 20 people from regulatory and resource agencies that normally review sill permits and visiting the 27 marsh sills that have been installed through the CAMA Major Permit or marsh sill General Permit process. Site visits occurred between June and August 2010, and at each marsh sill site, the field team visually evaluated the condition of the marsh sill structure, the property where the sill is located, and the adjacent properties (Fear and Bendell, 2011). Questions associated with the second criterion were assessed by using sill property owner surveys and adjacent property owner surveys to determine the perceptions of both groups regarding the use of marsh sills. Of sill property owners, 90% believe their structures are functioning effectively and have not been damaged by storms. Of the adjacent property owners that were surveyed, 55% believe sills caused impacts to their property. (Fear and Bendell, 2011).

The following are the key findings from the field team's marsh sill site visits:

- Marsh sills were not found by the field team to present a hazard to navigation.
- Marsh sills were observed to provide erosion protection to the property upon which they were installed.
- Marsh sills were often built in combination with other structures (bulkheads or groins).
- Marsh sills that utilized the gap or overlap design were observed to provide better water, fish, and other nekton access to the area behind the sill compared to ones utilizing the dropdown design.
- It was unclear whether marsh sills cause erosional impacts on adjacent property.
- The mound material used in the marsh sills is often colonized with oysters.
- The marsh sills supported marsh grass and do not appear to be creating new uplands.
- Marsh sills were observed to be free from damage.
- No marsh sill related impacts to water quality were observed.
- After completion of the field aspects of this project, the resource agencies still expressed a preference to review and comment on marsh sill permits on a case-by-case basis.

Effects of Shoreline Stabilization on Fish Habitat Function and Erosion
This study was performed by researchers from the University of North Carolina at Chapel Hill – Institute of Marine Sciences (UNC-IMS), with funding from the North Carolina Marine Resources Fund. The researchers quantified the biological and ecological impacts of marsh sills and their ability to provide and sustain habitat accessible to juvenile fish and crustaceans. At the same time, they assessed the ability of such structures to protect estuarine shoreline property from erosion. Sites were selected along the Bogue Sound shoreline of Pine Knoll Shores, N.C. with bulkheads, with sills, and with natural marsh (no structures) to compare the ecosystem functions of the different shoreline conditions. Results indicate that, when compared to the bulkhead sites and natural sites, the marsh sill sites serve as an additional predation refuge for juvenile fish and crustaceans, provide new hard substrate for oysters and other epifauna, and may serve a similar function as intertidal oyster reefs (Peterson and Bruno, 2012).

To assess the erosion control benefits of bulkheads, sills, or natural marsh shorelines, a post-Hurricane Irene survey was performed for the estuarine shorelines along Hatteras Village, Frisco, Salvo, Waves, and Rodanthe on the Outer Banks (Dare County), and from Atlantic Beach to Indian Beach on Bogue Banks (Carteret County) (Peterson and Bruno, 2012). Hurricane Irene made landfall on August 27, 2011 as a Category 1 storm in Carteret County, and these areas had some of the most significant impacts in the state. For the Outer Banks shorelines, of the approximately 20 km of bulkheads that were visually surveyed, about 30% showed some sort of damage whereas riprap revetments, sills, or hybrid structures did not show any obvious damage (Peterson and Bruno, 2012). For the Bogue Banks shorelines, of the approximately 20 km of bulkheads that were visually surveyed, about 5% showed some sort of damage whereas riprap revetments, sills, or hybrid structures did not show any obvious damage (Peterson and Bruno, 2012). The study concluded that marsh sills may provide better erosion protection from storm events than bulkheads, but marsh planting alone (without a sill structure) may be sufficient to stabilize a shoreline. Additionally, careful marsh sill design and construction is critical because not all materials may be suitable in all environments and gaps or overlaps in the sill structure itself may work better depending on site conditions.

Additional Research Needs

Continue Estuarine Shoreline Mapping and Analysis
In many cases, a living shoreline provides more ecosystem services than a bulkhead or revetment, but an improperly designed or sited living shoreline can also damage the environment. Improperly designed living shorelines can damage habitats by distributing loose oyster shell into a marsh, transporting empty oyster shell bags to adjacent shorelines, filling in existing marsh, or covering Submerged Aquatic Vegetation as the structure's footprint expands following damage. Marsh sills and other living shorelines should only be recommended for appropriate shoreline situations where such approaches have a high likelihood of reducing erosion and providing water quality and habitat benefits.

Recognizing the importance of pairing living shorelines with appropriate shoreline types, the Virginia Institute of Marine Science (VIMS) developed a non-regulatory GIS tool to provide guidance for property owners on the preferred shoreline stabilization structure to consider for specific shoreline segments. The Preferred Shoreline Best Management Practices are created by a geospatial model and are based on observed shoreline conditions including bank condition,

nearshore depth, exposure to waves, and locations of buildings (VIMS, 2012). The tool recommends living shorelines wherever they can provide adequate erosion control, but it prefers nonstructural approaches such as bank grading or marsh widening when possible. The GIS model outputs can be accessed via an interactive map viewer, along with data layers pertaining to shoreline condition, stabilization structures, and access structures (VIMS, 2012). The intent of the tool is to link stabilization options with shoreline conditions prior to a project permit application being submitted. Expanding the N.C. Estuarine Shoreline Mapping Project to include such factors as bank height, nearshore depth, fetch, and locations of buildings would allow DCM to provide a similar tool to encourage living shorelines most likely to succeed.

Long-Term Action #1: *DCM will continue analyzing its existing estuarine shoreline inventory and will consider adding such data attributes as bank height, nearshore depth, fetch, and locations of buildings. DCM will also continue to improve online access to estuarine shoreline data and explore development of a geospatial model similar to the VIMS example.*

Storm Impacts on Marsh Sills

Several marsh sills in North Carolina constructed of either rock or oyster shells have weathered multiple hurricanes up to a Category 2 (Meyer et al., 1997; Currin et al., 2008). Most recently, Hurricane Irene, which made landfall in 2011 as a Category 1 storm in Carteret County, damaged many bulkheads, but no marsh sill damage was observed (Peterson and Bruno, 2012). The existing, pre-storm conditions of marsh sills in the state are well documented (Fear and Bendell, 2011). Following a major storm, post-storm surveys of marsh sills should be performed to evaluate the effectiveness of the structures, both in terms of damage to the sill structure itself and erosion of the shoreline behind the structure. Bulkheads should also be assessed to determine their effectiveness after a major storm.

Effects of Marsh Sills on Adjacent Property

An initial survey of waterfront property owners adjacent to 27 marsh sills in the state revealed that the adjacent property owners have mixed perceptions about the effects of the sills. Of the adjacent property owners that responded to the survey, 45% believe that the marsh sill has had a positive impact on their property while the remaining 55% believe that the marsh sill has had a negative impact on their property (Fear and Bendell, 2011). The marsh sill property owners contend that their sills have either had a positive impact or no impact on their neighbors' property. Additional research is needed to characterize the impacts on adjacent property, and how these impacts compare with traditional bulkheads and revetments.

Oyster Shell as a Construction Material for Marsh Sills

The majority of marsh sills in the state have been constructed of rock, but some have also been built using either loose oyster shell or oyster shell bags. The durability of oyster shell as a construction material should be further evaluated, and the demonstration sill at the Rachel Carson component of the N.C. National Estuarine Research Reserve would be an ideal site to perform this analysis since pre-construction data are available (Fear and Currin, 2012). An oyster sill that was established in 2000 and had shell added to it in 2006 and 2007 on the east side of Pivers Island (adjacent to the NOAA Center for Coastal Fisheries and Habitat Research) is another site suitable for periodic monitoring (Currin, 2012). While oyster shell is a suitable material for construction of marsh sills in some cases, DMF has expressed concern about the widespread use of oyster shell as a construction material since the agency believes the limited quantities of recycled oyster shell that are available could be put to better use in oyster reef habitat restoration projects.

Short-Term Costs and Long-Term Maintenance Costs of Marsh Sills

The average cost of an installed marsh sill is approximately $150 per linear foot, the average cost of a riprap revetment is approximately $120 per linear foot, and the average cost of a wooden bulkhead is approximately $135 per linear foot (Seachange Consulting, 2011). These costs vary based on the scope of the project, equipment access, and materials used. Although the short-term costs of these different structures are comparable, it is unclear whether the long-term maintenance costs are significantly different. Further economic analysis should assess the initial construction costs, maintenance costs, and replacement costs of different types of existing shoreline stabilization structures.

Evaluation of Sheetpile Sills

This Living Shoreline Strategy document has focused on riprap marsh sills using either rock or oyster shell as a construction material. However, DCM has a second General Permit (15A NCAC 7H .2100) for the construction of offshore parallel sheetpile sills constructed from timber, vinyl, or steel (Figure 4). Similar to the Assessment of 27 (Riprap) Marsh Sills that was completed by DCM, a sheetpile sills study is needed to evaluate their environmental benefits, performance, durability, and short- and long-term costs.

Figure 4. Examples of Sheetpile Sills Constructed from Timber (left) and Vinyl (right).

<u>Long-Term Action #2</u>: *DCM and N.C. National Estuarine Research Reserve staff will pursue research projects and funding to evaluate storm impacts on marsh sills, the effects of marsh sills on adjacent property, the feasibility of using oyster shell as a construction material for marsh sills, the short- and long-term costs of marsh sills compared to other alternatives, and the effectiveness of existing sheetpile sills.*

Permitting Considerations

Vegetation

Planting marsh vegetation along the estuarine shoreline is the least expensive and most environmentally sound stabilization method. Marsh plants serve to reduce wave energy, and their roots help to further stabilize the shoreline. If the shoreline does not require filling or grading before planting, a Coastal Area Management Act (CAMA) permit is not required. Planting is most successful when done between April and June along low-energy shorelines that have little boat traffic, a gentle slope, and face a relatively small fetch or have other site conditions that reduce wave energy. A CAMA Major Permit is required for projects that require filling or grading (typically below the normal water level), or projects that require a riprap toe, oyster toe, or coir log to stabilize the site while the vegetation becomes established.

Oyster Reefs

Oyster reefs can function as natural breakwaters and are constructed by adding small bags of oyster shells, loose oyster shells, riprap, or marl to the water as a solid base for live oysters to grow on. The oyster life cycle begins with a free-swimming larval stage that eventually attaches to a solid substrate and becomes oyster spat (juvenile oyster). In addition to providing erosion control and habitat benefits, live oyster reefs also improve the water quality of the estuary by filtering nutrients, toxins, and fine sediments from the water. Constructing oyster reefs is most successful in water bodies with known oyster productivity, usually within certain depth limits and salinities. Selecting the appropriate type of reef substrate is also an important consideration. If the site has low wave and current energy, lightweight materials such as oyster shell bags or loose shells may be appropriate. For higher-energy areas, heavier materials such as riprap will provide a better reef substrate. A CAMA Major Permit is required to construct a private oyster reef when used as a method of shoreline stabilization. DCM coordinates the permit review process during which authorizations from the U.S. Army Corps of Engineers (USACE) and DWR are provided.

Marsh Sills

The construction of a marsh sill requires either a CAMA General Permit or a Major Permit, depending on the design, location, and potential for adverse impacts of the proposed structure. If the design of the proposed sill structure does not exceed certain specific use standards, it may be built with a riprap marsh sill General Permit (15A NCAC 7H .2700). General Permits are an expedited form of a Major Permit that has standardized general and specific conditions associated with the issuance of the permit. Currently, the riprap marsh sill General Permit has six general conditions and 29 specific conditions to guide the permit review and construction process. The number of specific conditions is higher than other general permits due to the complexities associated

with sill projects and additional required coordination steps. DCM staff have worked with other DENR agencies to reduce the number of specific conditions by no longer requiring coordination with DWR or DMF for each marsh sill being built under a General Permit. The General Permit language within 15A NCAC 7H .2700 has not yet been modified through the rule-making process as the Division continues to consult with the USACE on coordination issues. The USACE requires a review of each marsh sill General Permit individually to ensure compliance with its regulatory programs.

If a proposed project does not qualify for the riprap marsh sill General Permit, a CAMA Major Permit is required. The Major Permit process requires the applicant to submit a more formal permit application package, and the review of the application is coordinated with as many as 14 state and federal natural resource and regulatory agencies. The CAMA Major Permit review process typically takes 75 days to complete, but the USACE has the ability to use the 291 Programmatic General Permit, which is unique to North Carolina and can take as few as 30 to 45 days to complete. The CAMA Major Permit process in conjunction with the USACE 291 Programmatic General Permit results in one of the most efficient processes in the nation for authorizing riprap sills.

In October 2012, DCM and USACE staff met in an effort to further streamline the permitting of riprap sills. Discussions focused on the state General Permit (15A NCAC 7H .2700) for the construction of riprap sills for wetland enhancement in estuarine and public trust waters. Both parties discussed all possibilities to streamline permit reviews through the USACE permit and review process, including the use of Nationwide Permits, Regional General Permits, and the 291 Programmatic General Permit currently used to process these types of actions. DCM was interested in any design modifications to the existing General Permit Use Standards (e.g. reducing the maximum distance offshore or eliminating the use of backfill) that would facilitate more rapid USACE approvals for such projects. DCM anticipates that use of the state General Permit for riprap marsh sills would result in further reduced processing times if the USACE no longer requires reviews of individual projects.

Short-Term Action #1: *While application of the riprap marsh sill General Permit (15A NCAC 7H .2700) is currently somewhat limited, DCM will continue to coordinate with the USACE and other federal and state agencies to review the specific conditions of the state General Permit and identify opportunities to further reduce permit processing timelines at the state and federal levels.*

Staff Engagement and Public Awareness

DCM Field Representative Site Visits

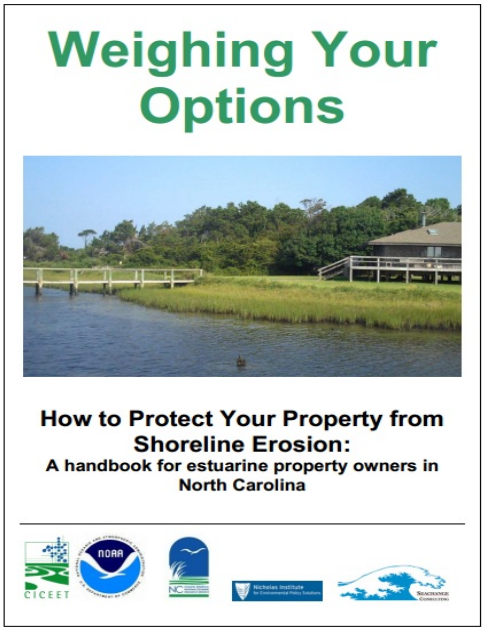
Before any estuarine shoreline stabilization structure can be built, an on-site meeting between the applicant and a DCM field representative must take place to review the proposed project. The site visit is attended by the property owner, the property owner's authorized agent or consultant, or the property owner's hired marine contractor. On occasion, the onsite meeting is attended by all involved parties. These meetings provide a good opportunity for DCM field representatives to see the site and determine if a living shoreline approach could be appropriate. DCM staff cannot explicitly recommend one stabilization structure over another due to liability concerns, but they can encourage property owners and marine contractors to consider all of the options that are available to them. Property owners may only be aware of structures that are recommended by their hired consultant, but if the consultant specializes in one type of structure (i.e. wooden bulkhead or rock revetment), it is likely that type of structure will be recommended. In cases where a living shoreline

may adequately protect the shoreline from further erosion, it is important for this approach to at least be considered.

Short-Term Action #2: *DCM field representatives will continue to distribute information about living shorelines to property owners, marine contractors, or consultants during site visits if a living shoreline may be appropriate. DCM will also provide continued training for staff utilizing information from research and other studies or observations.*

Weighing Your Options: How to Protect Your Property from Shoreline Erosion Handbook

Developed as part of the CICEET Bulkheads Study, the handbook, *Weighing Your Options: How to Protect Your Property from Shoreline Erosion Handbook*, provides information about the economic and environmental costs and benefits of vegetation plantings, oyster reefs, marsh sills, riprap revetments, breakwaters, and bulkheads (Seachange Consulting, 2011). For each option, the handbook discusses how it functions, the out-of-pocket costs and considerations, the ecosystem costs and considerations, sample project costs for small and large projects, and possible structure combinations (i.e. oyster reef with landward marsh). DCM field representatives are providing the handbook to property owners and marine contractors during site visits to encourage them to consider the full range of estuarine shoreline stabilization options. DCM staff have distributed approximately 500 copies of the handbooks and will reprint an additional 1,000 copies. The handbooks will continue to be distributed by DCM field representatives, and copies will be available at municipal and county offices as well. Some Community Conservation Assistance Program (CCAP) districts also have education and outreach capacity and can help distribute materials to property owners and other agencies.



Short-Term Action #3: *DCM will reprint hard copies of the handbook and continue to make the document available online.*

Training Courses for Property Owners, Marine Contractors, Landscaping Companies, Landscape Architects, and Realtors

In addition to on-site meetings and educational pamphlets, training courses are a very important mechanism for promoting living shorelines to property owners, marine contractors, landscaping companies, landscape architects, and realtors. During 2011-2012, the N.C. National Estuarine Research Reserve's Coastal Training Program (NERR-CTP) organized three free estuarine shoreline stabilization workshops. The first workshop was funded by a grant from the Albemarle-Pamlico National Estuary Partnership (APNEP), and took place in Nags Head in September 2011. The two subsequent workshops, which took place in Beaufort in April 2012 and Wilmington in May 2012, were funded by NOAA. At the workshops, participants heard presentations about the ecological functions and values of estuaries, shoreline stabilization designs and techniques, and related regulations. Participants also visited natural and stabilized estuarine shorelines in the area to learn more from existing examples. The workshops were well attended by the target audience of property owners, marine contractors, and realtors. Additionally, eligible attendees received 4.5

Certification Maintenance credits from the American Institute of Certified Planners (AICP) for their participation, and the NC Real Estate Commission recently approved the class for four realtor Continuing Education credits. DCM will invite landscaping companies and landscape architects to future workshops since they could also have a role in the design and installation of living shorelines.

The Virginia Institute of Marine Science has also developed a marine contractor training course that focuses on the ecosystem services of living shorelines, shoreline types where living shorelines may be appropriate, the site evaluation process, and the design and construction of living shorelines (VIMS, 2010). DCM will consider focusing future trainings on existing living shoreline examples and discuss the specific costs that were involved, materials that were used, equipment access issues, the permitting process, and demonstrated performance during storms. If estuarine shoreline property owners, marine contractors, and landscaping companies/landscape architects visit successful living shoreline projects in the field and learn more about the permitting and construction process, they may be more willing to pursue a similar living shoreline approach.

Short-Term Action #4: *The successful Estuarine Shoreline Stabilization workshops organized by the N.C. NERR-CTP in 2011 and 2012 will be used as a model for DCM to plan future training events and consider new ways to engage marine contractors, landscaping companies, landscape architects, and realtors on the topic of living shorelines. DCM will focus future trainings on existing living shoreline examples and discuss the specific costs that were involved, materials used, equipment access issues, the permitting process, and demonstrated performance of these methods.*

About 90% of the respondents of a recent Contractor Needs Assessment indicated that they would be interested in attending a training session on how to install living shorelines (N.C. NERR, 2009). Presumably, these professionals would also be interested in a certification program or marketing effort if it could benefit their businesses. DCM will explore the possibility of developing workshops, according to certain standards, that could provide engineering Continuing Education credits to eligible participants. As an added incentive, marine contractors, landscaping companies, or landscape architects that participate in the training could be added to a list of others that have successfully completed the training and are "certified" to install living shorelines. The certification would not carry any legal status or endorsement, but would allow property owners to view a list of marine contractors or landscaping groups who have participated in the training and are familiar with the techniques and requirements. Two similar examples are the Clean Marina Program and the N.C. Low Impact Development Certification Program. The Clean Marina Program is a voluntary program whereby marina operators complete an evaluation form about their use of specific best management practices, and upon approval, are eligible to fly the Clean Marina flag and use the logo in their advertising (N.C. DCM, 2010). The Clean Marina designation informs boaters that a marina has chosen to participate in the program and is doing its part to care for the cleanliness of area waterways. A list of marinas that have earned the Clean Marina designation is also available on the DCM website[3]. The N.C. Low Impact Development Certification Program certifies engineers, builders, contractors, or architects as "LID Certified" and indicates that they have demonstrated the knowledge, expertise, and skills necessary to implement LID projects. Those who attend two classes and pass a comprehensive LID exam become certified and are listed on the N.C. LID Group website[4].

[3] http://www.nccoastalmanagement.net/Marinas/list.htm

[4] https://www.bae.ncsu.edu/topic/lid/lidcertified_professionals.html

Long-Term Action #3: *DCM will work to develop workshops, according to certain standards, that could provide engineering Continuing Education credits to eligible participants as well as certification or other official acknowledgement for attendees.*

Informational Signage

A simple way to increase public awareness of living shorelines is to add informational signage near living shoreline projects that have been constructed in high-traffic areas. A good example is the marsh sill demonstration site that was constructed at the eastern tip of the Rachel Carson component of the N.C. National Estuarine Research Reserve near Beaufort and adjacent to the Intracoastal Waterway (Fear and Currin, 2012). This site is seen by many visitors to the Reserve or by those passing by on boats, and the informational signs will help them understand the benefits of the marsh sill.

Short-Term Action #5: *In the future, as new living shoreline demonstration sites are constructed (in conjunction with Wildlife Resources Commission boat ramps, for example), informational signs should be placed nearby.*

Grant Programs or Cost Reductions

When choosing a stabilization shoreline option, cost is a key consideration for property owners. Perceived and/or real increases in costs associated with sill construction (stone work, plantings, labor, transportation, etc.) can be a factor that discourages more widespread application. DENR staff have begun to explore grant programs and other financial incentives that may help offset or reduce costs associated with these projects, as outlined below.

Community Conservation Assistance Program (CCAP)

The Community Conservation Assistance Program, within the N.C. Department of Agriculture and Consumer Services, is a voluntary, incentive-based program available to all private and public landowners who use best management practices (BMPs) to improve water quality. Among the BMPs approved for funding are riparian buffers, stream bank and shoreline protection, and marsh sills. Interested landowners apply to local soil and water conservation districts for financial or technical assistance for the installation of approved BMPs. Applications are ranked based on local water quality priorities, and each project is eligible to receive up to 75 percent of the pre-established average cost of that type of project (N.C. CCAP, 2013). Marsh sill projects, for example, can be reimbursed up to 75 percent of the cost, with a maximum reimbursement cap of $5,000. CCAP funds are disbursed through local districts, and approximately $2.5 million has been spent in the last five years on a variety of BMPs. Some local districts choose not to participate in the program, and some counties were ineligible in the past due to grant limitations on CCAP funds. DCM will continue discussions with the CCAP Coordinator to ensure that the 20 coastal counties are eligible for CCAP funds, ensure that the local districts participate in the program, and determine whether it would be possible to increase the $5,000 reimbursement cap for marsh sill projects. Additionally, DCM will work with Division of Soil and Water Conservation (DSWC) staff to increase landowners' awareness of CCAP's financial incentives for estuarine shoreline best management practices.

Albemarle-Pamlico National Estuary Partnership (APNEP)
The Albemarle-Pamlico National Estuary Partnership is jointly sponsored by DENR and the V.A. Department of Conservation and Recreation, with additional financial support from the U.S. Environmental Protection Agency. The program seeks to identify, protect, and restore the natural resources of the Albemarle-Pamlico estuarine system, which includes the Chowan, Neuse, Pasquotank, Roanoke, Tar-Pamlico, and White Oak River basins. APNEP helps fund research, restoration, and demonstration projects in these areas, including living shoreline projects. For example, the partnership awarded the N.C. Coastal Federation a grant of approximately $16,000 in 2012 to restore and protect the eroding estuarine shoreline of Jockey's Ridge State Park with marsh plantings and an oyster reef sill (APNEP, 2012b). The Southeast Aquatic Resources Partnership (SARP) also contributed funding for this project. DCM will make property owners aware of potential funding from APNEP and SARP for living shoreline projects constructed along public trust shorelines.

N.C. DMF Coastal Recreational Fishing License (CRFL) Funding
The Coastal Recreational Fishing License (CRFL) Grant Program, administered by N.C. DMF, provides funding for projects that aim to manage, protect, restore, develop, cultivate, and enhance the marine resources of the state. Under state law, a portion of the revenues from sales of N.C. Coastal Recreational Fishing Licenses goes to the Marine Resources Fund, which supports the CRFL Grant Program. Each year, the Marine Fisheries Commission and Wildlife Resources Commission issue a Request for Proposals for projects that address priority research or management needs. As an example, researchers from the UNC Institute of Marine Sciences recently completed a project with CRFL grant funds to examine the effects of shoreline stabilization on fish habitat function and erosion (Peterson and Bruno, 2012). Only proposals from universities, community colleges, local or state government entities, DMF, or WRC are eligible to receive funding, but private individuals or groups can partner with one of these eligible agencies to receive funding. For the 2013 funding cycle, 20 grants were approved for funding, at a total amount of $2.43 million (CRFL, 2013). Some of these projects are related to estuarine shoreline stabilization, and it is feasible that future living shoreline installations or research projects could be funded by this program, provided that proposals are submitted by the eligible groups listed above.

Short-Term Action #6: *DCM and partners will draft living shoreline research proposals for funding from the CRFL Grant Program and will notify property owners about potential living shoreline funding assistance available through CCAP, APNEP, SARP, or other sources.*

Southeast Regional Partnership for Planning and Sustainability (SERPPAS)
The Southeast Regional Partnership for Planning and Sustainability is a unique six-state partnership comprised of state and federal agencies that promotes collaboration in making resource-use decisions supporting conservation of natural resources, working lands, and national defense. SERPPAS has expressed interest in working with DENR and DCM toward increased use of living shoreline techniques to meet shoreline stabilization needs at military facilities.

Long-Term Action #4: *DENR will partner with the military and other institutions to increase the number of living shoreline demonstration sites.*

Summary of Short-Term Actions

1) General Permit

While application of the riprap marsh sill General Permit (15A NCAC 7H .2700) is currently somewhat limited, DCM will continue to coordinate with the USACE and other federal and state agencies to review the specific conditions of the state General Permit and identify opportunities to further reduce permit processing timelines at the state and federal levels.

2) Property Owner Outreach

DCM field representatives will continue to distribute information about living shorelines to property owners, marine contractors, or consultants during site visits if a living shoreline may be appropriate. DCM will also provide continued training for staff utilizing information from research and other studies or observations.

3) Reprint "Weighing Your Options" Booklet

DCM will reprint hard copies of the handbook and continue to make the document available online.

4) Property Owner, Contractor, Landscaping Professional, and Realtor Training

The successful Estuarine Shoreline Stabilization workshops organized by the N.C. NERR-CTP in 2011 and 2012 will be used as a model for DCM to plan future training events and consider new ways to engage marine contractors, landscaping companies, landscape architects, and realtors on the topic of living shorelines. DCM will focus future trainings on existing living shoreline examples and discuss the specific costs that were involved, materials used, equipment access issues, the permitting process, and demonstrated performance of these methods.

5) Informational Signage

In the future, as new living shoreline demonstration sites are constructed (in conjunction with Wildlife Resources Commission boat ramps, for example), informational signs should be placed nearby.

6) Leverage Grant Resources

DCM and partners will draft living shoreline research proposals for funding from the CRFL Grant Program and will notify property owners about potential living shoreline funding assistance available through CCAP, APNEP, SARP, or other sources.

Summary of Long-Term Actions

1) Data Collection, GIS Analysis, and Product Development

DCM will continue analyzing its existing estuarine shoreline inventory and will consider adding such data attributes as bank height, nearshore depth, fetch, and locations of buildings. DCM will also continue to improve online access to estuarine shoreline data and explore development of a geospatial model similar to the VIMS example.

2) Marsh Sills Research

DCM and N.C. National Estuarine Research Reserve staff will pursue research projects and funding to evaluate storm impacts on marsh sills, the effects of marsh sills on adjacent property, the feasibility of using oyster shell as a construction material for marsh sills, the short- and long-term costs of marsh sills compared to other alternatives, and the effectiveness of existing sheetpile sills.

3) Certification Program for Living Shorelines for Contractors

DCM will work to develop workshops, according to certain standards, that could provide engineering Continuing Education credits to eligible participants as well as certification or other official acknowledgement for attendees.

4) Partner with the Military and other Public Institutions

DENR will partner with the military and other public institutions along the coast to increase the number of living shoreline demonstration sites.

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