ASSESSING DECISION-MAKING IN SHORELINE MANAGEMENT AMONG NORTH CAROLINA'S WATERFRONT PROPERTY OWNERS

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EXECUTIVE SUMMARY

Property values on North Carolina's rivers and sounds are high, often costing up to four or five times more than lots of similar size without waterfront. However, the strict property lines set by developers stand in direct opposition to the highly dynamic nature of estuarine shorelines, which undergo natural periods of erosion and accretion. Therefore, any loss of property is typically viewed as undesirable by landowners, and as a potential threat to built structures.

Use of bulkheads, seawalls, and other hardened structures constitute the majority of shoreline development. These structures have been shown to have a number of deleterious environmental effects, including increasing erosion rates and decreasing coastal marsh area over time. Marsh habitat provides a number of important services to coastal residents, including provision of nursery habitat, water purification, and coastal protection from storm events. Recent efforts have been made to increase the use of living shorelines, or natural infrastructure, which employ the use of organic materials such as marsh grasses, rock or oyster shell in lieu of wood, cement, or vinyl. However, bulkheads remain the most prevalent for shoreline management.

This study interviewed 11 North Carolina waterfront landowners about their perceptions of living shorelines, critical factors in selecting a method of erosion control, and their sources of information. Landowners were selected from a purposeful sample provided by the North Carolina Coastal Federation in an attempt to gain perspectives from diverse geographical areas and individuals at varying stages of the living shoreline installation process. Participants with completed living shorelines projects were generally satisfied, but identified a long, and often complicated permitting process. Landowners cited cost, awareness of shoreline management options, and contractor availability as the primary factors influencing their decisions. Additionally, the North Carolina Coastal Federation and the North Carolina Division of Coastal Management were identified as local champions and knowledge-holders for living shorelines projects.

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INTRODUCTION

The state of North Carolina is abundant in coastal resources, including more than 12,000 miles of estuarine shoreline (Schiavinato and Kalo, 2014). This vital habitat provides a number of important ecosystem services, including provision of nursery habitat for fisheries, water purification, and coastal protection from storm events (Barbier et al., 2011).

Waterfront property is highly desirable, and often purchased at a premium. Lots on North Carolina's rivers and sounds may cost as much as four or five times more than lots of similar size in the same development that lack waterfront (Schiavinato and Kalo, 2014). However, as in most coastal areas, shoreline erosion in North Carolina is an ongoing, natural process. Within estuaries, wind-driven waves, storm activity, and boat wakes transport sediment along the coast, creating periods of erosion and accretion over time (Riggs and Ames, 2003). Because of this, estuarine shorelines are highly dynamic, in stark contrast to the static property lines drawn by developers (Schiavinato and Kalo, 2014). As sea level rise and other outcomes of climate change increase, it is expected that erosion of waterfront properties will accelerate (Dugan et al., 2008).

Landowners typically see any loss of land as undesirable— a threat to their economic investment, and an impediment to their use of the land (Pilkey et al., 2012). To combat this, North Carolina "issued permits to stabilize an estimated 168.5 miles of estuarine shoreline against erosion" from 2000-2009, and experts do not expect demand to decline in the coming years (Schiavinato and Kalo, 2014). Landowners have access to a number of methods for combatting shoreline erosion, but "none are permanent solutions, and all have significant environmental trade-offs" (Riggs and Ames, 2003).

This project seeks to understand the critical factors that play a role in shoreline management decisions for North Carolina waterfront property owners. It will attempt to answer the following research questions:

1) Among North Carolina waterfront property owners who've requested more information on living shorelines, what perceptions, if any, do they have about their options for shoreline management?

2) How do these waterfront property owners make decisions about managing their shoreline?

a. Which factors are the most critical?

b. Where do landowners get their information?

SHORELINE HARDENING

Despite its prevalence, traditional methods of erosion control, including bulkheads, seawalls, and revetments, present a number of challenges for changing coastal systems including "high cost, difficulty of removal and damage to the fronting and adjacent beaches" (McQuarrie and Pilkey, 1998).

Of approximately 600 miles of "modified" shoreline in North Carolina, 86.8% involve a bulkhead (Schiavinato and Kalo, 2014). Bulkheads are vertical structures, typically constructed of wood, concrete or vinyl, designed to retain soil and prevent the sliding of land. These structures are stationary, and cannot easily be relocated based on changing conditions (Living Shorelines Academy, n.d). Bulkheads have a life expectancy of approximately 20-25 years, but require regular maintenance to maintain the integrity of the structure when exposed to saltwater and wood boring organisms (US Army Corps of Engineers, 1981). Bulkhead failure, caused by severe storm activity, lack of maintenance, or land subsidence, can be extremely costly to landowners— on the order of tens-of-thousands of US dollars (Living Shoreline Academy, n.d.).

Hardened structures also present a number of ecological challenges. Bulkheads and seawalls impede marsh's natural ability to accrete sediment, which has two main impacts on landowners: (1) It increases the erosion rate of downstream properties by cutting off the sediment supply to accreting marshes, and (2) Structures become unable to keep pace with sea level rise, due to the marsh's inability to migrate landward (Dugan et al, 2008). Additionally, seawalls decrease the biodiversity and abundance of estuarine communities by eliminating the connection between the terrestrial and aquatic environment, and by homogenizing the previously complex habitat required for settlement and recruitment of invertebrate species (Gittman et al., 2016).

Given that less than 5% of North Carolina's estuarine shorelines currently contain a bulkhead, managers concerned with the economic and ecological impacts of shoreline hardening still have time to encourage the use of natural infrastructure, such as living shorelines (Schiavinato and Kalo, 2014).

LIVING SHORELINES

Living shorelines refer to a suite of bank stabilization techniques that utilize natural materials such as marsh grasses, sand, rocks, or oyster shell to reduce waterfront erosion (National Ocean Service, 2017). These projects provide additional ecosystem services by trapping sediment, filtering runoff and maintaining or increasing wetland and riparian habitat (National Research Council, 2007).

While there are few long-term studies comparing the effectiveness of living shorelines to bulkheads, preliminary studies have shown that marshes are capable of outperforming bulkheads in a category 1 hurricane (Gittman, et al., 2014). Typically, living shorelines are not considered suitable for high wave energy environments, and thus, are not a viable option for all landowners (Schiavinato and Kalo, 2014).

The cost of living shorelines can vary widely depending on project specifications. Projects that do not require the installation of an attenuation sill cost an average of $50-$100 per foot, while projects with sand fill or a rock sill can cost $150-$200 per foot. This is in comparison to the $450 per foot average for bulkheads (Virginia Center for Coastal Resources Management, n.d.).

NORTH CAROLINA COASTAL FEDERATION

The North Carolina Coastal Federation is a nonprofit dedicated to protecting and restoring the North Carolina Coast. The organization has three offices in Wanchese, Newport, and Wrightsville Beach, dividing the state's coast into roughly equal northeastern, central and southeastern regions. The North Carolina Coastal Federation works closely with the Division of Coastal Management in both formal and informal capacities to provide guidance on living shorelines projects across the state. They are one of the major voices advocating for the use of living shorelines in the state.

One of the North Carolina Coastal Federation's top priorities is to ensure natural and productive estuarine shorelines by promoting the adoption of living shorelines in suitable locations (North Carolina Coastal Federation, n.d.). They have approached this in a number of ways, including the creation of the Living Shorelines Academy (an online resource which provides information on erosion control methods for landowners and contractors), provision of cost-share funds through a 2017 grant from the National Oceanic and Atmospheric Administration (NOAA), and providing living shorelines workshops to landowners, marine contractors, and real estate developers (North

Carolina Coastal Federation, n.d.). Funding availability was advertised through the North Carolina Coastal Federation's web and email channels, as well as in local newspapers and publications. Applicants to the cost share program were not required to be members of the organization. The grant matches funds provided by landowners for living shoreline installation, cutting the total cost in half.

Additionally, the North Carolina Coastal Federation has been working to increase the availability of contractors by providing workshops and trainings to marine construction companies. They provide a list of experienced living shorelines contractors to participants in the cost share program.

SUMMARY OF RELEVANT LITERATURE

Previous studies have attempted to understand the incentives and barriers to constructing living shorelines across the country. Kochnower et al. (2015) identified four critical factors for mainstreaming natural infrastructure: (1) Perception of benefits and costs, (2) Diffusion of innovation led by innovators, (3) Local champions, and (4) Social networks and norms. They also underscored the role of regulators in reducing the bias against natural infrastructure (Kochnower et al., 2015).

The role of regulators is particularly visible in the case of Maryland, which passed a policy that shifted living shorelines and other natural infrastructure projects from a preferred option "to the required option in places where scientific analysis suggested that gray infrastructure would be needed" (Kochnower et al., 2015). Kochnower found that the state of Maryland had an order of magnitude more natural infrastructure projects than North Carolina, and two orders of magnitude more than California, where living shorelines remain only a preferred option.

Additional studies have suggested that homeowner concern for the environment and preference for a natural landscape aesthetic may indicate a pathway for conservation initiatives along residential shorelines (Scyphers, Picou and Powers, 2014).

In many cases, homeowners and contractors decide which erosion control method will ultimately be used on a given property (Fear and Currin, 2012). The National Research Council concluded that the primary reason landowners selected seawalls and bulkheads over living shorelines was that homeowners were not informed of alternative methods of erosion control (2007).

SUMMARY OF RELEVANT STATE POLICIES

Currently, North Carolina's DCM categorizes living shorelines as the "preferred" method of shoreline stabilization, but there is no policy mandate or state-driven incentives for natural infrastructure (North Carolina Coastal Reserve & National Estuarine Research Reserve, 2016). The permit process for any type of shoreline stabilization is done through a single application to the DCM, which is reviewed at both the state and federal level. Depending on the size and extent of the project, permits may fall into one of three categories: General, Major, or Minor (North Carolina Department of Environmental Quality, "Types of Permits," n.d.).

Despite their "preferred" status, permits for living shorelines projects have historically taken as much as four times longer to obtain than permits for bulkheads (Schiavinato and Kalo, 2014). However, changes made at the federal level in January 2017 (outlined in the next section) are being implemented to reduce approval times for natural infrastructure projects (North Carolina Division of Coastal Management, personal communication, April 3, 2018).

Permit officers for DCM perform a mandatory site inspection on properties seeking to obtain a shoreline stabilization permit. This enables DCM staff to make recommendations about the type and extent of shoreline stabilization required to manage erosion. DCM staff can also provide guidance on what types of information should be included in a permit application so that it is accepted. While DCM can suggest particular methods of shoreline management, they are not authorized to mandate one technique over another without approval from the Coastal Resources Commission or the state. DCM has the ability to reject permits based on the location, size, or extent of a project, but they cannot reject a proposal simply because the landowner wants to install a bulkhead where a living shoreline would suffice.

When a landowner contacts DCM for information about shoreline management, they have the option of requesting site visits to other completed projects. This is not required, but may provide homeowners with ideas about how to incorporate various techniques onto their own property. The living shorelines sites are typically located in publicly accessible areas such as the North Carolina Center for Marine Science and Technology in Morehead City. DCM also refers individuals to the North Carolina Coastal Federation for more information.

SUMMARY OF RELEVANT FEDERAL POLICIES

At the federal level, shoreline stabilization is regulated by the US Army Corps of Engineers (USACE). Prior to January 2017, shoreline stabilization was regulated by Nationwide Permit 13 (NWP 13). This permit allowed for erosion control and prevention using a number of shoreline stabilization techniques, provided that projects were less than 500 feet and did not involve the use of dredge or fill material. Qualifying projects could be granted an automatic permit in 48 hours. Under these criteria, living shorelines involving a rock or oyster shell sill were ineligible for NWP because this fell under the permit's definition of dredge and fill material. This delayed permit applications and dissuaded homeowners from installing living shorelines on their property (B. Sapp, personal communication, December 2016).

In January 2017, USACE updated the language in NWP 13 and added Nationwide Permit 54 (NWP 54) to reduce the bias against natural infrastructure projects (US Army Corps of Engineers, 2017). NWP 54 states:

> *Living shorelines should maintain the natural continuity of the land-water interface, and retain or enhance shoreline ecological processes. Living shorelines must have a substantial biological component, either tidal or lacustrine fringe wetlands or oyster or mussel reef structures.*

Additionally, living shoreline projects must meet many of the same criteria as grey infrastructure projects, including being less than 500 feet in length in order to be eligible for NWP 54 (US Army Corps of Engineers, 2017).

METHODS

This study consisted of two primary components: a review of relevant federal and state policies and a series of semi-structured interviews (11). Both were informed by a literature review, and used to draw the conclusions found on page 15.

Ideally, a study examining decision-making in shoreline management would examine the views of landowners who have installed all types of erosion-prevention methods. This would provide a general understanding of the level of awareness around natural stabilization methods. However, when DCM was contacted about obtaining a list of permit holders, the information was unavailable in digital form. However, DCM staff recommended working with the North Carolina Coastal Federation, since the organization works closely with landowners on living shorelines projects.

The North Carolina Coastal Federation provided a list of individuals "interested" in living shorelines. For privacy purposes, the list was not comprehensive, but included 42 individuals from along the coast of North Carolina who had reached out to the organization for more information about living shorelines. These landowners fell into one of three categories: (1) Did not proceed with a living shoreline project, (2) In the process of obtaining a living shoreline, or (3) Living shoreline project complete. Most of the landowners on the list had completed or were in the process of completing a living shoreline project on their property. Four individuals on the list sought more information, but decided not to go through with the process. From this list, a purposeful sample of interview subjects was drawn to maximize geographic diversity, and include participants at varying stages of the installation process.

Subjects were contacted via phone and email and asked to participate in a phone interview. The semi-structured survey instrument can be found in Appendix A. These questions were designed to address the key decision-making criteria identified in the literature review, as well as any additional factors that influenced property owners. All interviews were recorded, transcribed, and imported into NVivo for coding of common themes. In total, 23 people were contacted for an interview. Eleven subjects responded and participated in this study with interviews ranging from 19 to 64 minutes. While the list provided by the North Carolina Coastal Federation contained landowners who had chosen not to install a living shoreline, none of these individuals responded to a request for an interview.

Participant experience varied widely ranging from a landowner who completed her project in 2011 to another in the early stages of obtaining a permit. One individual was not a landowner, but rather a citizen who was part of a community effort to have a living shoreline installed in a public park. Respondents were primarily from the northern and central parts of the North Carolina Coast.

After interviews were completed, I identified common themes across the three major components of my research questions. These themes are outlined in the following section.

RESULTS AND DISCUSSION

GENERAL PERCEPTIONS OF LIVING SHORELINES

Interview participants expressed five general themes about their perceptions of living shorelines: (1) Living shorelines are environmentally friendly, (2) Skepticism or lack of knowledge prior to installation, (3) Satisfaction after installation, (4) Obtaining a living shoreline is a complicated process, but not prohibitively so, and (5) Living shorelines are low maintenance and low cost after installation.

With regard to being environmentally friendly, two major subthemes emerged. The first was an understanding that bulkheads increase erosion rates and decrease habitat. One landowner stated, "One of the things we learned was how damaging to the environment bulkheads are. Obviously we didn't want to do that," said one landowner. Several others discussed how they had learned about bulkheads increasing erosion rates over time, and described witnessing that among their neighbors.

The second subtheme identified was an understanding of living shorelines' capability to provide habitat. One said, "Looking at the water and seeing the baby fish and baby crabs swimming around, you realize how important the habitat is for them." Another said, "We thought maybe we could create some oyster habitat. Not just oysters— maybe something that would hold a little bit of water behind it [for] some SAVs. We could have the rocks really contribute to something."

Overwhelmingly, landowners described a lack of knowledge about natural infrastructure techniques prior to exposure through the North Carolina Coastal Federation or another local champion. "We had decided to let nature course, and just be glad that the house was set back 300 or 400 feet from the shoreline when we saw notice that the Coastal Federation had received funding for cost-sharing." Another landowner said, "The reason I knew what we wanted was because I had

inside knowledge of what was going on in [a nearby refuge]. Otherwise we would have just rip-rapped the shoreline or bulkheaded it or something."

One of the interview subjects, whose living shoreline was a relatively new project, said "We still [have concerns about its effectiveness.] Installation was completed in October-November of last year, and we still look at it and put out candles every time there's a storm or something. So far it seems to be holding."

This initial lack of information and skepticism was uniformly followed by satisfaction with their living shorelines projects. All of the interview subjects with completed projects expressed contentment with their decision, and faith that it would continue to be effective in the future. "At the beginning, when we were seeing the drawings and we were seeing what happens when there's a southerly wind that pushes the water in, we were kind of skeptical. But the minute it went in, and it looks like it belongs there, our anxiety level went down a lot. There was a feeling of, 'Yes. We have done the right thing.'"

Landowner descriptions of permitting were mixed. Some interviews expressed frustration with the length and cost of the process, saying things like, "They made us pay for a permit and go through the CAMA major permit process to do this marsh restoration project, which seemed sort of backwards to me, honestly. I felt like we were landowners who weren't being cost-shaded for anything. We were paying to protect the marsh. And, although they weren't uncooperative, the agencies still made us jump through all the hoops to do the project."

On the other end of the spectrum, on interview subject said, "Dealing with the Coastal Federation was great. CAMA[*] was very responsive and knowledgeable, while obviously keeping to their own guidelines. The engineer and the contractor were also really easy to work with. There's nothing to complain about." While it is not possible to draw conclusions from 11 interviews, this discrepancy seemed to improve over time. In general, landowners who'd completed more recent projects seemed to describe a smoother process.

[*] The North Carolina Division of Coastal Management (DCM) is colloquially referred to as "CAMA" by coastal residents. While CAMA typically refers to the Coastal Area Management Act, the piece of legislation responsible for establishing DCM, the two terms are often used interchangeably. References to "CAMA" in this paper refer to the DCM unless otherwise specified.

Overall, it appeared that most viewed permitting as complicated and time consuming, but not prohibitive. This was best illustrated by one homeowner who said, "I understand that it's going to become more complicated, but I'm a person who goes one step at a time, but I always keep the goal in mind. My goal is to have a living shoreline. I just know it's going to take a whole lot of steps to get there."

Two additional findings about the permitting and installation process are worth noting here. (1) One landowner described a three month wait to receive her permit. Instead of frustration, she felt like this period made logical sense, since marine contractors in her area had a wait list. This suggests that longer wait-times for permits aren't necessarily prohibitive if landowners are educated about the broader timeline of the installation process. (2) Three landowners discussed a general level of comfort with the DCM permitting process through prior experience. As waterfront property owners, several had installed boardwalks or other projects on their property. They knew who DCM was, and how to get more information about permits, and were therefore more comfortable with the living shorelines permitting process.

Finally, the majority of homeowners described living shorelines as low-cost and low maintenance after installation. "I thought we'd have to spring for a lot of vegetation—maybe some myrtles and *Spartina*, but it all came roaring in on its own once we got the [boat wake] and the foot traffic off of the marsh." Another said, "There's really been no maintenance to speak of, on the sill," said one landowner.

CRITICAL DECISION MAKING FACTORS

Cost and availability of marine contractors were cited by all interview subjects as the most critical factors affecting their decision to install a living shoreline. This was followed by awareness of living shorelines and access to information regarding their construction and effectiveness. Additional themes included a desire to make environmentally-friendly choices and concerns about access for marine contractors.

"We have a friend who owns a wetland plant nursery close by, and she had been telling us about what plants could do to stabilize the shoreline," said one landowner. "We had seen several other projects but hadn't thought that we'd be able to do anything like that until we heard of the Coastal Federation cost-sharing program."

Another said that, "The hardest part was getting local contractors to call back. I guess some of them said the job was too small. Some of them never returned our call. Most of them seemed to be closer to the Outer Banks and it was too far for them to come."

The limited availability of contractors contributed to cost. "We were sort of a captive audience as far as cost goes because there wasn't a lot of choice," said one interviewee. Most people who had constructed a living shoreline did not have the option of getting quotes from multiple contractors because most only had one person in their area with the time and ability to complete it.

Nearly 75% of interview subjects described visiting a living shoreline as an important piece of their decision because it 1) introduced them to the idea of natural infrastructure as a method of erosion control and 2) gave them insights into the options available for construction. One woman described her experience with DCM where she visited several sites at local parks and points of interest. She noted that a lot of these locations were equipped with informational signage, but stated that she probably wouldn't have visited these locations if DCM hadn't brought her. She suggested working with homeowners to have living shorelines on their private property so that people recognize that living shorelines can be done on a smaller lot, too. "Regular people don't visit the CMAST building or the NOAA[†] lab in Beaufort very often," she said. "Signs should be in places where people will see them." Later, the same landowner added, "I think people would be more apt to do a living shoreline if they could see how cool one was."

Multiple interview subjects stated that they wanted to make sure they protected the environment around their property to the extent possible. "We're a fishing community," said one interview subject. "We need habitat. We need nurseries. If you start putting up bulkheads, you destroy all that." Several described that the natural beauty of North Carolina's coast is what attracted them to the region. Many participated in recreational activities on the water and felt a desire to preserve both the aesthetics and quality of the region. "We're so thrilled that it's there," said one landowner. "Now, we take all of our friends down to see it. It's like a neighborhood sightseeing expedition."

[†] North Carolina State University's Center for Marine Sciences and Technology in Morehead City and the National Oceanic and Atmospheric Administration's Beaufort Laboratory have living shorelines demonstrations projects.

Finally, three landowners discussed challenges associated with access. Their properties had specific geographic features (such as shallow water or protected Cyprus wetlands in the area surrounding erosion) that made it difficult for contractors to bring necessary equipment to the site. However, one family described how their contractor had done research to find a portable pile driver capable of completing the job without having to bring heavy machinery onto the property.

It should be noted that none of the subjects interviewed cited state or federal policies as a key factor in their decision, even when prompted. Most cited a desire to comply with the law, but took the rules as a given. Two individuals discussed feelings of frustration around having to pay for a permit in the first place. ("I get that we were working in wetlands, but we were trying to protect wetland.") None of the recent permit recipients discussed NWP 13 or NWP 54, and it did not indicate familiarity with the recent changes to the federal permitting process. Participants who'd completed their living shorelines prior to these changes mentioned a desire to "make things easier" for future applicants, but had not kept up with permitting policies after project completion.

SOURCES OF INFORMATION

Interviews revealed five primary sources that landowners used to obtain information about their options for shoreline management: 1) Local champions such as the North Carolina Coastal Federation and DCM, 2) Contractors, engineers and other marine construction professionals, 3) Site visits, 4) Other homeowners who have implemented a living shoreline, and 5) A general interest in local environmental issues.

Everyone who participated in this study cited the North Carolina Coastal Federation and DCM as their primary sources of information for learning more about their shoreline management options, which is not surprising given that interview subjects came from a list provided by the North Carolina Coastal Federation. Many had seen promotional materials in the newspaper about their general work on living shorelines, or specifically the announcement about the availability of the cost share program. While not all of the individuals interviewed were Coastal Federation members prior to their living shoreline installation, all of them had been familiar with the North Carolina Coastal Federation previously. Homeowners participating in cost share program received a folder of information about constructing a living shoreline, such as the differences among natural infrastructure techniques, how to obtain a permit, and a list of experienced contractors. Two

individuals also cited the Coastal Federation's Living Shorelines Academy website as a particularly helpful resource.

Similarly, DCM was seen as responsive, knowledgeable and fair while adhering to their own guidelines. "The one thing the [DCM] lady made very clear was, 'Do not abuse my trust. If I say 20 feet, do not do 20 feet and 2 inches,'" said one participant. "I think we had a very trusting relationship and she saw that we were willing to obey all the rules and legislation—because they were very logical, and we worked on it together."

North Carolina Coastal Federation and DCM staff were typically the ones responsible for taking interested parties for a site visit. This presented another opportunity to gain information about living shorelines, by providing examples of prior projects. One interviewee specifically said that she had been planning on installing a granite sill until she saw a limestone sill and realized that it would provide better habitat for oysters, crabs, and other organisms.

Additionally, site visits— especially to private properties rather than public sites— allow landowners to connect and share information. "CAMA staff took me to see a landowner who had done a living shoreline," said one individual. "I asked the landowner who they used [as a contractor] and they told me."

Contractors and engineers also proved to be a tremendous resource for homeowners. Nearly everyone interviewed discussed their contractor's ability to control the pace and ease with which their project was completed. "Somebody who was really helpful was [our contractor]. He contracts a lot of work for rock sills and things. [He] works with all the agency people, and he knew just what we needed… CAMA was used to working with [him], and so they knew I'd be working with somebody who was familiar with how the operation would have to take place."

Another landowner said, "Of the [contractors] we contacted, he came out on his own dime a lot and was really excited about it. He put in a lot of unpaid work and he was really great to work with. I know they did a lot of research about how sills work and they talked to other engineers who had more direct experience with attenuation sills."

Two individuals mentioned that they had not minded the longer permitting times because their contractors had wait-times that coincided with the wait-period for a permit.

Finally, more than half of interviewees mentioned that they were familiar with living shorelines because of a general interest in outdoor recreation or the environment. One woman said, "My husband is a farmer, but he follows a lot of the marsh debate— on both sides." Most of the individuals interviewed were members of the North Carolina Coastal Federation, which suggests a high level of environmental consciousness among interview participants that likely isn't mirrored by the broader North Carolina public.

CONCLUSIONS

With a survey of only 11 people, there are obvious limitations to the generalizability of this study. However, the themes presented in this paper are meant to provide insight into the decision-making process of homeowners, and not draw causation from correlation.

Based on these interviews, it is clear that the North Carolina Coastal Federation is succeeding in their role as local champions for living shorelines and other natural infrastructure. While it is not possible to draw causation from 11 interviews, it would also seem that there has been improvement over time in the method of communication and usefulness of information shared with the Coastal Federation's stakeholders. The individual who completed their living shoreline reported a long, drawn out permitting process with a lot of setbacks. However, participants in the recent North Carolina Coastal Federation cost share program reported permit approval times of 1-2 weeks. Of the 42 individuals on the list provided by the North Carolina Coastal Federation, only 4 did not proceed with a living shorelines project. This suggests that 1) individuals who seek out more information about living shorelines typically go forward with the project and 2) the North Carolina Coastal Federation have improved their communications strategy over time.

These findings align with The National Research Council's (2007) assertion that landowners don't pursue alternative stabilization methods because they aren't informed of their options. Once informed, most of the landowners making inquiries proceeded. If the North Carolina Coastal Federation can continue to educate local landowners about natural stabilization methods and living shorelines, it follows that they would see an increased interest in pursuing projects.

Similarly, DCM is generally viewed as knowledgeable, fair, and reasonable— even when permits take a long time. With the recent addition of Nationwide Permit 54, there are good indicators that their reputation will continue to improve. Comments by interviewees suggest that recent permitting times have decreased and that DCM has streamlined their permitting process. Interview subjects who were in the midst of obtaining a permit reported positive interactions with DCM staff, and any delays in the permitting process were caused by factors outside DCM's purview (i.e. property line disputes with neighbors).

Though adoption of living shorelines appears slow, there are also indicators that early adopters are helping to spread the word with their friends and neighbors in the same way that they

did for Kochnower's research (2015). Even though 86.8% of North Carolina's *modified* shoreline involves a bulkhead, large portions of the coast remain undeveloped (Schiavinato and Kalo, 2014). Theses early innovators have will be critical to shifting perceptions before modification becomes more widespread. Additionally, capitalizing on the knowledge and enthusiasm of landowners with completed living shorelines projects though the creation of a "Living Shorelines Ambassador Network" or other efforts would be a low-cost, high-impact way to accelerate these connections.

Contrary to my original assumptions, it appears that local policies are less salient than cost and contractor availability. Most individuals understood the permitting process, but not the specific interplay between the state and federal requirements. Barring a political mandate for soft-shore stabilization techniques, such as Maryland's Living Shoreline Protection Act, is likely that landowner and contractor education will have to be the primary agents of change in environmental behavior.

The case of the homeowner whose contractor did additional research on specialized equipment points to the need for increased communication among marine contractors While the North Carolina Coastal Federation and DCM conduct workshops for marine contractors, it appears that they would also benefit from a state or region-wide network of living shorelines professionals. The North Carolina Living Shorelines Academy has a web forum for marine contractors and living shorelines professionals, but it has not seen widespread adoption.

While incentives for homeowners have begun to emerge, such as the North Carolina Coastal Federation cost-sharing program, it is crucial to look at establishing incentives for marine contractors and engineering professionals. This could take the form of continuing education credits or financial support for agreeing to take on smaller projects. This would increase the availability of contractors to homeowners, and therefore give homeowners a greater degree of choice.

These findings highlight a possible new strategy when communicating with homeowners about living shorelines. In addition to focusing on living shorelines' effectiveness, lower cost and environmental benefits, it may be possible to market living shorelines as a value-added benefit to landscaping. This may resonate stronger with individuals who do not consider themselves environmentally-minded, but still appreciate the aesthetics of the coast. "I think for me, it's knowing that I can look down and see little things swimming around in the water," said one participant. "You don't have to be a biologist to appreciate living things."

Future research efforts should prioritize individuals who have sought more information about living shorelines and chosen not to go forward with a project, as well as looking specifically at contractor perceptions and barriers. DCM is undergoing an effort to digitize their permit records, which may make these efforts more feasible.

Finally, testing specific messages about shoreline management or performing a hierarchy ranking of landowner preferences would provide more insights for future communications strategies. Responses to these interviews suggest that communications messages should appeal to common sense. While many of the interview participants expressed environmental motivations, this is not likely to be reflected in the general public. Appealing to cost-conscious homeowners about reclaiming their eroding property is likely to be more effective. "You have to justify it economically," said one homeowner. "You have to look at the future and say, 'What do I want this to look like?' And what we didn't want to do in the future was continue to let it erode away. As long as our property line is where it was, we were going to get taxed." They added that living shorelines were the only option that allowed them to regain lost marsh, rather than just stop erosion.

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APPENDICES

APPENDIX A: Semi-Structured Survey Instrument

General Questions

- Please describe your property and the reasons you sought information about shoreline stabilization.
- Where did you first hear about using natural bank stabilization techniques? What was your initial perception?
- When determining how to stabilize your shoreline, what options did you consider?

Group 1: Inquired About Living Shorelines, Did Not Proceed with Project

- Why did you decide not to proceed with natural bank stabilization?
- What were some important factors when choosing to use a [bulkhead/seawall/no stabilization?]
    - What was the most important factor?
    - Was there a key individual or group who influenced your decision? [Friends and neighbors, local organizations, contractors, Division of Coastal Management etc.]
    - Was there a state or local policy that influenced your decision?
- Now that you've chosen a [bulkhead/seawall/no stabilization] for your property, what is your perception of its effectiveness? Would you make the same decision again?
- Where do you get your information about managing your property's shoreline?
- How did you find your contractor?
    - Did your contractor suggest a living shoreline or other natural bank stabilization techniques?
- Do you have any more thoughts that you'd like to share on this topic?

Group 2: Inquired About Living Shorelines, In the Process of Implementing a Living Shoreline

- Have you decided whether or not you will proceed with natural bank stabilization? Why or why not?

- [If yes] You're at the very beginning of this process. Do you feel like you know what to expect? Is there anything that feels uncertain?

- Please describe your experience with the permitting process. How long [did it take/do you expect it to take]?
    - Have there been any individuals to help guide you through the process?
- What were some important factors when choosing a living shoreline?
    - What was the most important factor?
    - Was there a key individual or group who influenced your decision? [Friends and neighbors, local organizations, contractors, Division of Coastal Management etc.]
    - Was there a state or local policy that influenced your decision?
- Now that you've chosen living shoreline for your property, what is your perception of its effectiveness? This may be different than your initial perception, which we discussed earlier.
- Where do you get your information about managing your property's shoreline?
- Do you have a contractor selected? How did you find him or her?
    - [If yes]: Do they have previous experience constructing living shorelines?
- So far, what has been the easiest part of this process? The most difficult?
- What do you feel is the best way to spread information about shoreline management to homeowners? What resources would be most useful?
- Do you have any more thoughts that you'd like to share on this topic?

Group 3: Inquired About Living Shorelines, Project Complete

- Please describe your experience with the permitting process. How long did it take?
    - Were there any individuals to help guide you through the process?
- What were some important factors when choosing a living shoreline?
    - What was the most important factor?
    - Was there a key individual or group who influenced your decision? [Friends and neighbors, local organizations, contractors, Division of Coastal Management etc.]
    - Was there a state or local policy that influenced your decision?
- Now that you have a living shoreline on your property, what is your perception of its effectiveness? This may be different than your initial perception, which we discussed earlier.

- Where do you get your information about managing your property's shoreline?
- Did you use a contractor? If so, how did you find them?
    - [If yes]: Do they have previous experience constructing living shorelines?
- During this process— from making a decision to installing the final product— which parts went smoothly? What parts were more difficult?
- What do you feel is the best way to spread information about shoreline management to homeowners? What resources would be most useful?
- Do you have any more thoughts that you'd like to share on this topic?

APPENDIX B: Informed Consent

The following consent form was provided to all interview participants. The statement was read aloud prior to the interview, and participants were asked to sign a paper copy of the form.

You have been selected to participate in an interview for a study conducted by a graduate student at Duke University. The purpose of this interview is to obtain your insights and opinions on living shorelines and as to obtain your feedback on different options for shoreline stabilization for homeowners in your state. Your contact information was shared with me by the North Carolina Coastal Federation. You have been selected because of your past interest in receiving information about living shorelines.

The interview will take approximately 30 minutes. During this discussion, you will be asked to share your opinions; there are no right or wrong answers.

In order to ensure privacy, your name and any identifying information not be connected to your responses. The final report will be presented at the Duke Nicholas School of the Environment, and will be available online through the University Library.

If you consent, this interview will be audio recorded. The recording will be used to summarize my findings. As soon as the final report is completed, the recording will be erased.

Your participation in this interview is entirely voluntary. You may decline to answer any question and you may choose to end the conversation at any time. If you have any questions or concerns, you may ask me now or at any time during or after the discussion. You may also contact me via email at jaclyn.mcgarry@duke.edu.

I agree to participate in this interview and to be audio recorded. I understand that I will receive a copy of this consent form for my records.

_____

Print Name

_____

Signature

_____

Date