Tools and Decision-Making: Facilitating and Encouraging Living Shoreline Implementation

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NOAA's Shoreline Management Technical Assistance Toolbox

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ABSTRACT

Erosion will claim 25% of all homes within 500 feet of ocean or Great Lakes shorelines over the next 60 years according to a recent Heinz Center study. Therefore, it is not surprising that shoreline stabilization is one of the "hot" coastal management issues many states are trying to address today. A recent survey conducted by the Coastal States Organization found that 68% of coastal managers and staff ranked coastal hazards as either a very important or important topic in their state. The survey also found that 88% of the coastal management community ranked managing areas prone to erosion as the most important coastal hazards issue. Specifically, managers were most interested in additional information on design standards for shoreline management technologies, risk and vulnerability assessments, and alternative shoreline protection technologies.

Therefore, the National Oceanic and Atmospheric Administration's (NOAA) Office of Ocean and Coastal Resource Management, has developed a Shoreline Management Technical Assistance website (http://coastalmanagement.noaa.gov/shoreline.html) to provide coastal resource managers with centralized access to information, resources, and tools to address shoreline erosion and management, focusing on alternatives to traditional shoreline hardening. The website includes information on planning and policy tools, alternative stabilization techniques such as "soft" or hybrid methods (e.g., marsh restoration with breakwater sill), and the economics of shoreline management. For each technique, the website provides links to relevant websites, reports, and management tools, as well as case studies describing how the techniques have been applied.

INTRODUCTION

Shoreline erosion is a natural process. However, coastal storms, sea level rise, and poorly planned shoreline development projects can accelerate natural erosion rates. Additionally, a 2000 Heinz Center report found that within the next 60 years, erosion will claim a quarter of U.S. homes within 500 feet of the shore, costing coastal property owners roughly $530M/year (1).

With over 127 million people living along our coasts and estuaries and 180 million more visiting to recreate each year, the impacts of coastal erosion are a significant problem for coastal managers. In a recent study, 88% of the coastal management community ranked managing areas prone to erosion as the most important coastal hazards issue they face (2).

The Coastal Zone Management Act (CZMA) directs state coastal management programs to minimize loss of life and property caused by erosion and to protect the nation's natural coastal resources. Therefore, the solution to shoreline erosion is not as simple as hardening our shorelines with bulkheads, riprap, or groins to wall off the sea. While traditional hard stabilization techniques (riprap, jetties) may be appropriate and effective solutions under some circumstances, they are not always the best option. These types of hard erosion control structures can be very costly, interrupt natural shoreline processes and sand movement, and lead to increased erosion. In addition, shoreline hardening often destroys valuable shoreline habitats such as wetlands and intertidal areas.

Recently, alternative shoreline management techniques such as soft or nonstructural (vegetative plantings), hybrid (replanting coupled with rock sills), and planning and policy approaches (set-backs, managed retreat) are receiving more attention as potential solutions to shoreline erosion.

To assist coastal managers in addressing these shoreline management issues, NOAA's Office of Ocean and Coastal Resource Management developed a website to provide centralized access to information, resources, and tools to address shoreline erosion and management, focusing on alternatives to traditional shoreline hardening (3). The Shoreline Management Technical Assistance Toolbox (http://coastalmanagement.noaa.gov/shoreline.html) includes four main sections: (1) Planning, Policy, and Regulatory Tools; (2) Alternative Shoreline Stabilization Methods; (3) Economics of Shoreline Management; and (4) Resources. Each section is discussed in more detail below.

PLANNING, POLICY, AND REGULATORY APPROACHES

Planning, policy, and regulatory approaches to shoreline management are intended to influence human use and development near the shoreline. These approaches can be preventative measures to avoid the need for physical shoreline stabilization, or can be implemented in response to shoreline erosion when physical shoreline stabilization would be too costly, ineffective, or undesirable. While each planning, policy, or regulatory approach has merit by itself, coastal managers often find a combination of these methods is the most effective way to manage the shoreline.

Developing strong shoreline management policies, regulations, and planning approaches is very important as they are the only way to effectively reduce, or avoid altogether, the need for costly erosion control measures. They can also help maintain the natural shoreline dynamics and preserve important coastal environments. In addition, shoreline planning is one of the few techniques that allows for a regional, more holistic approach to shoreline management that can be used to address both direct and cumulative impacts.

Therefore planning, policy, and regulatory tools should be employed as the first line of defense against erosion. Despite the numerous benefits these tools offer, implementing these approaches can be technically and politically difficult, especially when good scientific data is lacking or where significant development has already occurred. Table 1 lists the 18 policy, regulatory, and planning techniques included in the Shoreline Technical Assistance Toolbox. More in-depth pages for each technique, which provide a brief overview of the technique, describe its benefits and drawbacks, and provide case studies to illustrate how it is being applied at the state or local level, can be found on the website.

ALTERNATIVE SHORELINE STABILIZATION METHODS

Even with the best planning and regulatory programs, some type of shoreline stabilization is often needed when eroding shorelines threaten waterfront development. To restore, protect, and enhance the natural shoreline environment, "soft" or "nonstructural" stabilization techniques that rely on vegetative plantings and sand

Planning & Policy Tools	Regulatory Tools
High-Risk Erosion Area Disclosure	Construction Setbacks
Insurance Incentives/Disincentives	Erosion Control Easements
Managed Retreat	Erosion Control Structures Regulation
Mitigation *(cross listed)*	High-Risk Erosion Area Disclosure
Shoreline Management Plans	Mitigation *(cross listed)*
Tax Incentives	Shorefront Development Regulation
Transfer of Development Rights Programs	Restrictive Covenants
	Zoning and Erosion Overlay Districts
Other Management Tools	
Cost-Share/Loan Programs	Land Acquisition
Education/Outreach Campaigns	Relocation Assistance/Buy-Back Programs
Research and Monitoring Programs	

Table 1. *List of the 18 policy, regulatory, and planning techniques included in the Shoreline Technical Assistance Toolbox.*

fill, or "hybrid" techniques that combine vegetative planting with low rock sills, can be effective alternatives to hard stabilization structures such as bulkheads, riprap, or groins along low to mid-energy shores. These alternative "soft" and "hybrid" approaches are often collectively referred to as "living shorelines" since they help to preserve the natural, living shoreline.

The Alternative Shoreline Stabilization Methods page describes the difference between "soft" and "hybrid" stabilization approaches as well as benefits and drawbacks of "living shorelines." The page also links to the NOAA Restoration Center's Restoration Clearinghouse. The Clearinghouse includes a section dedicated to living shorelines which provides more in-depth information about living shoreline approaches, including:

- Descriptions of what living shorelines are;
- Outlines the planning and implementation steps needed to install a living shoreline erosion control structure;
- Discussions of the type of living shoreline treatments that would be most appropriate given the type of shoreline;
- Case studies of several NOAA Restoration-funded living shorelines projects;
- Lists of Federal and state statutes, regulations, and permits that living shorelines projects must adhere to; and
- Publications, websites, brochures, news articles, restoration information, and guidance documents related to living shorelines.

Although this section presents many different options for soft-structural stabilization or living shorelines, it is important to note that conducting a thorough site evaluation is still important to identify which approach, if any, would be most effective, given the site conditions.

ECONOMICS OF SHORELINE MANAGEMENT

Economics plays an important role in most decisions we make, including shoreline management. For example, coastal managers may want to use economics to understand what type of shoreline management approach would be most economically feasible to employ, given the social and environmental costs and benefits of a project and its expected lifespan. This section of the web toolbox discusses how economic analyses can help coastal managers make decisions about which shoreline management approaches may be best to use under different circumstances.

The Economics of Shoreline Management section is intended to provide coastal managers and the general public with enough information to:

- Understand basic economic principles and know how they can be applied to shoreline management and erosion control;
- Understand the primary types of economic analyses, what type of questions each can be used to answer, and where to find more in-depth information on certain types of analyses; and
- Know where to go for more information.

RESOURCES

Finally, the last tool in the Shoreline Management Toolbox is the "Resources" section. The Resources section contains an annotated bibliography of papers, reports, websites, and other resources on a variety of shoreline management topics. To facilitate use, resources are grouped by the following categories: (1) General; (2) Shoreline Change, Hazard Assessment, and Other Decision-Support Tools; (3) Policy or

Regulatory Approaches; (4) Model Ordinances/Bylaws; (5) Engineered Shoreline Management Approaches (Hard and Soft Stabilization); and (6) Shoreline Management Economics. When available, links to the website or online documents and reports are also provided. Links are also provided to other state and federal programs for shoreline management.

CONCLUSION

The Shoreline Management Technical Assistance Toolbox is a useful, online resource to help coastal managers address shoreline management issues by highlighting a variety of techniques that can be used to avoid shoreline hardening. The Toolbox is intended to be a dynamic resource, with the capability to add additional approaches, case studies, and resources, as appropriate.

REFERENCES

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Maryland Shorelines On-line: A Web Portal and Geospatial Tool for Shoreline Planning and Management in Maryland

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ABSTRACT

Geographic Information Systems are important to natural resource management, but access to data is a challenge for some local governments and the public. A web-based open source tool, Maryland Shorelines Online (MSO), was developed to specifically address access issues. MSO is organized into six major topic areas that include: 1) Introduction, 2) Laws, Regulations, and Permits, 3) Education and Outreach, 4) Assistance, 5) Coastal Hazard Management, and 6) Interactive Mapping. An overview of the MSO portal, and its uses and limitations, is discussed in this paper. The data sets are used in case studies to demonstrate the use of the Maryland Shorelines Changes Online interactive web mapping tool in shoreline management decisions. As the promotion of living shoreline restoration and demonstration projects occur, this website will provide an opportunity for the public and local governments to be more engaged in planning and decision-making. As the potential use of this application is varied, training and outreach on this application will be important for its success in reaching the target audiences.

INTRODUCTION

Web technology and geographic information systems (GIS) are greatly improving the ability of planners and scientists to plan and manage natural resources. The utilization of GIS has provided significant advantages, but the access to utilize GIS-based information is not equal across all levels of government or by the public. The issues associated with accessibility and utility of geospatial products has impeded the incorporation of geospatial information into many of the day-to-day shoreline planning and decision-making activities in Maryland, especially at the local level.

A web-based open source tool, Maryland Shorelines Online (MSO), was developed by the Maryland Department of Natural Resources (MDNR) and Towson Center for Geographic Information Sciences to specifically address some of the access issues. The MSO website was designed as a portal for shoreline and coastal hazard management. The web provides the ideal platform to provide information and data to a desktop. Users are not required to possess or be practiced in the skills of using GIS technology. These tools utilize GIS along with the Internet to serve data right to a personal computer and require no additional software. Target audiences for this website ranges from regulators of tidal wetlands, Critical Areas and local government planners, marine contractors, teachers, and the public. As managers are continued to be asked to do more with less resources, web-based applications and GIS will be important for the future of planning, visualization, and management of shorelines and coastal hazards in Maryland.

An overview of the MSO portal and its uses and limitations will be discussed in this paper. The accuracy of the data should be considered when formulating assumptions from the web-mapping tool as it is intended for general use and educational purposes. Focus will be on using data sets that are available on the website and include the historical shoreline series, shoreline rates of change, and comprehensive shoreline inventory. Case studies will be provided to demonstrate the uses of Maryland Shorelines Changes Online interactive web mapping tool when making shoreline management decisions.

Overview of Maryland Shorelines Online Web Portal

MSO is organized into six major topic areas that include: 1) Introduction, 2) Laws, Regulations, and Permits, 3) Education and Outreach, 4) Assistance, 5) Coastal Hazard Management, and 6) Interactive Mapping (http://shorelines.dnr.state.md.us).

The ***Introduction*** section contains a general overview, discussion, and summary/trend information on coastal hazards affecting Maryland's Coastal Zone. A sub-menu option is a section of definitions that are hyperlinked to the word's position throughout the website.

Laws, Regulations, and Permits has been developed into a series of quick reference matrices that describe federal, state, and local programs/regulations/permitting processes that guide shoreline management activities.

Education and Outreach has been divided into three sub-menus and has general information such as fact sheets, posters, resource links, and studies. The other sub-menus are targeted to training opportunities and educational lessons for middle and high school students. These lessons specifically target coastal hazards and different impacts that shoreline change, natural processes, and human activities have on the natural environment. The lessons are divided into five separate components and address: 1) weather, 2) coastal processes, 3) sea level rise, 4) human activities, and 5) biological communities. All of these subjects are interconnected to affect and contribute to understanding coastal hazards in Maryland (http://shorelines.dnr.state.md.us/k-12.asp).

The ***Assistance*** portion of the website describes opportunities for property owners, communities, and local governments to receive technical and financial assistance with flood and erosion mitigation activities.

The ***Coastal Hazard Management*** section covers multiple topics that address coastal hazard and shoreline management issues. It is divided into the following subjects: 1) technology, data, and research; 2) modeling and monitoring; 3) planning, 4) case studies, and 5) living shorelines.

The ***Interactive Mapping*** section provides hands-on data and tools that can be utilized in decision-making. Links to Maryland Shoreline Changes Online interactive map viewer, Erosion Vulnerability Assessment, Comprehensive Shoreline Inventory, and the Shoreline and Littoral Drift Conditions maps are available in this section.

Maryland Shoreline Changes Online: An Interactive Internet Mapping Application

Maryland Shoreline Changes Online is the interactive GIS mapping application found on the MSO portal (http://shorelines.dnr.state.md.us/sc_online.asp). The tool contains data layers that can be viewed through the web by using ArcIMS 9.2 ® (Internet Mapping System) software, which is produced and published by ESRI (Table 1). The MSO mapping tool represents the gateway to information on shoreline conditions, coastal hazard risk, land use, and infrastructure. It allows users to view site-specific data and information at various scales and to choose any combination of data and characteristics. The flexibility of this tool allows it to work for different audiences and allows for shoreline management to be conducted in a more regional and holistic perspective/approach.

MSO Shoreline Changes Online mapping application contains a set of mapping tools to assist with navigating, analyzing, and displaying data and information (Table 2). This tools gives the user flexibility and functionality and allow him/her to move freely throughout the mapping interface.

RESULTS

Case Studies

Users of this mapping application are varied and can range from federal/state managers, local government regulators/planners, contractors, teachers, and the public. Scenarios are given to illustrate the wide scope of applications for the tools. These scenarios are crafted to address the varied audiences.

Data Layer Category	Data Layers
Shoreline Rates of Change	Shoreline change rates – Summary layer Transects, Baseline, All Historical Shorelines
Historical Shoreline Series	1988-1995, 1946-1977, 1925-1945, 1904-1924, 1883-1903, 1862-1882, 1841-1861 Shoreline photos (move to shoreline inventory below)
Shoreline Inventory	Access structures (docks, piers, marinas, ramps, boathouses) Riparian land use (agriculture, residential, commercial, etc) Stabilization structures (bulkheads, riprap, groins, breakwater, etc), *Phragmites* invasive areas, beach buffer, marsh buffer, bank cover, bank height and condition
Shoreline and Littoral Drift Conditions	Wind rose, sediment transport patterns, shoreline conditions
Storm Surge Areas	Category 1-4 inundation zones
Hydrology	Streams, rivers and lakes, water bodies, rivers and lake labels, stream labels
Transportation	Interstates, major highways, major roads, detailed roads, routes, road names
Topography	LIDAR Digital Elevation Model (DEM) (not currently available in the tool at this time – either indicate that it is coming in the future, or delete it), Bathymetric Contours
Watersheds	8-digit sub-basins, 10-digit watersheds, 12-digit sub-watersheds
Boundaries	Municipalities, counties, states
Imagery	Orthophotography

***Table 1**. Inventory of data layers available on MSO interactive mapping application.*

Scenario 1: A county land use planner is approached by a town manager about annexing several acres for residential development to accommodate the town's growth. The County planner remembers that the area has flooded in the past. Questions and characteristics that might be important to investigate and view in this situation include the following:

- Are there currently any roads or other transportation infrastructure that would be affected by storm surge? How will flooding of these roads impact the evacuation of residents in a new community? Are upgrades to the roads required to accommodate this growth? (Data layers: storm surge areas and transportation).
- Is the shoreline in this area eroding and if so, at what rate? (Data layers: all historical shorelines, transects, baseline, or shoreline rate of change summary layer. Use the ID or select by rectangle analysis tool to allow the online mapping tool to calculate rates of change).
- Are there currently any shoreline structures or buffers in place along the shoreline? (Data layers: stabilization structures, marsh buffers, and beach buffers).
- Are there any alternative locations to implement smart growth principles such as infill or redevelopment? (Data layers: land use/land cover, riparian land use, or use the Add Mapservice display tool to upload remote census data).

Scenario 2: A property owner has just attended a workshop on living shorelines and is interested in determining if the option could work along his or her shoreline.

- Is the shoreline in this area eroding and at what rate? (Data layers: all historical shorelines, transects, baseline, or shoreline rate of change summary layer. Use the ID or select by rectangle analysis tool to calculate rates of change).
- What is the fetch along the shoreline? (Use the measure tool and measure points in multiple directions to the next point of land).

Tools	Mapping Tools Functions
Navigation	
Zoom in	Increases resolution (replace with publication scale) of a map to allow a closer view of a selected area
Zoom out	Moves the view to a wider view perspective
Pan	Drags the view to another position using the mouse
Zoom to coordinate	User can navigate to specific coordinates using either MD State plane NAD83 or Latitude/ Longitude in decimal degrees
Zoom to previous	Allows user to return to the previous map view
Full extent	Map reloads to show a full view of Maryland's Coastal Zone
Locate Address	A point is placed on the map to mark the location of a submitted address
Analysis	
ID	Retrieves and displays information for a feature on a map from an attribute table from the database
Select Rectangle	Allows the selection of multiple features to be displayed together
Find	Locates a specific feature on map
Measure	Allows the distance between two selected points to be measured.
Display	
Print	A map can be printed on an 8.5" by 11" sheet of paper with legend and title
Clear	Removes previous selections and analysis activities
Add Mapservices	Provides connection to information from a remote map services and allows the data layers to be used in the MSO mapviewer
Adjust Mapservices (web page says map services)	Allows adjustment to map display of remote services data layers
Jump to County	Load view to selected county
Jump to Watershed	Load view to selected watershed

Table 2. *Summary of MSO interactive mapping application tools and functionality.*

- What is the bank type and is it stable? (Data layers: height, bank condition, and bank cover).
- Are there currently any shoreline structures up-drift from the shoreline that are contributing to a sediment starvation problem on the property? (Data layers: stabilization structures and littoral drift conditions).
- Could planted vegetation grow along the shoreline? Is there vegetation growing within 100 feet of the shoreline? (Data layers: marsh buffers).
- Will *Phragmites* sp. cause maintenance issues for a living shoreline technique? (Data layer: *Phragmites* invasive areas).

Scenario 3: A teacher working in a coastal county of Maryland would like to educate students about coastal issues. The teacher is required to teach about geography, GIS, and coastal processes. The teacher would also like to plan a field trip that reinforces the course materials.

- Under the "Human Activities" Section, carry out the Information Superhighway lesson and PowerPoint to introduce students to GIS.
- Teach the "Coastal Process" Lesson plan and read the associated Coastal Process fact sheet series.

- Develop a field trip to Assateague Island to conduct a beach profile and view coastal processes in action.
- Go to the Coastal Management section of the MSO website and link to the Living Shoreline section. Find a living shoreline demonstration site in this section and have students visit these as an extra credit assignment.

DISCUSSION

The historical shoreline series and the rates of change derived from the application are intended for general and educational purposes. Data are not intended to determine jurisdictional wetland and Critical Areas boundaries. The information is also not intended to predict future shoreline position, or show short-term changes associated with storm events. These limitations are provided in a disclaimer before a user is allowed to access the mapping tool. The user must first agree that he or she has read over the conditions before launching the tool.

Accuracy of the data should be considered when formulating assumptions from the web mapping tool. In particular, the method used to generate a layer (mapping error) compared to the actual change reflected in the shoreline change database needs to be considered when utilizing this tool. The application is capable of providing shoreline change trends since the mid-1800's. Since shoreline sources earlier than 1940's are less accurate, the application reports shoreline change for the last 50 years. The original sources from which the historical shorelines series were derived are at the scale of 1:10,000 to 24,000. Metadata is available for all layers and can be viewed in the web mapping interface. An error analysis has not been conducted on these data.

As the potential use of this application is varied, training and outreach on this application will be important for its success in reaching the target audiences. To specifically address these concerns, a training manual is being created that will be available online as well as sent out to each local government planner. A series of workshops will be advertised and held at a local library throughout the coastal zone and a workshop especially tailored to citizens and homeowners will be held after hours at MDDNR. The tool has already been promoted through a series of marine contractor workshops and will continue to be a lesson component in any future workshops.

Web-based open source applications and GIS will be important for the future of planning and management of shorelines and coastal hazards. As the promotion of living shoreline restoration and demonstration projects occur, this website provides an opportunity for the public and local governments to be more engaged in planning and decision making. Training and outreach on this application will be important for its success in reaching the target audiences. Improving aerial imagery and the addition of new data layers will be essential for long-term maintenance and usefulness.

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Living Shorelines: A Strategic Approach to Making it Work on the Ground in Virginia

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ABSTRACT

Eighty-five percent of the tidal shoreline in the Chesapeake Bay and its tributaries is privately owned (1). Shoreline management decisions in Virginia thus involve many thousands of individuals and dozens of local government regulatory bodies. The living shoreline initiative seeks to reverse the cumulative impacts of decades of individual decisions to harden the Chesapeake Bay shoreline. This goal can only be implemented "on the ground" with the involvement of those individual landowners, marine contractors, municipal governments, and local conservation organizations. Wetlands Watch, a conservation group in southeastern Virginia, examined ways to influence those landowner/contractor/local government decision points on shoreline alteration. We found little published social science and policy guidance on possible approaches to this task. We did assemble a range of fairly simple policy and programmatic initiatives that could translate Bay-wide living shoreline visions into a more effective strategy for locally based activities.

INTRODUCTION

Despite advances of living shoreline techniques in recent years, many shorelines are still hardened using traditional shoreline armor. The decision to use armor is made by many individuals who play a role throughout the project process, including individual landowners, contractors, and regulators. Therefore, efforts to advance use of living shorelines will need to involve changes to each of these types of decision makers and reach a large number of individuals. The marine contractor plays a key role in landowner selection of shoreline alteration approaches. According to a survey addressing landowner information sources (2), 67% of responding landowners received their information on shoreline erosion strategies primarily from marine contractors and came to the regulatory process with a contractor in hand.

Very few contractors offer a living shoreline approach. In southeastern Virginia, an informal phone survey by Wetlands Watch in 2005 found no marine contractors who offered living or soft shoreline services. At that time, an Internet search turned up only two contractors within the Chesapeake Bay region advertising bioengineered solutions to erosion/shoreline management problems.

The contractor, a developer, or even the landowner presents plans for shoreline alteration as part of the permit application. In Virginia, these tidal wetlands permits are jointly heard by the local wetlands board, the Department of Environmental Quality (DEQ), and the US Army Corps of Engineers. The Virginia Marine Resources Commission cedes its permitting authority for tidal wetlands to local governments that have adopted a model statute and 35 local governments in Tidewater Virginia have this authority. In reality, the local wetlands board dominate the decision-making process on routine, small permit applications that disturb and alter tidal wetlands at the land-water margin.

The Virginia Institute of Marine Sciences (VIMS) reviews the permit application, makes site visits, and provides an advisory report to the local board on the suitability of the proposal. While VIMS advisories have begun moving away from excessive shoreline hardening and encouraging more bioengineered approaches, the local wetlands boards do not routinely follow those advisories, especially if the applicant objects to the recommendations. In the experience of Wetlands Watch, without countermanding opinions present at the wetlands board meetings, the requested shoreline hardening is usually allowed. In addition, with property taxes as the major source of funding for local governments in Virginia, there is some pressure to allow the landowner's requested development to go forward.

Even if landowners and local governments were predisposed to encourage living shoreline approaches, the regulatory process can make approval of these projects difficult. Regulations and regulatory guidelines discourage placement of fill along the shoreline or disturbance of benthic habitat, a necessary component of many living shoreline approaches. Local decision makers are often unprepared to advocate for changes in the *status quo* due to lack of familiarity with the conditions conducive to successful bioengineering of shorelines and incomplete understanding of the ecological benefits of these approaches. In addition, doubts about the long-term viability of these approaches, especially in cases without landowner maintenance in the first years, are other factors contributing to the reluctance of many local governments to press for living shoreline approaches.

Changing this series of decisions by landowners, contractors, and regulators will take a carefully targeted effort. Decision dynamics at each of the key points need to be understood so that outreach and education efforts are property focused and targeted. These efforts need to be undertaken by local partners, "on the ground," willing to provide support for changes in local land use and regulatory decisions in Tidewater Virginia.

Unfortunately, there is insufficient information on key decision dynamics to guide these local partners and no strategic effort was taking place to provide them with the information or expertise needed to enhance efforts directed at living shoreline work.

MATERIALS AND METHODS

In 2006, Wetlands Watch researched ways to promote living shoreline applications along watersheds in Virginia. We believed we could target a watershed in a locality experiencing rapid growth with a program to educate landowners in the watershed about the advantages of living shorelines. Creating that "market demand" from property owners would educate marine contractors and other sources of referral to shoreline hardening approaches about these techniques. Finally, any approach to living shorelines also must include local regulators and wetlands board members to familiarize them with living shoreline work to minimize any regulatory hurdles to adoption.

We identified target localities by examining the statewide data on shoreline alteration and hardening. However, in the course of our research, we discovered a lack of information about landowner decision-making, impeding efforts to properly focus outreach and education work. Similarly, there was a lack of information about decision dynamics and available tools at the local government level, impeding work on local regulatory elements.

These shortcomings provide both a research agenda for the living shoreline effort and a strategic approach that may enhance efforts to promote living shorelines in Virginia.

Research Needs

Only four sources of information on decision dynamics and education and outreach were appropriate to this endeavor. The valuable Department of Environmental Quality (DEQ) report, authored by Krista Trono (2), on regulatory and individual landowner decisions, surveyed local wetlands boards on a range of information related to landowner, contractor, and local regulatory decision dynamics. More practical research of this type needs to be done. Researchers at VIMS looked at the relationship between environmental protection and economic development at the local level in a study conducted for the Environmental Protection Agency (3). This study just begins to examine the economic forces at work at the local government level, a necessary element to effecting change in land use and environmental regulatory decisions. A researcher at Iowa State looked at the reasons why farmers chose to enroll in wetlands restoration programs (4). This paper, while not specifically focused on wetlands decisions made by landowners in the Chesapeake Bay, indicates the strong role that ethics and aesthetics plays in landowner decisions to preserve and restore wetlands, as well as the key role of financial incentives. Finally, a study by the National Academy of Sciences on shoreline erosion control presents many views on the processes involved in applying living shoreline methods (5). Chapter 5 of that publication is especially relevant to discussions on decision-making.

Beyond these few sources of information, there is little to guide those who want to change the decision dynamics of landowners on shoreline alteration. Many of the research needs mentioned at conferences on living shorelines stress the biological or physical aspects of living shoreline work. As critical to the success of these efforts is information on the social and economic aspects of landowner and local government decision processes.

To move beyond single case living shoreline demonstration projects, we will need to know much more about how landowners make shoreline alteration choices, who is involved in helping shape these decisions, what incentives, aesthetic changes, or educational efforts have the most impact, and generally gain a better understanding of the motivations and behavior of landowners and developers. We need to better understand the decision dynamics of local governments on wetlands permits, Chesapeake Bay Protection Act/Critical Areas Act decisions, and zoning and land use decisions, as well as identifying regulatory barriers and any sources of local government reluctance to accepting these practices. We need to examine the local government's role in creating regulatory and financial incentives for living shorelines. The lack of information on these issues presents challenges to those devising a demonstration program with any certainty of success.

A final area of additional research is information about where these efforts will have the most impact. When Wetlands Watch examined the shoreline hardening figures provided by VIMS for the period 1999 – 2004, we discovered that four localities accounted for 50 percent of Virginia's shoreline hardening (Table 1). This clearly demonstrated that we needed to concentrate our work in one of those localities.

Strategic Programmatic Needs

Landowner economic and aesthetic considerations, lack of contractor capability, and lack of engagement with the regulatory process, especially at the local level, will hinder widespread adoption of living shoreline approaches. As government agencies, foundations, and community organizations increase efforts on living shorelines, a more strategic approach will be required, involving some of the following elements.

1) Strategic investment in demonstration projects. With future funding efforts/initiatives, attention needs to be paid to strategically addressing the location and type of projects funded. As shown in Table 1, four localities in Virginia accounted for half of the state's permitted shoreline alteration. Placing demonstration living shoreline projects in those high activity localities would serve to educate landowners and regulators in those high-activity communities on the benefits of these approaches. A contractor capacity would be developed in the communities where those services would be of most ecological benefit. Some of these high activity localities may lack a host organization capable of handling a grant, so early identification of groups and capacity building in targeted areas may be required. In addition, given the length of existing hardened shoreline, funding for retrofit and replacement projects should be a focus.

2) Enhanced attention to the outreach and education elements of funded projects. Demonstration projects serve as places where people can come and "kick the tires" on living shoreline projects. Field days (similar to those used in agricultural extension) should be a part of each project, allowing interested parties like landowners, contractors, local government officials, etc. to see completed projects. Media outreach should also be a component of this phase of the project and a required element of any project located in an area where large numbers of shoreline permits are issued (Table 1). Funding sources should look to multiply the impacts of projects by providing media packages and training, mentoring, or assistance on the conduct of "field days," and other outreach assistance. Funding conditions should include requirements for rigorous

LOCALITY	1999-2004 Hardening (lin. ft.)	% Statewide Total
Northumberland	121,993	20%
Lancaster	78,953	13%
Virginia Beach	66,235	11%
Westmoreland	35,914	6%
State Totals	617,812	

Source: Virginia Institute of Marine Science Wetlands Program (2005) Tidal Wetlands Impacts
Data Home Page: http://ccrm.vims.edu/wetlands/tables.html.

Table 1. *Shoreline hardening of Virginia's top four localities, 1999-2004.*

documentation to allow proof of concepts used, create a pool of information for outreach and education, and develop program guidance to be fed back and inform the awarding of grants in subsequent rounds. Outreach and education for local governments and citizen boards is essential. Wetlands board/Chesapeake Bay Board members in Virginia are not kept abreast of new scientific developments, like living shorelines, because state funding for these functions has been cut over the years and many local governments cannot fill the gap.

3) Better understanding of how the regulatory process impedes or speeds these projects. As some of the currently funded projects move to completion, a set of information is developing on how these approaches fare in the regulatory process. Back casting through these experiences will begin to expose points of conflict between the regulatory *status quo* and the goal of adoption of newer, bioengineered processes. Requirements for adequate documentation (see #2 above) and analysis of final project reports will increase efficiency of the regulatory process. An additional need in this area is the development of detailed guidelines or guidance documents on where these systems are applicable and what constitutes acceptable and best practices for each of the approaches used. These will provide landowner and regulatory reassurance as well as protection against "green scamming" or re-labeling status quo approaches as "living shorelines."

4) Development of a contractor community capable of delivering desired services as demand is built. This is a critical need that has been identified by funders and government agencies alike

At this point it is uncertain what the contractor sector for these services will look like, whether existing contractors will adopt living shoreline services or whether a new contractor sector will emerge. Whatever direction the contractor community takes, if funders are successful in creating demand for these approaches, there is a need to have a contractor community prepared and capable of providing services to landowners. This is especially critical given their central role in shaping the landowner's approach to shoreline projects.

5) Analysis of approaches used to change behavior/adopt new technology in other areas, such as the adoption of no-till farming. There are many parallels between efforts to promote living shorelines today and the work to promote low-till/no-till farming in the 1980's. In both cases, individual landowners were responsible for a broad environmental impact, the minimization of which required the individual landowner to make changes in traditional land management approaches, at the landowner's risk and cost. In both cases, there is a large aesthetic component that needs to be addressed: shoreline homeowners have been conditioned to appreciate "neat" linear shorelines and the farming aesthetic was for fields to be cleaned of all stubble with the soil turned under in the fall. However, in both cases research clearly shows the environmental benefit of minimalist approaches to land management: living shorelines provide numerous environmental benefits just as no-till farming reduces soil erosion.

Achieving adoption of no-till required working with farmers to change their behavior while documenting the cost/profitability of the practices, and making sure that new equipment and materials were ready when the farmers decided to change their ways. Early adopters were given full cost-sharing to adopt the practice and "field days" were held by the Agricultural Cooperative Extension Service/Soil Conservation Service/Agriculture Stabilization and Conservation Service for surrounding farmers to come onto the land and see the benefits. Today in highly erodable areas, no-till farming is practiced with pride in the stewardship ethic it represents. "Messy fields" over the winter are a symbol of good farming

The challenges facing widespread adoption of living shoreline approaches are similar to those facing no-till farming in the 1980's. Changing aesthetic values, proving the economics, developing technology standards and best practices, conducting outreach using successful examples – all need to be part of a strategic approach to adoption of living shorelines. Reviewing the earlier no-till effort (6) and examining the technology adoption practices used then can help guide strategic funding and technology adoption in this area.

6) Work on model zoning and planning tools to create regulatory incentives for living shorelines. Shorelines and adjacent landscape features provide a number of unique environmental services and development in these areas should be avoided or restricted. Local land use decisions are critical to the conservation of these areas and can also be used to provide incentives for living shorelines. Virginia State zoning authority allows the use of zoning to protect water quality and could be of use in living shoreline efforts.

In addition, other zoning and land use tools are options and should be explored, such as special overlay districts, model zoning ordinances, and the like which impose special conditions on construction and development within shoreline zones. Some localities are already using some of these approaches.

7) Creation of financial incentives for living shorelines. In 2005, the Virginia Marine Resources Commission closed a loophole in the regulations that exempted tidal wetlands impacts of less than 1,000 square feet from paying mitigation. These impacts were the exact ones usually associated with shoreline alteration by individual landowners. With this "new" source of funds available to localities, incentives could be provided for living shoreline efforts, should local governments act to sequester the funds. While all shoreline alterations, including living shorelines, are subject to this change, exemptions or lower rates for living shorelines could be an additional incentive option. As shown in the no-till experience, financial incentives can go a long way toward changing behavior.

A comprehensive review of shoreline alteration permits issued in Virginia Beach in 2001 showed 4,265 square feet of uncompensated vegetated wetlands impacts and 19,443 square feet of nonvegetated wetlands impacts. If just the vegetated wetlands were compensated for at the current rate set in Virginia Beach of $25 per square foot, this would yield $106,625 that could be applied toward living shoreline efforts in that city.

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Willingness to Pay for Risk Reduction and Amenities: Applications of the Hedonic Price Method in the Coastal Zone

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ABSTRACT

Expansion of development along U.S. shorelines has put increased pressure on coastal ecosystems. As a result, many shoreline ecosystem services have been degraded or lost. As coastal populations become more vulnerable to natural hazards, policy makers search for methods to evaluate the benefits and costs of different shoreline management alternatives. In this paper, we describe hedonic property models as one method for measuring the benefits and costs of shoreline management alternatives. Hedonic property models are used to investigate homeowner preferences for risk factors and environmental amenities using information on housing market transactions. With appropriate data, these models allow analysts to assess whether such factors affect buyer's bids for property and to estimate the associated private costs or benefits. We begin with a basic description of the model, followed by examples of studies that have applied the method in the coastal zone. Lastly, we speculate on how the model could be relevant to analysis of living shorelines.

INTRODUCTION

Coastal populations have expanded rapidly in the past twenty years, increasing pressure on a multitude of scarce coastal resources. In the U.S., coastal watershed counties, which comprise less than 25 percent of the land area, are home to more than 52 percent of the US population (1). Areas in Florida with shoreline zip codes experienced a 25% increase in population and a 24% increase in housing between 1990 and 2000 (2). The number of building permits in Carolina Beach, North Carolina over a recent 24 month period exceeded the number of permits issued over the previous 20 years (3). As population density rises, open space and natural amenities become scarce resources.

At the same time, coastal property values have increased dramatically. For example, average selling price for residential properties in Wrightsville Beach, North Carolina increased 420 percent since 2001 (3). Numerous factors facilitate growth in the value of coastal real estate. Increases in disposable income have played a role (4). Economists describe coastal recreation as a normal good, meaning that as income increases, demand for coastal recreation also increases. Moreover, with average life spans longer than ever before, many want to spend some portion of their "golden" years on the coast. Coastal areas have experienced a large influx of retirees as the Baby Boomers begin to leave the workforce. Increasing demand with finite land availability leads to escalating prices.

Coastal shorelines constitute dynamic environments where change is often a function of some combination of physical forcing processes (e.g., weather, waves), spatial characteristics (e.g., shore orientation, shore slope), underlying geology (e.g., sediment type, consolidation of material), vegetative communities (e.g., salt marshes, sea grasses), and the physical characteristics of human development (e.g., concrete structures, residential buildings). Expanding populations are not only susceptible to natural coastal hazards—including storms, flooding, sea level rise, and coastal erosion (5,6)—but development patterns can exacerbate the physical and social impact of such hazards. The situation presents a formidable challenge for managers and policymakers—what, if anything, should be done in the public interest? At least two

preliminary questions arise in this regard—to what extent do developers and property owners incorporate coastal risk and amenity factors in their decision making process? And, what trade-offs are property owners willing to make? That is, how do they value changes in risk and amenities?

Local governments and property owners must choose a strategy for management of shorelines. Historically, many have chosen hard stabilization techniques such as bulkheads, revetments, breakwaters, sills, and seawalls. These methods often successfully stabilize the shoreline, but have negative impacts on ecosystem services. Many of the hardening strategies have direct impacts on intertidal areas by eliminating nursery habitat and disrupting sediment transport. Shoreline hardening can drastically change the sediment budget of water bodies, affecting sediment inputs from upland areas as well as in stream transport of material. Hardening structures also impact nutrient budgets and wildlife habitat.

Vegetated or living shorelines offer an alternative for addressing erosion. Living shorelines play a crucial role in the transition from terrestrial to aquatic environments, providing important ecosystem services such as wildlife habitat, nutrient uptake, and water purification. Economists argue that the lack of an identifiable market for these services often leads to ecosystem degradation. In many cases, the ecosystem services associated with living shorelines have considerable net social benefits, but property owners often consider only the private benefits and costs when making land use decisions. Under these circumstances, individuals making decisions in their own best interest can engender a situation in which society is made worse off. Economists refer to this phenomenon as market failure, and such a situation may justify—from a strictly normative economic standpoint—government intervention to reconcile private and public interests.

This paper focuses on the application of hedonic property models as they relate to the coastal zone. Hedonic property models are used to investigate homeowner preferences for risk factors and environmental amenities using information on housing market transactions. With appropriate data, these models allow analysts to assess whether environmental and risk factors affect buyer's bids for property and to estimate the private costs or benefits associated with these factors. We begin with a basic description of the model, followed by examples of studies that have applied the method in the coastal zone. Lastly, we speculate on how the model could be relevant to analysis of living shorelines.

HEDONIC PROPERTY MODELS

It is difficult to measure people's preferences for environmental amenities because, in most cases, individuals and firms do not trade environmental amenities in explicit markets[1]. In fact, real estate markets comprise one of the few existing explicit markets on which environmental amenities are implicitly traded. Consumption of property confers an array of associated spatial attributes, such as access to local recreation sites, exposure to local air and water quality, proximity to toxic and hazardous waste sites, and so forth. In a competitive market with many housing bidders and many available properties, market prices reflect the value of the "bundle" of attributes of individual properties. Housing is traded in a single market, but the price adjusts to reflect differences in attributes, and as such, differences in market price reflect individuals' preferences (or "willingness to pay") for housing attributes[2].

The hedonic property model is predicated on the notion that the observable price of a house is a function of structural, neighborhood, and environmental attributes. Homebuyers are assumed to have "well-behaved" preferences (meaning that each individual is able to compare goods and their method of comparison, whatever the motivation, is consistent) for consumption goods and housing attributes. Their choices of housing and consumption goods are constrained by the prices they must pay to consume these

[1]Economists often call goods without explicit markets Non-market Goods. Subsequently, they refer to the process of measuring individual's economic value for these goods using a common metric, non-market valuation.

[2]Housing markets are geographically delineated to include properties which are viewed by buyers as substitutes for one another. This may be influenced by numerous factors, including labor markets. See Palmquist (7) for more information.

goods and their level of income. If they are well-informed about their options and rational in their decision making, they will make choices that maximize their own happiness (or utility). Under this theoretical framework, statistical estimates derived from housing data can be used to estimate the average consumer's "marginal" willingness to pay (WTP) for housing attributes. We refer to marginal WTP because estimates from the hedonic price model only reveal the value of an additional unit of a housing characteristic—for example, an extra bedroom or an extra square foot of living space. Additional assumptions, information, and/or statistical estimation are required to estimate the total value of housing characteristics. Nonetheless, the hedonic property price method can be used to estimate marginal WTP for environmental amenities and risk factors, items not explicitly traded in markets.

A chief advantage of the hedonic property price method is the accessibility of housing data. Local tax assessor offices record information on property transactions, including final price, housing attributes, and date of sale. If there is sufficient variation in housing attributes, an equilibrium hedonic price function can be estimated to recover estimates of homebuyer's marginal valuation of housing attributes. For example, the hedonic price function might take the following form:

$$\ln(price_i) = \alpha + \beta_1 S_{1i} + \cdots + \beta_s S_{si} + \gamma_1 N_{1i} \cdots + \gamma_n N_{ni} + \theta_1 E_{1i} \cdots + \theta_e E_{ei} + \varepsilon_i \qquad (1)$$

where 'ln' represents a natural logarithmic transformation (logarithm to the base e), $price_i$ represents the recorded price of housing unit i, $S_{1i}...S_{si}$ represent s structural attributes of house i, $N_{1i}...N_{ni}$ represent n neighborhood attributes of house i, and $E_{1i}...E_{ei}$ represent e environmental attributes of house i.

In equation (1), α, β, γ, and θ are model "parameters" that are estimated via statistical techniques (e.g., method of least squares, maximum likelihood, or some other method). The model parameters represent the marginal contribution of each attribute to housing price. Some of these attributes, such as structural attributes, are specific to an individual house. Other attributes vary spatially. In coastal environments, housing prices have been shown to reflect beach quality, erosion risk, flood risk, ocean view, proximity to wetlands, proximity to open space, and shoreline armoring. Many of these characteristics are spatial in nature, affecting homes in different locations to varying degrees. For a more complete description of the hedonic property model, see Palmquist (7).

APPLICATIONS OF HEDONIC PRICE MODEL

Housing values capitalize (i.e., adjust to reflect) various aspects of environmental quality based on the nature of the flow of environmental services provided to the property. If environmental quality diminishes (increases), housing value may decrease (increase). In studies of beach quality, researchers have found that homeowners assign a price premium to sections of shoreline with superior beach quality. The dynamic nature of coastal shorelines makes this type of analysis potentially difficult due to variation in beach quality over time. Pompe and Rhinehart (8) examine the impact of beach quality on oceanfront homes in SC, finding that increasing beach width from 79 to 80 feet increases oceanfront home value by $558. Landry, Keeler, and Kriesel (9) investigate the impact of beach quality on all barrier island homes, since beach quality affords protection not only to oceanfront homes, but also recreational benefits to all landowners. They find a lower overall value for beach quality, when compared to the results of Pompe and Rhinehart. In their study, increasing beach width from 27 to 28 meters increases home value by $233. This result is not unexpected since adding other, non-oceanfront properties to a sample lowers the average home value.

In addition to valuing beach amenities, hedonic property models have a rich history in valuing other environmental amenities. An amenity relevant to living shorelines is the wetland ecosystem. Wetlands provide a wide array of ecosystem services including provision of flood protection, biogeochemical processing of nutrients, and wildlife habitat. In an urban setting, wetlands also provide open/green space. Mahan, Polasky, and Adams (10) find urban wetlands have a positive impact on Oregon home values. Their results indicate that increasing the size of the nearest wetland by one acre increases property value by $24. Decreasing distance to the nearest urban wetland by 1,000 feet increases value by $436. However, empirical evidence suggests that wetlands are not perceived as desirable spatial characteristics in rural

settings. Bin and Polasky (11) find that increasing the size of nearest wetland by 25% decreases property value by $217. Similarly, they find that decreasing the distance to wetlands by 25% decreases property value by $945. This finding certainly does not imply that wetlands in a rural setting have no value, but rather that rural landowners are not willing to pay a premium to locate near wetlands or that there is some other disamenity associated with these wetlands.[3] This finding, in fact, makes economic sense, as wetlands and open space are typically not scarce in rural settings. Scarcity, the central tenet of economic theory, is fundamental in economic valuation. Thus, hedonic models may not be useful in estimating economic value of rural wetlands. Some other valuation method must be used if one would like to assess the value of rural wetlands. In this case, property markets are not picking up many of the public benefits provided by rural wetlands, but they are picking up some of the disamenities.

In addition to environmental benefits, housing properties can also capitalize risk. Intuitively, risky properties should sell for less, all else being equal. In their investigation of erosion risk, Landry, Keeler, and Kriesel (9) find a substantial discount for those properties in close proximity to high erosion hazard areas. The market value of homes in high erosion areas were reduced by $9,269. Dorfman, Keeler, and Kriesel (12) examine shoreline protection schemes along the Lake Erie coast, focusing on the impact of hardened structures placed offshore to prevent bluff erosion. They find that housing values capitalize the value of erosion protection; erosion protection structures increase average property value by $16,261 by decreasing probability of erosion loss to a low level (0.05%). In a study of the effects of flood hazards on property values in Carteret County, North Carolina, Bin and Kruse (13) find that average property values are 5% to 10% lower when located in inland flood zones. These results indicate that hedonic models can be used to estimate willingness to pay to avoid erosion and flood risks.

Estimation of willingness to pay from hedonic property price models can be complicated by correlation of housing characteristics. Correlation is found in housing data when two or more characteristics tend to move in the same or opposite directions. For example, houses with large square footage will tend to have more bedrooms and vice-versa, a positive correlation. If too much correlation exists in housing characteristic data, the separate effect of characteristics on housing value cannot be identified. Correlation can be a problem in coastal housing data. Bin and Kruse (13) find that houses in flood zones on the coast tend to sell for more than other houses. However, these homes tend to be oceanfront and/or have superior ocean view (a positive correlation between flood risk and amenities). As such, it can be difficult to separate the effect of flood zone and view amenities in coastal housing markets.

Bin, Crawford, Kruse, and Landry (14) use a novel approach to solve this identification problem. Many previous papers have used ocean frontage as a property attribute (8, 9, 13). These studies argue that ocean frontage primarily conveys benefits in terms of access and amenities. Instead of controlling for ocean-frontage, Bin et al. use distance from the water to account for benefits of access, and use a GIS[4]-derived viewscape measure to account for benefits associated with coastal ocean view. Viewscape is a three-dimensional measure of ocean view that is designed to capture the view amenities associated with a property, taking into account man-made and natural obstructions to view and how these obstructions change over time. Importantly, the viewscape measure varies independently of risk, allowing researchers to disentangle spatially integrated attributes. The authors find that increasing ocean view by one degree increases housing value by $995. For their access measure, they find that a 10 foot decrease in distance to the beach increases housing value by $853. Location in a flood zone decreases housing value, on average, by $36,081.

DISCUSSION

The Committee on Mitigating Shore Erosion along Sheltered Coasts identifies four primary approaches to addressing erosion: 1) manage land use, 2) vegetate, 3) harden, and 4) trap and/or add sand (15). Each of these approaches can be applied individually or in conjunction with one another. In the past,

[3]The authors control for flood risk, so the negative estimates are not picking up this disamenity.
[4]Geographic Information Systems – a computer-based spatial data processing program

many communities have chosen to harden their shorelines. Hardening techniques form a physical barrier to natural erosive processes. They typically reflect wave energy and bisect coastal habitat, which leads to degradation of nearshore ecosystems (15).

Living shorelines offer an alternative. From an ecological perspective, living shorelines offer a multitude of ecosystem services that are lost with hardening. The societal benefits of these ecosystem services may not coincide with how individuals derive benefits from the use of their private property. Policy makers must determine the extent to which individuals are willing to implement living shorelines as an alternative to hardened structures on their property, and what affects the choice of erosion management techniques. Do property owners value living shorelines as a shoreline management strategy? How do they perceive their effectiveness in controlling erosion and providing for enhanced ecological services and function? Individual choices are rooted in a potentially complex behavioral process influenced by many factors, such as personal experience, knowledge, beliefs, attitudes, and personal constraints.

Analysis of shoreline protection projects and surveys of property owners could be helpful in answering these questions, but the hedonic property price model may also play a role. Any property investment that is commonly viewed as providing protection or enhancing natural amenities may influence housing value. In other words, a home that lacks erosion protection faces higher erosion risk and likely sells at a discount. The discount will likely reflect perceived erosion risk associated with the location, the cost of fortifying the shoreline, and any uncertainty about one's ability to protect the property. Homes that are protected from shoreline erosion should sell for more, all else being equal. A key empirical question is whether homebuyers view hardened structures and living shorelines as equally effective in terms of erosion control and equally desirable aesthetically.

We propose using the hedonic property model to evaluate homeowner's preferences for erosion risk protection and natural amenities. Such a modeling exercise requires data with adequate variation in housing attributes, risk factors, and erosion protection schemes. This type of variation would likely necessitate many data points (i.e., housing sale observations) within a single housing market. In addition to the information recorded in the typical tax assessor's database, one would require various erosion risk factors, such as slope, sediment type, and historical erosion rate. To assess the value of living shorelines *vis-à-vis* hardened structures, one would need to witness a reasonable number (e.g., 10-20%) of properties that had chosen one of these strategies for shoreline erosion management. Ideally, the spatial pattern of these observations would be random, with management strategies allocated in a stochastic manner to different property types and shoreline configurations. One must be careful to ensure that shoreline management strategies are not correlated with other property attributes, such as newer homes tending to utilize living shorelines (this would induce a correlation between age of the house and management strategy).

In order to adequately assess the impact of living shorelines on housing prices, one needs to know shoreline condition that existed at the time of sale. Only properties that had living shorelines installed at the time of sale can be used to infer the value of this type of protection in the hedonic price framework. It may be difficult or impossible to record shoreline conditions for property sales that occurred in the past, though the permitting process could assist in compiling the information as it provides a paper trail on shoreline protection projects. Additional information, such as detailed living shoreline characteristics, could improve the analysis and the quality of inference. The type of shoreline vegetative community should influence the services derived by homeowners. If enough variation exists in available market data, classifying living shorelines by community type may help managers understand the trade-offs that homeowners are willing to make and could assist in designing optimal policies.

If homebuyers find living shorelines more aesthetically pleasing, we would expect a positive effect on home price (all else being equal). A hedonic price analysis would require detailed information on shoreline erosion protection, such as age of the project, whether it is in good shape and performing well at the time of sale, and perhaps other information. Lastly, one might want to consider the array of erosion protection surrounding an individual property. Homebuyers may perceive hardened structures on their neighbor's shorelines as unsightly, or may (perhaps rightly) believe that erosion on their own shore is exacerbated by their neighbor's protection devices. Recording the extent of shoreline armoring and green space on the waterway visible from a property would allow one to explore these potential external effects.

The hedonic property model gives policymakers a method to measure individual values for housing attributes as revealed through market transactions. To the extent that homebuyers value living shorelines as risk mitigants and aesthetic enhancements, one might find that their hedonic price is in fact positive—they tend to increase property value. Such a result would suggest that there exists some purely economic incentive to utilize living shorelines for erosion management. By including data on other erosion management strategies, a hedonic model could provide information on how homeowners view living shorelines *vis-à-vis* other alternatives. To the extent that homebuyers do not value living shorelines, a hedonic property model could identify whether they have no effect on property value or a negative effect. In the case of the latter, results could indicate the magnitude of incentives (i.e., subsidies or reduce property taxes) required to increase the use of living shorelines.

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Incentives to Promote Living Shoreline Techniques in the Chesapeake Bay

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ABSTRACT

Management incentives can be broadly described as financial, technical, and regulatory in nature. A majority of the incentives for living shoreline techniques in the Chesapeake Bay fall under the financial assistance category. Financial assistance includes grant and loan programs for public and private lands. These financial assistance programs have, in turn, begun to indirectly develop an incentive for marine contractors and engineers. These groups have been responding by adding living shoreline techniques to their design toolbox. This paper provides an overview of existing types of grant and loan programs for Chesapeake Bay public and private property owners, and investigates additional types of potential incentives for property owners, contractors, and local governments to promote living shoreline implementation in the future.

INTRODUCTION

Management incentives applicable to living shorelines can be categorized as: (a) financial, such as grants, loans, and tax credits or deductions; (b) technical, such as site review or design assistance; and (c) regulatory, including, for example, permit exemptions, no fees or reduced fees, and streamlined or expedited permits. A majority of the existing incentives for living shoreline protection and restoration techniques in the Chesapeake Bay fall under the financial assistance category, and include grant and loan programs for public lands, local governments, communities associations, and private property owners.

The term "living shorelines" describes the incorporation of natural habitat elements into shoreline protection design, while ensuring effective buffering from erosion. The goal of living shoreline implementers is to use this approach, in place of hard shoreline armor, in as much of the Chesapeake Bay shoreline as possible. Implementing this goal can be achieved by (a) replacement of bulkheads, seawalls, or revetments, where conditions allow, with designs that include habitat elements such as marsh grasses; and (b) installation of living shoreline techniques instead of hard armor approaches in eroding areas that have not yet been stabilized.

Several impediments exist limiting the use of living shorelines instead of structural stabilization. First, as with any shoreline stabilization method, soft or hard, these practices can be expensive. The cost often depends on such factors as energy regime and design, but is generally on the order of hundreds of dollars per linear foot. Many sectors of the public assume that living shoreline options are more expensive than traditional armor, which is generally only true in high energy regimes. In high energy areas, the living shoreline requires large quantities of rock to reduce wave energy enough for vegetation to persist, a factor that can push the living shoreline option above $500 per linear foot (though prices vary greatly depending on conditions). In low energy regimes, living shorelines require less rock than traditional armor, reducing the cost (usually $50-$200 per linear foot, but again, these prices vary depending on conditions).

Second, 95% of Maryland's Bay shoreline is privately owned, which requires major behavior change on the part of waterfront property-owners to achieve wide-scale living shoreline implementation. Some sectors of the public prefer the aesthetics of a neat and trim bulkhead to the natural and wildlife–supporting marsh grasses of a living shoreline. This behavior change requires considerable public education, as well as financial incentives to make the path to living shorelines easier than traditional stabilization.

The third obstacle to implementation is the fact that living shoreline techniques are still considered relatively new and do not have an extensive documented history of performance. Guidelines for living shoreline designs are also still under discussion, and no formal process exists to certify newly trained practitioners. Marine contractors have been resistant to add living shoreline techniques to their suite of solutions due to lack of exposure to the new techniques and/or a perceived greater level of liability for project failure with living shorelines.

The final impediment to implementation of living shorelines is regulatory in nature. In the Bay region of Maryland, both living shoreline projects and shoreline armor projects (bulkhead and revetments) less than 500 linear feet fall under the same general tidal wetlands permit category. Currently, no regulatory preference for the selection of a living shoreline design exists. To the contrary, in some cases, living shorelines may go through a more rigorous review process due to a larger impact on public trust bottoms and encroachment into navigable waters, which may require a public notice and meeting. Since standard designs and specifications for living shorelines are only beginning to emerge, permit applications can include a wide range of designs that may be unfamiliar to both state and local permitting staff. In addition, designs may contain "non-traditional" elements such as woody debris or coir fiber logs, which may slow down the permit approval process.

Identifying these impediments to implementation is the first step towards creating a set of incentives to promote use of living shoreline techniques. Several types of incentives already exist, mostly in the financial realm. However, a broader suite of incentives needs to be crafted to overcome current hurdles. Groups that may be the focus of such targeting include property owners, marine contractors and builders, engineers and designers, and local governments and regulatory staff.

EXISTING INCENTIVES

Incentives for Property Owners

At present, there are several types of grant and loan programs that are designed to encourage public and private property owners to use a living shoreline solution to address erosion. Most of these programs are meant to serve as a cost-share, rather than to finance an entire project. The logic behind the cost-share aspect is that property owners benefit directly from shoreline stabilization, and therefore should play a financial role in the process.

Both public and private landowners, including individuals as well as organizations such as community associations, churches, and schools, are eligible for several grant and loan programs for help with living shoreline implementation (Table 1). Virginia landowners can apply to either the Living Shorelines Initiative administered by the Chesapeake Bay Trust with National Oceanic and Atmospheric Administration Restoration Center, Campbell Foundation, and National Fish and Wildlife (NFWF) partners, or to the Chesapeake Bay Small Watersheds Program administered by the NFWF. For either of these programs, individual private property owners must seek a nonprofit organization such as a regional Resource Conservation and Development Council or county-based Soil Conservation District to serve as the lead applicant on his or her behalf. Technical assistance for applicants is available for both of these programs through the NOAA Restoration Center and the Chesapeake Bay Trust.

Maryland property owners have the same two options described above, in addition to a few others. In terms of grant programs, the Maryland Department of the Environment (MDE) Small Creeks and Estuary Restoration Program serves both private and public lands, and the MDE Tidal Wetland Compensation Fund serves private lands only. For smaller projects, the Chesapeake Bay Trust's Stewardship Program, which funds projects at a lower dollar amount, is also an option for public and private nonprofit projects.

The State of Maryland also offers three loan programs (Table 1). The Department of Natural Resources (DNR) Nonstructural Erosion Control Program offers a no interest loan program for both private and public projects. A DNR Structural Erosion Control Program also exists and can be used for large living shoreline projects such as offshore breakwaters. MDE offers low interest loan programs for projects on either public or private lands sponsored by a local government (Water Quality Revolving Loan Fund) or individually owned public lands (Linked Deposit Program).

Although not direct financial assistance, local government and Natural Resource Conservation Service programs have provided free wetland plants to waterfront homeowners. These programs can provide just enough of a cost savings for a property owner to move from traditional hard stabilization to a greener approach. For example, Anne Arundel County has grown plants and provided up to 2,000 plants to shoreline property owners, who can return each year for a new stock of plant materials.

Incentives for Marine Contractors

Why should a marine contractor or design firm take time to learn about living shorelines techniques? The answer is that the demand will continue to rise. As Bay problems receive increasing attention, more and more waterfront owners are becoming interested in determining an environmentally friendly approach to protecting their shorelines. This demand is developing in part independently of the financial incentives described above. However, those grant and loan programs do often serve as the impetus for a landowner to take action on a failing bulkhead or eroding shoreline. These financial incentives have created a niche addressed by some marine contractors and engineers. Examples of marine contractors taking a lead in an area, becoming known as "living shorelines" contractors, are becoming more common.

State and local government shoreline groups, such as the Maryland and Virginia Coastal Zone Management Programs, have recognized this emerging incentive for contractors and have conducted introductory courses to encourage more contractors to add living shoreline techniques to their project toolbox. More sophisticated regional contractor training sessions that delve into greater design and construction detail are planned. Marine contractors are often the first point of contact a private property owner has when seeking consultation on how to address a shoreline erosion problem. They can also provide feedback to managers about the relative success or failure of projects and policies. It is imperative that managers and marine contractors share more information with each other.

FUTURE INCENTIVES

Investigation into expanding the types of incentives offered to promote living shorelines is ongoing in both Maryland and Virginia. This activity includes both bolstering existing incentives programs and creating new programs to target additional stakeholders.

Incentives for Property Owners

As demand for living shoreline solutions increases, existing grant programs for public and private property owners will likely be expanded by private and government funders. The existing programs listed in Table 1 will most likely continue to fund living shoreline work. As water quality benefits of living shorelines are quantified, other types of grant programs may become open to funding part or all of living shorelines projects. The Conservation Reserve Enhancement Program (CREP) of the United States Department of Agriculture represents a future opportunity for living shorelines on agricultural lands. CREP currently provides financial assistance to farmers for the restoration of buffers to protect water quality. Living shorelines would work well in this program by providing a wider buffer for more effective nutrient absorption, while also protecting the existing riparian buffer from eroding. However, additional studies are needed to quantify the erosion-control benefit of living shorelines in order to overcome perceptions about the lack of long-term success of these designs.

Investigation into a living shoreline tax credit program for waterfront landowners is a viable incentive option requiring further investigation. Tax incentives could be used in a manner that would reward landowners for implementing approved shoreline practices that provide habitat enhancements. Tax incentives can also be offered to property owners for donating land for conservation purposes or for adding a conservation easement along the waterfront of their property to either limit development and/or prevent shoreline hardening (1).

Two other types of tax-related programs may help with implementation of living shoreline projects. In Maryland, the Taxing District Law (Annotated Code Article 25 County Commissioner/Erosion Control)

Organization	Program	Type	Eligible Project Types	State	Amount	Due Date	Contact Information
Chesapeake Bay Trust, NOAA-Restoration Center, Campbell Foundation, National Fish and Wildlife Foundation	Living Shorelines Initiative	grant	public and private	VA, MD	up to $75,000	Sep	(410) 974-2941 cbtrust.org
Chesapeake Bay Trust	Stewardship Program	grant	public and some private	MD	up to $25,000	Jul, Dec	(410) 974-2941 cbtrust.org
National Fish and Wildlife Foundation	Chesapeake Bay Small Watersheds Program	grant	public and private	VA, MD	up to $50,000	Feb	(202) 857-0166 nfwf.org
MD Department of the Environment, Water Management Administration	Small Creeks and Estuary Restoration Program	grant	public and private	MD	75% cost share	Feb	(410) 537-3908 http://www.mde.state.md.us/Programs/WaterPrograms/WQIP/index.asp
MD Department of the Environment, Tidal Wetlands Division	Tidal Wetland Compensation Fund	grant	private	MD	generally up to $50,000	on-going	(410) 537-3835
MD Department of the Environment, Water Quality Financing Administration	Water Quality Revolving Loan Fund	low interest loan	public and private; applicant must be local gov't	MD		Feb	(410) 537-3908 http://www.mde.state.md.us/Programs/WaterPrograms/Water_Quality_Finance/index.asp
MD Department of the Environment, Water Quality Financing Administration	Linked Deposit Program	low interest loan	private	MD		Feb	(410) 537-3908 http://www.mde.state.md.us/Programs/WaterPrograms/WQIP/index.asp
MD Department of Natural Resources Shore Erosion Control Program	Nonstructural Erosion Control	no interest loan	public and private	MD	public: no limit; private: up to $25,000	on-going	(410) 260-8523 http://www.dnr.state.md.us/grantsandloans/shoreerosion-control.asp

Table 1. *Financial assistance programs for Living Shoreline Implementation on public and private lands in Maryland and Virginia.*

permits property owners in a community, with agreement by 75% of the property owners, to become a special tax district, allowing the collection of taxes to pay for community projects. These tax funds provide another erosion control financing option. An example of a community that has used such funds to implement living shoreline projects is Anne Arundel County's London Towne Property Owners Association, which owns almost all of the waterfront property within the community boundaries.

In addition, in 2005, the Maryland State Legislature allowed local governments to develop a Property Tax Credit for shoreline erosion control structures through the authority of Section 9127, Tax-Property Article, Annotated Code of Maryland. Dorchester County was the only local government to take advantage of the opportunity to grant real property tax credit of 30% of the total cost of an erosion control structures over a period of fifteen taxable years. Although intended for larger, more traditional erosion control structures (steel or timber bulkheads, concrete walls, revetments), projects such as stone toe reinforcement, breakwaters, and groins were also included. If properly designed, these projects could be modified to have a greater natural habitat component, qualifying them as living shorelines, and still take advantage of this financial opportunity.

Incentives for Marine Contractors

The growing number of property owners aware of living shoreline techniques serves as the biggest incentive for marine contractors and engineering firms. Additional incentives may include (a) certifying and developing a "green" contractors list to support a broader clientele base, (b) increasing technical assistance opportunities, and (c) establishing regulatory modifications to streamline living shorelines permits that meet certain minimum standards.

In terms of promoting a greater clientele base, managers should continue to hold events, publish literature, and advocate for these projects in order to continue property owner awareness and demand. However, in order to keep pace with demand where high and create demand where low, contractor training programs at which experts discuss and demonstrate design, construction, and maintenance should continue to be developed. By providing more technical assistance opportunities, contractors will become more confident in the designs and more familiar with the biological components, allowing them to add this technique to their repertoires. Trainings should demonstrate to contractors that under some conditions, such as low energy and low fetch areas, the profit margin of living shoreline techniques may be higher, which might be the greatest incentive of all for a contractor, particularly if technical assistance with the various grant and cost sharing programs is also provided.

The Virginia Coastal Zone Management Program has identified living shorelines as a major enhancement area for the next five years under its Section 309 Strategy. The strategy has outlined the development of a living shoreline manual and a marine contractors training program. The Maryland Coastal Zone Management Program has already begun to organize contractor trainings at various locations in Maryland. A formal certification program has also been suggested, such that a contractor or engineer can be awarded a certificate indicating proficiency in living shoreline techniques. These contractors could also be placed on a green contractors list to assist in advertising their special training and services.

Finally, streamlining the regulatory process, such that living shorelines are "green-taped" relative to harder armor options, has been suggested. "Green-taping" or streamlining could potentially increase the profit margin, or at least time efficiency, for a contractor that handles the permit application process. This process may require the adoption of new policies or laws that clearly define what types of projects qualify for the streamlined process and may be aided by the increase in availability of site-specific technical design assistance for contractors. This assistance includes pre-application evaluations for specific projects or assistance with project drawings for the permit process, services already provided to some degree in Virginia by, for example, the Virginia Institute of Marine Science and the Virginia Department of Conservation and Recreation Shoreline Erosion Advisory Service (SEAS)

Incentives for Local Governments

Several incentives have been suggested to facilitate implementation of living shorelines by local governments. As water quality benefits of living shoreline techniques are quantified, these techniques could

be established as a best management practice to meet Total Daily Maximum Load (TMDL) requirements or could be counted as wetland mitigation credits. Financial assistance could be made available for local governments to work on and implement zoning and subsequent code changes that promote living shorelines. These changes could require certain types of shoreline protection or land use tools, such as setbacks and no-build areas, to be implemented depending on the sensitivity of a particular watershed, extent of erosion, or benefits to water quality.

Land use laws, such as the Maryland Critical Areas Law and the Virginia Chesapeake Bay Preservation Act, already grant authority to local governments to become more involved in shoreline permitting activities. For example, Kent County, Maryland, Department of Planning and Zoning has developed language in its comprehensive plan that requires landowners seeking to protect their shorelines to first consider a living shoreline technique, and if not appropriate, to demonstrate why it would not work. The County has devoted considerable staff time to implement this policy, with technical help from the Soil Conservation District and the Eastern Shore Resource Conservation and Development Council. Providing such technical assistance can serve, if not quite an incentive, as a mechanism to overcome hurdles in the ability of a county to implement living shoreline policy. In Virginia, local Wetland Boards also require significant technical assistance to adequately function in a capacity to promote living shorelines. The Virginia Institute of Marine Science provides the necessary information tools (permitting database, maps, and studies) to maintain the capacity for these local groups to make these decisions. In order to have more local governments act in a similar capacity, issues with staff time, liability, and lack of data and technical information need to be addressed.

Local governments could use several additional tools or resources to help them with living shorelines policies and planning. The 2006 National Academies of Sciences study on erosion along sheltered coasts promoted regional shoreline management plans that would take into consideration the movement of sediment, hydrology, aesthetics, and recreation opportunities in shoreline management (2). Local government land use authority would provide the optimal mechanism for these plans to be implemented. However, more data on sediment transport and budgets and regional Geographical Information System (GIS) studies are required to build the local government knowledge to make regional land use and shoreline decision making.

SUMMARY

Collectively, the financial and technical assistance and regulatory programs discussed above should provide incentives for various groups to install and maintain living shorelines where hard armor with lower ecological and water quality value might otherwise be used. Incentives for property owners include grants or loans to allow installation to be more affordable, expediting the permit process (assuming change in regulatory programs), improving aesthetics, and increasing awareness of the benefits of selecting an environmentally sensitive approach. Incentives for contractors include a growing clientele base, developing a "name" or a niche in the market, a streamlined permit process (again assuming change in regulatory programs), improved training and potential certification, and potentially a higher profit margin. For local governments, future incentives may include credit for water quality improvements, gaining another tool in the mitigation and management toolbox, and additional financial assistance for comprehensive and land use planning and management. Together, these types of incentives should promote use of living shorelines and increase the rate of adoption in the future.

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Note: See page *xiii* for changes in Maryland Living Shoreline Policy, 2008.

Living Shoreline Case Studies

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INTRODUCTION

Case studies were solicited as a component of the Living Shoreline Summit to provide a sharpened understanding of living shoreline implementation in the Chesapeake Bay. These case studies deliver an in-depth perspective to guide future project implementation, policy activities and enhancements, and research. The following case studies supply a "real-life" context and systematic way of looking at shoreline management alternatives, presented in a manner to offer insight and contemplation on success/performance and habitat benefits/trade-offs. These projects occur throughout the Chesapeake Bay in Maryland and Virginia in variable energy regimes and waterways. Documenting projects in a suite of settings and in more detail, through a more anecdotal account, gives heightened and realistic perspectives on challenges, opportunities, and lessons learned when conducting shoreline restoration activities.

CASE STUDY 1: Longwood University Foundation, Hull Springs Farm's Living Shorelines Research and Habitat Restoration Project: Sharing Living Shoreline Recommendations with Shoreline Property Owners

Project Overview

The project was located on Longwood University Foundation's Hull Springs Farm (HSF) and encompasses the tidal shoreline area of Lower Machodoc Creek, a tributary to the Potomac River, upstream from Coles Neck, near the community of Tidwells in Westmoreland County, Virginia. HSF, a 637-acre property with a mix of agricultural fields and forested tracts, was a bequest to Longwood University by Mary Farley Ames Lee who was committed to preserving the natural state of the farm. The property has approximately 8,400 feet of shoreline along Glebe and Aimes Creeks. The purpose of the project was to establish a framework for potential living shoreline treatments within Lower Machodoc Creek and to implement a living shoreline stewardship program and demonstration project on HSF property. Through three workshops (held in 2005 and 2006) and future access to the demonstration site, landowners, coastal managers, contractors, and others will learn about integrated approaches to shoreline stabilization and habitat enhancement.

The project was designed with the intention of being a catalyst in Virginia's Northern Neck and the Chesapeake Bay region for future living shorelines initiatives. Introducing living shorelines to property owners in Virginia's Northern Neck fit the Foundation's objective to establish Hull Springs Farm as a focal point for area residents, academics, and others interested in conservation and restoration methodologies. The long-range goal is to develop a myriad of "state-of-the-art" stewardship practices, including living shorelines, where people from Northern Virginia, the Northern Neck, and beyond can gain first-hand exposure to Bay-friendly best management practices.

The HSF "Living Shorelines Research and Habitat Restoration Project" was partly funded in 2005-06 by a grant from the National Oceanic and Atmospheric Administration through the National Fish and

Wildlife Foundation. Additional in-kind and financial support came from the project partners. The project was a collaborative effort of several entities that are interested in the advancement of living shorelines in Virginia and Maryland, including: Longwood University Foundation, Inc (LUF), Virginia Institute of Marine Science (VIMS), Burke Environmental Associates LLC (BEA), Northern Neck Soil and Water Conservation District (NNSWCD), Northern Neck Planning District Commission (NNPDC), National Oceanic and Atmospheric Administration, Restoration Center (NOAA), Virginia Commonwealth University (VCU), Clean Virginia Waterways (CVW), and local citizens and students who served as workshop volunteers.

Benefits and/or Trade-offs

The project resulted in two educational workshops about environmentally-friendly shoreline erosion control techniques, as well as a volunteer event where citizens from the Northern Neck assisted in planting 800 plugs of marsh grass (*Spartina alterniflora*) to restore three shoreline areas. More than 110 property owners attended the workshops. Future communication about living shoreline projects will be facilitated by the partnership of government agencies, nongovernmental groups, and academic institutions that was created during this project. In addition, the NNSWCD helped create a database of shoreline property owners' in Lower Machodoc Creek that will assist with future outreach efforts.

Data about the existing shoreline conditions and shore erosion control structures for Lower Machodoc Creek were collected and incorporated into a shoreline conditions database housed at VIMS. Living shoreline treatment suggestions for Lower Machodoc Creek were developed and these recommendations were mapped by NNPDC. The PDF maps are housed on the HSF website (www.longwood.edu/hullspringsfarm/environment/shoreline.htm) for shoreline property owners to review along with extensive information about living shorelines techniques. The web site has received enthusiastic praise from the Virginia Coastal Zone Management Program and several Chesapeake Bay nonprofit organizations.

To acquire biological monitoring data, the VCU Department of Biology collected baseline information on the benthic invertebrates before project construction. Additional surveys will be conducted on vegetation and benthic invertebrates post-construction to determine changes or enhancements to the biological communities from the living shoreline project.

Issues and Lessons Learned

The cumulative effect of Tropical Storm Ernesto (September 1, 2006) and a Nor'easter in October 2006 removed several feet of soil and vegetation from the Hull Springs Farm shoreline near the historic oak tree and "Big House," forcing Longwood and its VIMS advisor to be flexible in plans. The original plan for that highly-exposed bank was to install a low sill of rocks that would reduce wave energy. Between the sill and the bank, a fringe marsh of cordgrass was to be planted to enhance habitat for wildlife, while also preventing further erosion. Due to the extensive loss of shoreline and in order to protect HSF's beloved oak tree, Longwood and VIMS modified the plan to include a riprap revetment at the toe of the bank nearest the oak tree. The revetment will be in place as soon as funding and the permitting process allow, in anticipation of the 2007 hurricane season. The fringe marsh and sill is to be installed as soon as funding is secured, perhaps in 2008. If the sill and fringe marsh had been in place, the bank may have been spared the storms' harshest impacts.

While purchasing plugs of *S. alterniflora*, Longwood found the demand for marsh grasses surpasses the supply in the Chesapeake Bay watershed. The lack of resources have lead to preliminary research on the feasibility of growing marsh grasses at HSF to help meet this demand, especially as living shoreline methods are increasingly used.

CASE STUDY 2: South River, MD – Living Shoreline Demonstration Project Using Volunteer Labor for Construction

Project Overview

The South River Federation was approached to assist the Londontowne Property Owners Association with stabilizing their community owned waterfront property and re-establishing the fringe marsh habitat. The low marsh at this area had completely eroded, jeopardizing the remaining high marsh habitat. The community chose to pursue a living shoreline option that would replace lost low marsh and protect existing shoreline, rather than pursuing a hardened shoreline armor option.

The project was completed over two summers and was installed by volunteers, who moved 220 tons of rock and 250 tons of sand to build the project. The major source of energy along the shoreline is from boat wakes as the fetch to the south is 0.5 miles. The site involved the placement of 33 segmented stone sills across 750 linear feet of shoreline (Fig. 1). The sill structures were built 12 ft in length with 6 foot windows between each sill (Fig. 2). Sand was then backfilled behind the sills and the site was planted in *S. alterniflora* to re-establish low marsh that had eroded.

The community also agreed to create a vegetated buffer that expanded the high marsh and provided a healthy vegetated buffer protecting the waterway from the area with very high impervious coverage. The purpose for these enhancements was to improve water quality.

Figure 1*. Placement of 33 segmented stone sills to create a living shoreline along 750 linear feet of shoreline in Glebe Bay, South River, Maryland*

Benefits and/or Trade-offs

The project was built during the summer months through the efforts of twelve work parties (Fig. 3). More than 200 volunteers and 800 volunteer hours were needed to complete the project. A marine contractor and board member donated time towards design, permitting, and project management. The use of volunteers decreased the overall cost of the project, while providing a cause for the community to come together and work towards a common goal: creating a restored, protected shoreline with a native buffer.

The site has held up extremely well (3 years post-completion), even under extreme wave events.

Figure 2*. 12-foot long sills with 6-foot windows at the living shoreline site in Glebe Bay, South River, Maryland.*

Figure 3*. Contribution of volunteer labor: 200 volunteers contributed 800 hours to construction of the living shoreline in Glebe Bay, South River, Maryland.*

During the 7+ foot storm surge event created during Tropical Storm Isabel, the site captured sand despite the fact that local residents had to borrow significant amounts of sand to fill sand bags. The project also began to gain sand over time once the plants became established, a process highly dependent upon local littoral drift. In this particular project, sand fill was placed in one area and allowed to naturally establish a grade through tidal action and redistribution of sandy material.

Issues and Lessons Learned

One of the biggest challenges working with a community is balancing multiple views and opinions within that community. People are often skeptical of projects that are not standard practices and that are more innovative. Garnering support and backing of community leaders is highly important for project success. Community leaders are vital in the effort of facilitating and moving forward with a project in spite of the comments and objections from (initially) unsupportive community members.

CASE STUDY 3: Hermitage Museum Foundation Living Shoreline and Wetland Restoration

Project Overview

The project was designed to be implemented through a three phase operation. The Living Shoreline segment consisted of approximately 250 linear feet (LF) of stone breakwater and marsh toe protection together with approximately 600 cubic yards of sand beach fill and the planting of 7500 square feet (SF) of marsh grass, primarily smooth cordgrass, *S. alterniflora*. This protected over 300 LF of shoreline including a historic brick wall surrounding the formal garden at the Hermitage. The next phase involved removal of a stand of invasive *Phragmites australis* and replacing it with 5000 SF of tidal marsh. The last phase involved removal of 110 linear feet of riprap and approximately 400 cubic yards of debris to restore approximately 7500 SF of tidal wetlands. These marshes were planted with a combination of smooth cordgrass and saltmeadow hay, *Spartina patens*, depending on the elevation of the sand fill. All totaled, the project restored almost ½ acre of wetlands by removing riprap and debris placed in historic wetlands and providing a "softer" approach to shoreline stabilization, providing intrinsic habitat value as well.

Benefits and/or Trade-offs

One of the purposes of the project was to demonstrate the effectiveness of "Living Shorelines" as an alternative shoreline protection strategy that provides protection as well as habitat value. "Living shorelines" are designed to only use structures where necessary to modulate wave energy sufficient to allow natural structures and processes, like beaches and marshes, to be able to provide effective shoreline protection. This integration of natural shoreline into the erosion protection scenario has the added benefit of providing habitat for many species of fish and wildlife including killifish, blue crabs, spot, croaker, puppy drum, herons, egrets, and ducks. The major trade-off involved the conversion of approximately 3000-4000 SF of shallow subtidal bottom into marsh, beach, and rocky intertidal habitat.

Issues and Lessons Learned

Besides funding, there were two issues that had to be addressed. The first was obtaining regulatory approval for encroachment beyond the previously existing mean low water shoreline. The Living Shoreline design necessitated an encroachment of up to 40 feet for the marsh, beach, and sill construction. It was argued that there was no net loss of aquatic habitat, only the conversion from one type to another.

The other consideration was finding a contractor with the small equipment required for the job that was willing to take a chance on constructing the project for the funding available. Three bids were received. The two high bids were both $100,000 above the $50,000 grant award.

To date, the sills, beach, and marsh constructed by the project have effectively protected the shoreline. The Living Shoreline has also improved habitat at the site by increasing the amount of edge that provides

substrate suitable for benthic colonization, rocky intertidal habitat for oysters, and fringe marsh for fishes and crabs. The *Phragmites* sp. and fill removal components have added a substantial area of tidal wetlands that is being used by an array finfish, shellfish, and birds.

SUMMARY

Collectively, these case studies demonstrate the possible successes and challenges faced when constructing living shoreline in the Chesapeake Bay. Volunteerism was a very important component of each of these projects, which minimized costs and assisted in promoting outreach and stewardship for shoreline resources. Monitoring should be incorporated into volunteer activities. This promotes stewardship efforts and generates a baseline of information for long-term reference. As living shorelines are implemented more regularly, more sources of appropriate wetland vegetation will need to be available. There will also be a demand for planners, contractors, and individuals knowledgeable about construction and design of living shoreline projects.