Survey Results – Shoreline Management Barriers and Benefits

Chesapeake Bay Program

action RESEARCH

3630 Ocean Ranch Boulevard
Oceanside, CA 92056

40 Exchange Place, Suite 1403
New York, NY 10005

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Acknowledgements

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Action Research

Jennifer Tabanico, *President*

Lori Large, *Director of Research Operations*

Kaitlin Phelps, *Project Director*

Dani Ballard, *Research Coordinator*

Doug McKenzie-Mohr, *Scientific Consultant and Community-Based Social Marketing Founder*

Steering Committee

Co-lead: Rachel Felver, *Alliance for the Chesapeake Bay*

Co-lead: Rebecca Chillrud, *Chesapeake Research Consortium*

Morgan Corey, *Chesapeake Research Consortium*

Jennifer Dindinger, *University of MD, College of Agriculture and Natural Resources*

Jim George, *Maryland Department of Environment (MDE)*

Gina Hunt, Nicole Carlozo, *Maryland Department of Natural Resources (DNR)*

Pamela Mason, *Virginia Institute of Marine Science (VIMS)*

Alison Rogerson, *Delaware Department of Natural Resources and Environmental Control*

Lisa Wool, *Nanticoke Watershed Alliance*

Contributing Experts*

Justin Bereznak, *Maryland Department of Environment (MDE)*

Donna Marie Bilkovic, *Virginia Institute of Marine Science (VIMS)*

Jana Davis, *Chesapeake Bay Trust*

Heather Nelson, *Maryland Department of Environment (MDE)*

Mary Phipps-Dickerson, *Maryland Department of Environment (MDE)*

Alison Rogerson, *Delaware Department of Natural Resources and Environmental Control*

Kevin M. Smith, *Maryland Department of Natural Resources (DNR)*

Megan Spindler, *Maryland Department of Environment (MDE)*

Sarah Stafford*, William and Mary*

Bhaskaran Subramanian, *Maryland Department of Natural Resources (DNR)*

*Other experts were surveyed for this work and declined to leave their contact information

1: Research Goals and Background

The goal of this work was to improve the health of the Chesapeake Bay and its tributaries through reducing excessive shoreline erosion, preventing sediment, nitrogen, and phosphorus pollution, creating more healthy ecosystems, and mitigating the impacts of climate change. To achieve this goal, a steering committee[1] of shoreline and communication experts was assembled to provide oversight and expertise. Action Research was then contracted to complete the work, which began with a literature review and a survey of shoreline management experts. Next, we conducted a survey of Maryland and Virginia shoreline property owners across the Chesapeake Bay to understand what challenges and situations shoreline property owners face when managing their shoreline. In the next phase, we will use this information to design strategies and improve materials to help shoreline property owners in the Chesapeake Bay better manage their shorelines by motivating them to remove shoreline armor, leave their natural shorelines alone, plant upland vegetation, or, where applicable, install living shorelines.

Literature Review

The Action Research team began by reviewing the existing literature on shoreline management. The goal of this literature review was to establish a foundation for further research to inform efforts to improve shoreline management in the Chesapeake Bay. The literature review identified research gaps about behaviors and social science related to living shorelines, removing existing armoring, planting vegetation, and leaving shorelines untouched/unarmored. The literature review identified numerous behaviors relevant to the project goals, including planting upland native plants, removing current armor, leaving a natural shoreline alone, and installing a living shoreline. For the living shoreline, several challenges to engaging in the behavior were identified, including the cost, permitting, long-term maintenance, and complexity of the action. The full review can be found in the *Shoreline Management Literature Review* memo from October 2019, Appendix A.

Behavior Selection

Our review of the literature identified a set of eleven behaviors to improve shoreline management, listed below.

Behavior list

1. Leave an unarmored shoreline alone - let it erode, accrete, or stay neutral.
2. Install beach nourishment (non-structural).
3. Install armor – groins with no vegetative component (structural).
4. Install armor – jetties with no vegetative component (structural).
5. Install armor – breakwater with no vegetative component (structural).
6. Install armor – revetment with no vegetative component (structural).
7. Install buffer (upland/riparian) vegetation.
8. Install living shoreline (LS) – jetties/groins with wetland vegetation (structural).
9. Install living shoreline (LS) – offshore breakwater with wetland vegetation (hybrid).
10. Install living shoreline (LS) – sills with wetland vegetation (hybrid).
11. Install living shoreline (LS) – slope grading/vegetation (non-structural).

[1] Steering committee members: Rachel Felver; Morgan Corey; Rebecca Chillrud; Alison Rogerson; Jim George; Gina Hunt, Nicole Carlozo; Lisa Wool; Pamela Mason; and Jennifer Dindinger

Using the behavior list as a foundation, we developed and implemented a short online survey with 15 shoreline management experts to determine the relative **impact** of each of the eleven shoreline management actions on: (1) excessive erosion; (2) water quality; (3) habitat; and (4) climate change resiliency. Each impact was clearly defined, and the survey respondents were asked to rate each behavior using a scale from 0 (*no impact*) to 10 (*a significant impact*). See Table 1 for definitions of the types of impacts.

Table 1: Definition of Impact Types

Impact Type	Definition
Excessive Erosion	Property loss or infrastructure damage caused by or resulting from water and/or wind.
Water Quality	Preventing excessive nitrogen, phosphorus, and sediment from entering the watershed.
Habitat	Increasing the amount of ecosystem area for birds, fish, and other wildlife.
Climate Change Resiliency	Increasing the ability of the shoreline to adjust over time to climate changes and continue providing ecosystem services.

The results of the impact survey are summarized in Table 2, and in the recommendations section below. After the expert survey, the table contained information on the associated environmental impact of each behavior (**impact**) and the proportion of the population to which each behavior applies (**applicability**). The outcome of this step was rank ordering of these behaviors using a weight that considers these four factors. To create the weights listed, the impacts were each equally weighted (multiplied by .25 to represent a quarter of the impact) and then added together to calculate the impact of each behavior. A weight was then calculated by multiplying Impact by Applicability.

The weight does not represent any specific measure of the amount of impact of each behavior – rather, they represent a relative relationship between the behaviors (such as, given the impact and applicability of the behavior, which behaviors should programs prioritize?). The behaviors were rank ordered by their weight scores from highest to lowest. The full findings are available in the *Shoreline Management Expert Survey Results* memo from April 2020, Appendix B.

Table 2: Ranked Behaviors for Further Research

Behavior	Impact[2]	Penetration	Probability	Applicability	Weight[3]
Install buffer (upland/riparian) vegetation	7.40			1	7.40
Living Shoreline with sills	8.21			0.8	6.57
Living Shoreline with offshore breakwater	7.95			0.8	6.36
Living Shoreline - wetland vegetation	7.87			0.8	6.30
Living Shoreline with jetties/groins	7.81			0.8	6.25
Install beach nourishment	4.31			0.8	3.45
Armor - revetment with no vegetative component	3.42			1	3.42
Armor – breakwater with no vegetative component	3.16			1	3.16
Armor – jetties with no vegetative component	2.87			1	2.87
Armor – groins with no vegetative component	2.80			1	2.80
Leave an unarmored shoreline alone	3.47			0.8	2.78

Recommendations

Based on the literature review and expert interviews, we provided the following recommendations to guide the next project phase, which was to survey shoreline property owners in Maryland and Virginia to gather data on the extent to which individuals are already engaged in each action (penetration), the likelihood of change (probability) and the barriers and benefits for each behavior.

1. **Prioritize behaviors related to living shorelines for additional research**. Within each impact area, the suite of behaviors around living shorelines scored high for impact, resulting in a higher final weight. Based on the erosion rate data alone, the actions may be applicable to 80% of shorelines. If additional data was available, it might demonstrate that the estimate of 80% is too high. Despite these concerns, we recommended prioritizing this suite of behaviors for the next survey to understand the perspective of shoreline property owners.
2. **Prioritize the behavior, "install buffer (upland/riparian) vegetation" for additional research**. While this behavior rated lower on the excessive erosion impact, it rated highly for all other impacts. Additionally, this behavior is likely applicable for most, if not all, shoreline properties. Given this pattern, we recommended prioritizing this behavior for the next survey to understand the perspective of shoreline property owners.
3. **Prioritize the behavior, "leaving an unarmored shoreline alone" for additional research**. Experts were divided on their impact ratings related to leaving a shoreline alone, likely due to

[2] Impact = (Erosion*.25) + (Water Quality*.25) + (Habitat*.25) + (Climate Resiliency*.25)
[3] Weight = Impact * (1-Penetration) * Probability * Applicability

varying assumptions about the site context. Furthermore, leaving the shoreline alone will likely have the fewest barriers to action due to the low complexity. Finally, this behavior is applicable to most shorelines. Therefore, we recommended prioritizing this behavior for the next survey to understand the perspective of shoreline property owners.

4. **Remove the suite of armor-related behaviors and beach nourishment from the list.** Armor-related behaviors were either in the middle or bottom for impact. Beach nourishment was higher ranked, given the larger impact on erosion. However, this behavior likely has more barriers to action, while not achieving the higher weights of the living shoreline behaviors. While the armor-related and beach nourishment behaviors are broadly applicable, we did not believe that they warranted further research in this project.

Updated Behavior List

Based on the findings from the impact survey, we promoted the six behaviors below for additional research.

1. Leave an unarmored shoreline alone - let it erode, accrete, or stay neutral.
2. Install buffer (upland/riparian) vegetation.
3. Install living shoreline (LS) – slope grading/vegetation (non-structural).
4. Install living shoreline (LS) – jetties/groins with wetland vegetation (structural).
5. Install living shoreline (LS) – offshore breakwater with wetland vegetation (hybrid).
6. Install living shoreline (LS) – sills with wetland vegetation (hybrid).

Shoreline Property Owner Survey

Based on the literature review and expert survey research, the next step was to conduct a mail survey to better understand property owners' current shoreline management actions, their probability of taking the six desired shoreline management actions, and what barriers and benefits they perceive to the six specific shoreline management actions. The methodology and results of the shoreline property owner survey are outlined in the next two sections of this report.

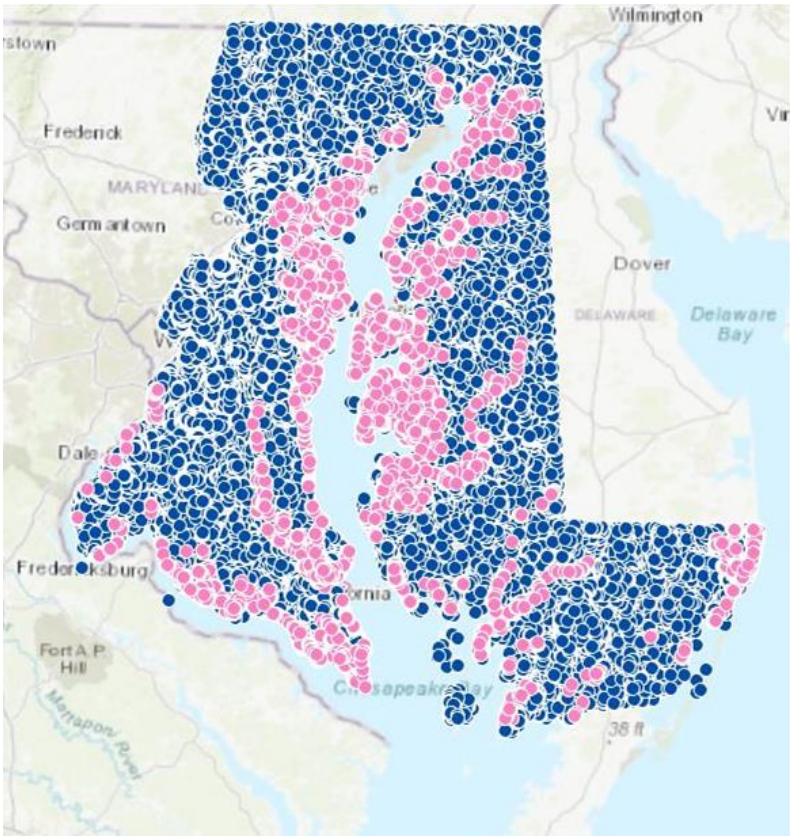
2: Methodology

In February and March of 2020, we administered a mail survey to residents of 1,600 shoreline properties along the Chesapeake Bay in Maryland and Virginia. These shoreline properties were randomly selected from an address list of all shoreline properties in Maryland and Virginia created from state-level GIS data.

Address List Generation

After importing all GIS parcel data of Maryland and Virginia, we removed counties with no contact with the Chesapeake Bay, coastline, or any river or tributary. We then filtered the addresses to select only residential addresses that were within 250 feet of any coastline. This process resulted in a final list of addresses, which are represented in pink on the map below.

Figure 1: Map of Addresses in Maryland and Virginia



Using the address data along with data on the locations of shoreline erosion management structures, the addresses were sorted into three groups:

1. All residential addresses within 150 ft of ANY shoreline barrier or structure;
2. Residential addresses found within 150 ft of any shoreline barrier/structure **except** bulkheads and riprap; and
3. Residential addresses with NO shoreline structures found within 250ft.

The list of addresses was divided to include those with and without bulkheads and riprap due to the high frequency of bulkheads (46%) and riprap (37%) among the total shoreline structures. Selecting from

addresses that specifically did not have bulkheads and riprap ensured that our sample included residences that had less frequently used structures (like breakwaters, debris, groin fields, etc.) to create a more generalizable sample. Refining the addresses by these parameters resulted in a list of 46,947 residential addresses (27,488 in the state of Maryland and 19,459 in the state of Virginia). It is important to note that because the shoreline structures may overlap, there was address redundancy between residences within 150ft of ANY shoreline structures, as well as residences within 150ft of any shoreline structures EXCEPT bulkheads and riprap. However, this redundancy was accounted for during the final random selection phase where any duplicates were removed.

Sample Selection

The initial desired sample size was 1,200 addresses in order to obtain survey responses from a minimum of 240 properties (assuming a response rate of at least 20%). However, after conversations with the steering committee about the expected accuracy of the list, the sample size was increased to approximately 1,600 properties. The sample was split between Maryland and Virginia, with 800 addresses selected from each state. Within each state, 267 properties were randomly selected from each of the three groups and checked for duplicates.

Survey

The survey was administered using the Tailored Design Method (TDM)[4]. In February 2020, selected properties received a prenotification postcard followed a few days later by a hand-addressed survey packet with an addressed and stamped return envelope. In March 2020, non-respondents to the initial mailing received a reminder postcard and a second survey packet. The full survey is attached as Appendix C. The survey also included a color photo reference sheet showing various shoreline management techniques.

[4] Dillman, Don A., Smyth, Jolene D., Christian, Leah Melani. 2014. Internet, Phone, Mail and Mixed-Mode Surveys: The Tailored Design Method, 4th edition. John Wiley: Hoboken, NJ

3: Results

As discussed in the *Sample Selection* section, the address list was demonstrated to have errors that originated from the GIS data. The survey was sent to 1,600 addresses. Of these, 452 were returned undeliverable. An additional 15 were returned or reported as ineligible (e.g., commercial properties, condominium complexes). This left a final valid population size of 1,133 addresses that were sent a survey. From the 1,133 valid addresses, there was a total of 349 completed surveys returned, for a response rate of 30.8%. There were also 71 refusals (blank surveys returned in the pre-stamped envelope). Table 3 lists each category by state. Virginia had more undeliverable addresses, leading to a smaller valid sample and therefore, fewer completed surveys. However, the final response rate still provided a sufficient sample for comparison by state as needed.

Table 3: Responses by State

	(A) Original Sample	(B) Undeliverable	(C) Ineligibles	(D) Valid Sample *(A – (B+ C))*	(E) Refusals	(F) Completes	(G) Response Rate *(F/D)*
MD	800	151	9	640	41	207	32.3%
VA	800	301	6	493	30	142	28.8%
Total	**1,600**	**452**	**15**	**1,133**	**71**	**349**	**30.8%**

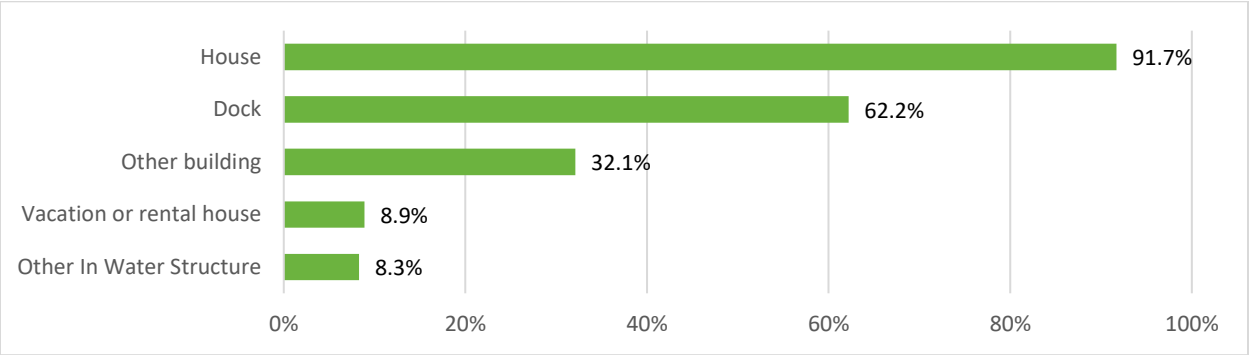
Demographics

Most respondents reported owning their property (97.7%). Respondents length of ownership of their property averaged 20 years and ranged from one year to 85. Respondents ranged in age from 26 to 94 years (Average = 62). Respondents had an average of 2.2 people in their household (one (18.4%) or two (57.6%) people). Fewer had three (11.7%) or four (7%) household members, with only 5.3% having five or more members. The majority of respondents did not have children under 18 in their household (85.3%).

Structures

Respondents were asked to indicate which types of structures they have on their property. Nearly all respondents' properties had houses (91.7%, N=320). One-third of respondents had some kind of building (32.1%, N=112) on their property. A small number had a vacation or rental home (8.9%, N=31). About two-thirds of properties had a dock (62.2%, N=217). Only three respondents reported having both primary and vacation homes on their property.

Figure 2: Structures on Shoreline Properties



Shoreline Management Techniques

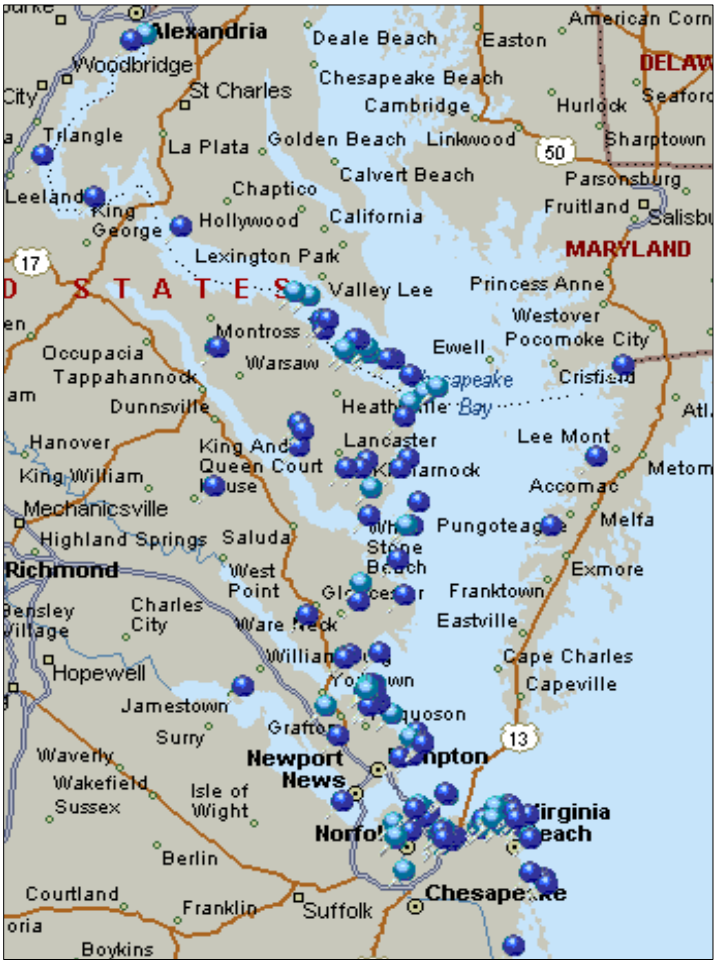
Frequency

Respondents were asked two questions regarding the shoreline management techniques in place on their property. Question two had a list of structures, from types of armor to living shorelines to sills, and asked the respondent to report which ones were on their property. However, despite the provided photo sheet of each possible technique, the results of that specific question suggest that question two was misinterpreted. For example, only 17% of respondents reported having revetment, riprap, or a bulkhead, but the GIS data from the Virginia Institute of Marine Science (VIMS) showed these are the majority of structures (see *Address List Generation* section). Furthermore, in question five, "Do you have any type of armoring on your shoreline (Photo 4 and Photo 5)?" 68% of respondents reported having armor (revetment, riprap, or a bulkhead), as compared to the 17% that reported it in question two.

Our team hypothesizes that for question two respondents may have (1) been confused about the specific technique terminology, despite the reference color photo sheet, and/or (2) interpreted the question as asking if the respondent installed the structure, as opposed to a previous property owner. See Appendix D for the results of this question.

For the purpose of this analysis, the data on current installations were drawn from question five, "Do you have any type of armoring on your shoreline (Photo 4 and Photo 5)?" More than two-thirds of respondents (68.8%) reported having either riprap or bulkheads on their shoreline. Respondents with and without armor were mapped by location in Virginia (see Figure 3) and in Maryland (see Figure 4).

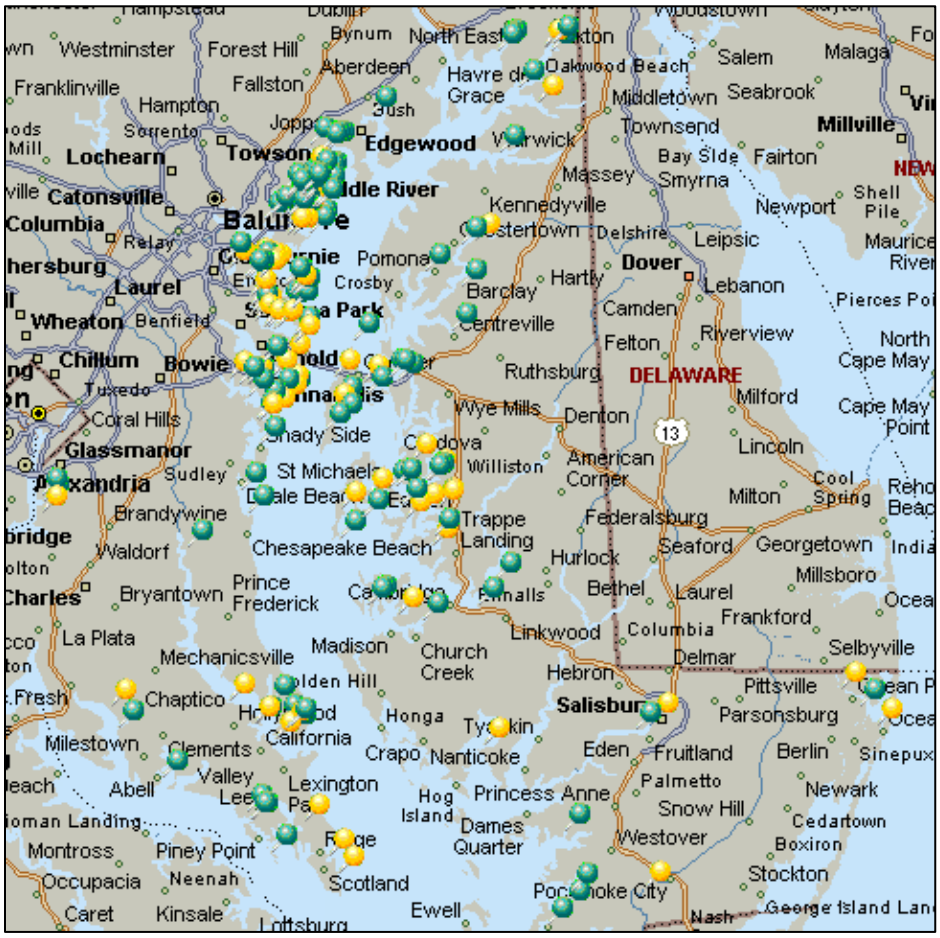
Figure 3: Virginia Respondents by Armor and No Armor



N=142

- Armor (*N*=98, 69.0%)
- No Armor (*N*=44, 31.0%)

Figure 4: Maryland Respondents by Armor and No Armor



N=195, 12 residents did not indicate whether or not they had armor, so are not included.

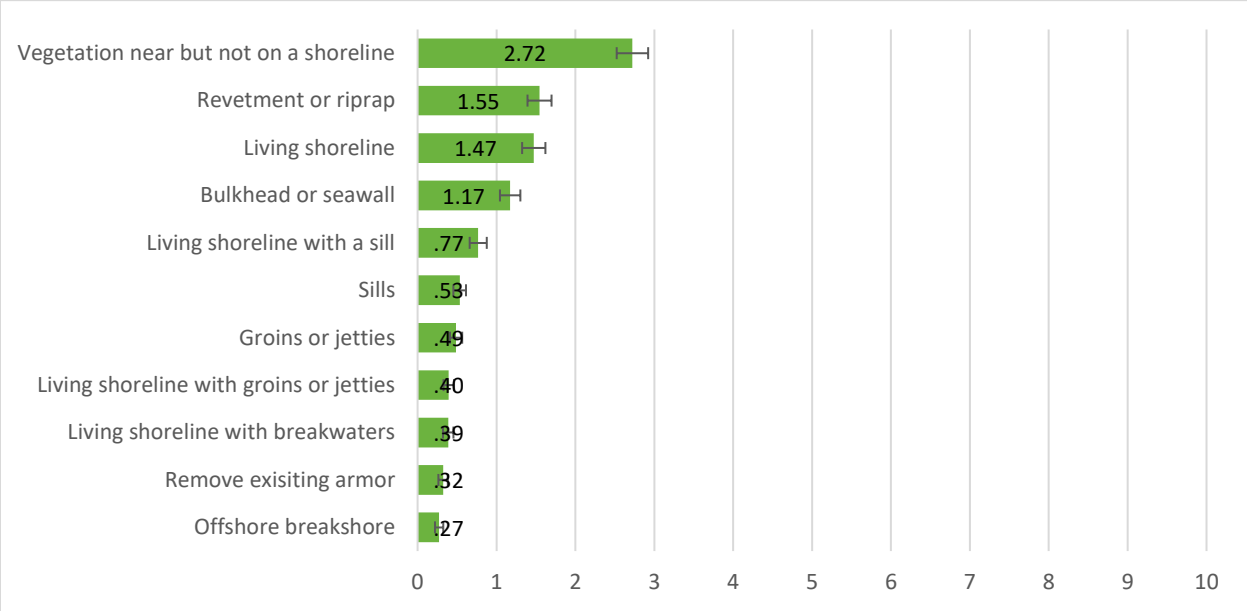
- Armor (*N*=134, 68.7%)
- No Armor (*N*=61, 31.3%)

The maps suggest that there are respondents with and without armor across both state's shorelines.

Probability

Respondents were asked how likely they were to install various shoreline erosion management structures (if they did not already have them) using a scale from 0 (not at all) to 10 (extremely likely). The potential confusion with the "completed or in progress" column was noted in the *Frequency of Shoreline Management Techniques* section of the results. However, the likelihood ratings are useful for prioritizing which actions property owners are likely to take.

Figure 5: Likelihood of Installing Shoreline Management Techniques[5]



The action respondents reported they were most likely to do is plant *vegetation near but not on shoreline*, followed by installing *revetment or riprap*. Installing *living shorelines* was next, followed by installing a *bulkhead or seawall*. However, the overall ratings are low – with plant *vegetation near but not on shoreline* only reaching a 2.72 rating out of 10. Overall, these ratings suggest that respondents are not likely to do anything at all, but they are most likely to plant upland vegetation.

[5] Standard error bars represent a measure of the statistical accuracy of the mean, or in other words, how accurate the sample mean is likely to be compared to the true mean of the population.

Install Living Shoreline

Barriers

To assess barriers to installing a living shoreline on their property, respondents were provided a list of statements and asked to rate each one using a scale from *0 (strongly disagree)* to *10 (strongly agree)*.

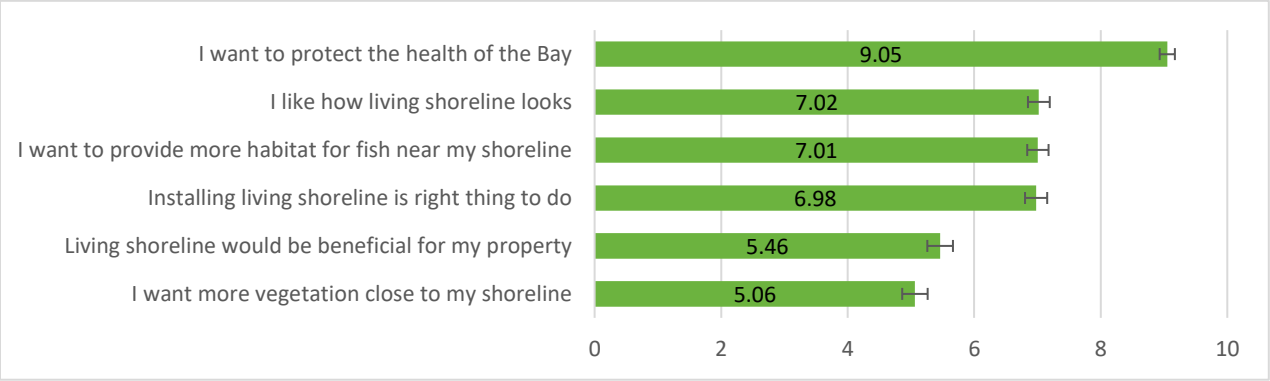
Figure 6: Ranked Barriers to Installing a Living Shoreline

The highest ranked barriers to installing a living shoreline had to do with external issues: they did *not want to apply for permits*; felt *a living shoreline is too expensive*; and perceived that *a living shoreline would not provide erosion control*. Respondents reported that they also did *not want to take care of vegetation* or perceived that *a living shoreline would reduce shoreline accessibility*. Respondents disagreed that they *do not understand what a living shoreline is*.

Benefits

To assess benefits to installing a living shoreline on their property, respondents were provided a list of statements and asked to rate each one using a scale from *0 (strongly disagree)* to *10 (strongly agree)*.

Figure 7: Ranked Benefits to Installing a Living Shoreline



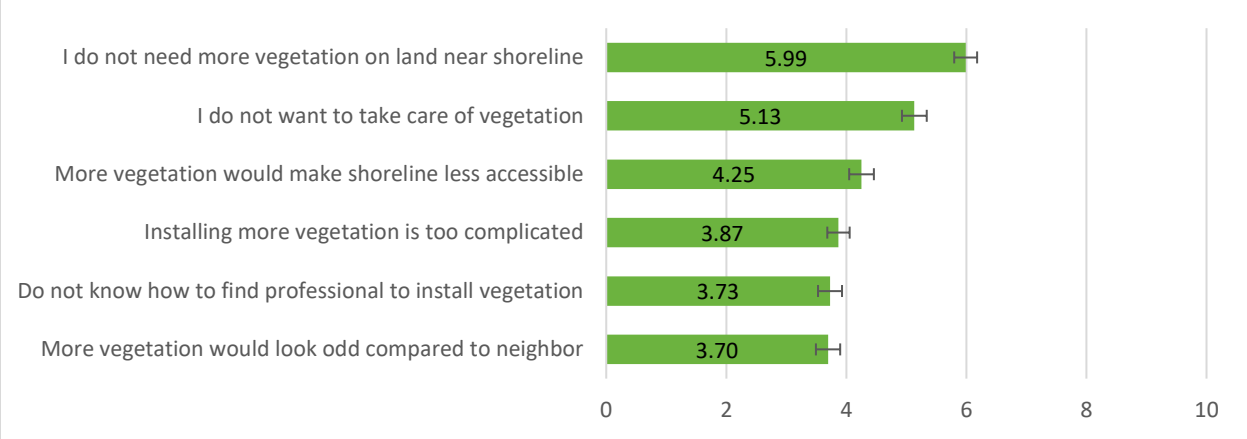
The highest valued benefit to a living shoreline was *protecting the health of the Bay*. The Bay is clearly a highly valued benefit, though respondents may or may not connect living shorelines to it.

Plant Upland Vegetation

Barriers

To assess barriers to planting upland vegetation on their property, respondents were provided a list of statements and asked to rate each one using a scale from *0 (strongly disagree)* to *10 (strongly agree)*.

Figure 8: Barriers to Planting Upland Vegetation

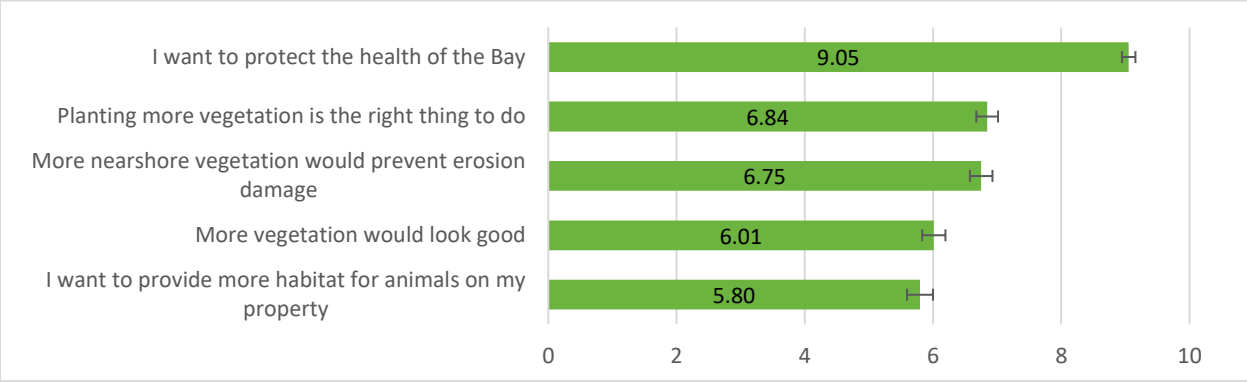


Among respondents, the most significant barrier to planting more vegetation was a perception that they *did not need more vegetation near their shoreline*. The next barrier was that they *did not want to take care of vegetation*. Respondents were also concerned about *making their shorelines less accessible*.

Benefits

To assess benefits to planting upland vegetation on their property, respondents were provided a list of statements and asked to rate each one using a scale from *0 (strongly disagree)* to *10 (strongly agree)*.

Figure 9: Benefits to Planting Upland Vegetation

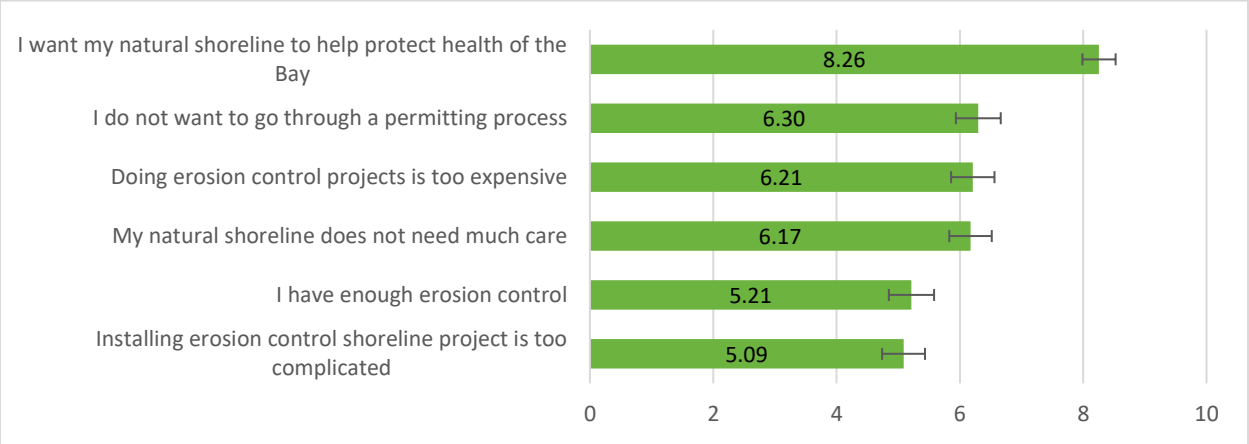


Among respondents, the primary benefit perceived to planting more upland vegetation was *protecting the health of the Bay*, followed by *planting more vegetation is the right thing to do* and *more nearshore vegetation would prevent erosion damage*. The lowest reported benefits were a perception that *more vegetation would look good* and *providing more habitat for animals on their property*.

Leaving a Shoreline Unarmored

To assess barriers to leaving a shoreline unarmored on their property, respondents who did not have armor were provided a list of statements and asked to rate each one using a scale from *0 (strongly disagree)* to *10 (strongly agree)*.

Figure 10: Barriers and Benefits to Leaving Shorelines Unarmored

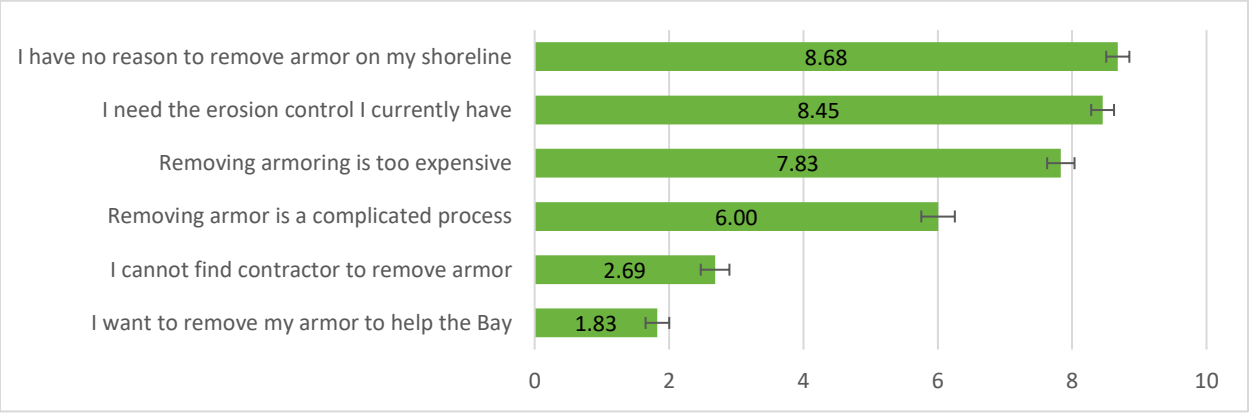


Wanting *to help protect the health of the Bay* was rated as the most important benefit of having a natural shoreline. The next set of statements were related to the convenience of a natural shoreline, where respondents reported that they *did not want to go through a permitting process*, *doing erosion control projects is too expensive*, and *their natural shoreline does not need much care*. Respondents reported some agreement as to whether their natural shoreline *has enough erosion control*, and if *installing erosion control shoreline projects is too complicated.*

Removing Armor

To assess barriers and benefits to removing armor on their property, respondents who had armor were provided a list of statements and asked to rate each one using a scale from *0 (strongly disagree)* to *10 (strongly agree)*.

Figure 11: Barriers and Benefits to Leaving Shorelines Unarmored



The highest ranked barriers to removing armor were that they *have no reason to remove armor* and the perception that they *need the erosion control they have*, followed by that *removing armor is too*

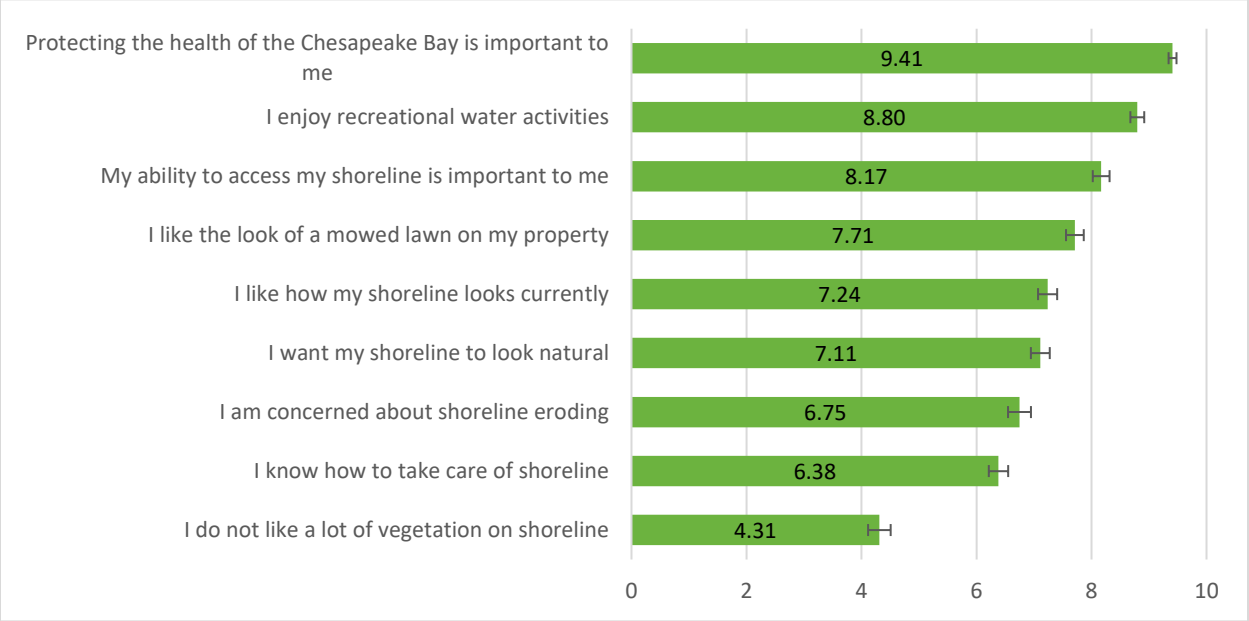
expensive. Respondents somewhat agreed that *removing armor is a complicated process*. Respondents reported low agreement that they *want to remove my armor to help the Bay*.

Attitudes

In this section, we first present the average attitude ratings for the full sample. Next we list the attitudes that were significantly different for those who do and do not have armor. These two groups had significantly different rankings that suggest they may need a different approach to motivating action. Attitudes were also compared by those who live in Maryland and Virginia, but no significant differences were found.

Respondents were asked to rate their agreement with a variety of statements about their shoreline-related attitudes using a scale from 0 *(strongly disagree)* to 10 *(strongly agree).*

Figure 12: Shoreline-Related Attitudes

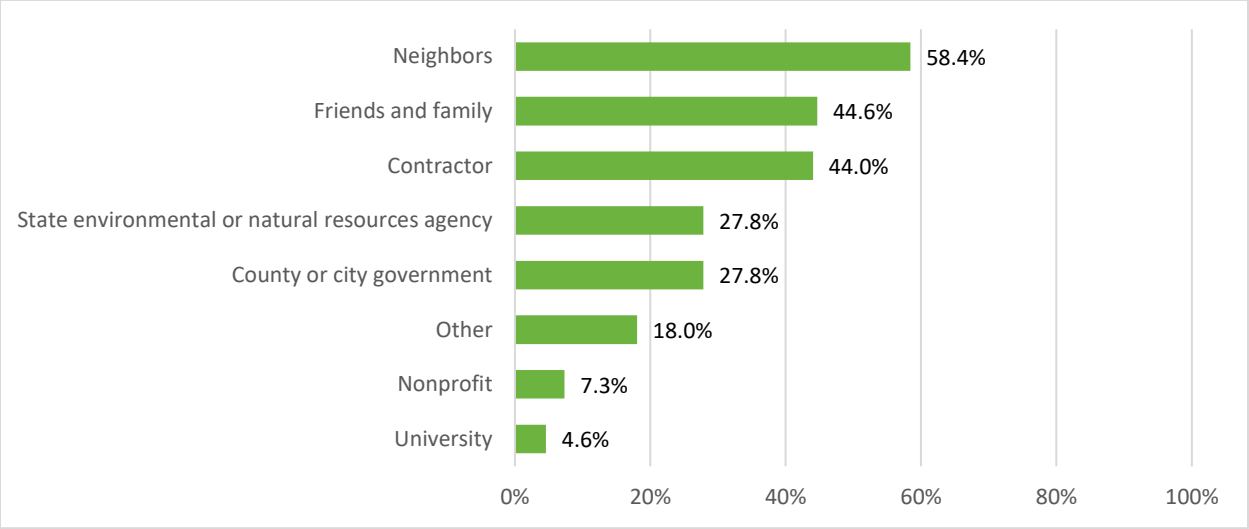


Respondents reported very strong agreement to *protecting the health of the Chesapeake Bay is important to them*, followed by that they *enjoy recreational water activities* and *their ability to access the shoreline is important.* Respondents reported both *liking how their shoreline looks currently* and *wanting their shoreline to look natural*.

Communication

Respondents were asked to indicate which sources of information that they would use when they have questions about managing their shoreline and were allowed to check as many options as they wanted.

Figure 13: Information Sources for Shoreline Management



About half of respondents identified a social connection as a source of information, such as neighbors (58.4%) or friends and family (44.6%), or a contractor (44.0%). Only about a quarter of respondents would use a state agency (27.8%) or their city or county government (27.8%).

Exploratory Analysis

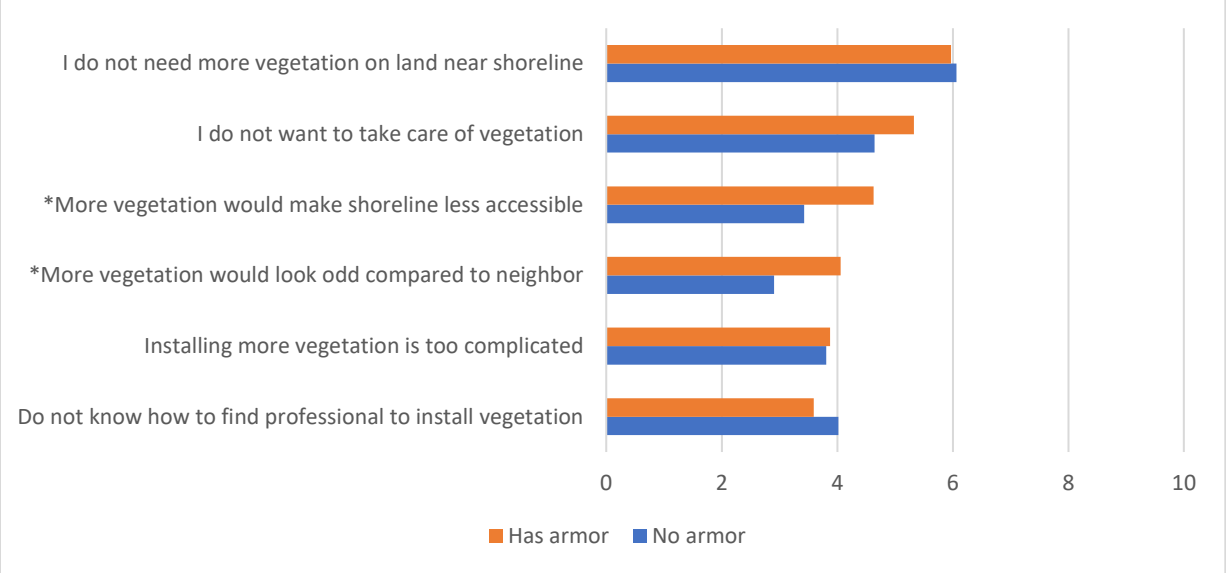
After a review of the overall results, two sets of exploratory analyses were conducted on the barriers and benefits for each behavior and attitudes. First, we compared respondents who do and do not have armor. Properties with armor represent the majority of the target audience and may face additional barriers due to having to remove armor prior to taking any additional action. The results for the respondents who have and do not have armor are shown below.

Next, we compared respondents who live in Maryland to those who live in Virginia, as properties in each state are subject to different laws, culture, and available municipal resources. However, only one significant difference was found for respondents by state, signifying no meaningful differences between the states.

Planting Upland Vegetation

To assess barriers and benefits to planting upland vegetation on their property, respondents were provided a list of statements and asked to rate each one using a scale from *0 (strongly disagree)* to *10 (strongly agree)*. Statements with a statistically significant difference by properties with and without armor are noted using a "*". There were no meaningful significant differences across groups in terms of perceived benefits. The only differences were for the lowest ranked benefits and these differences were small.

Figure 14: Barriers for Planting Upland Vegetation by Armor

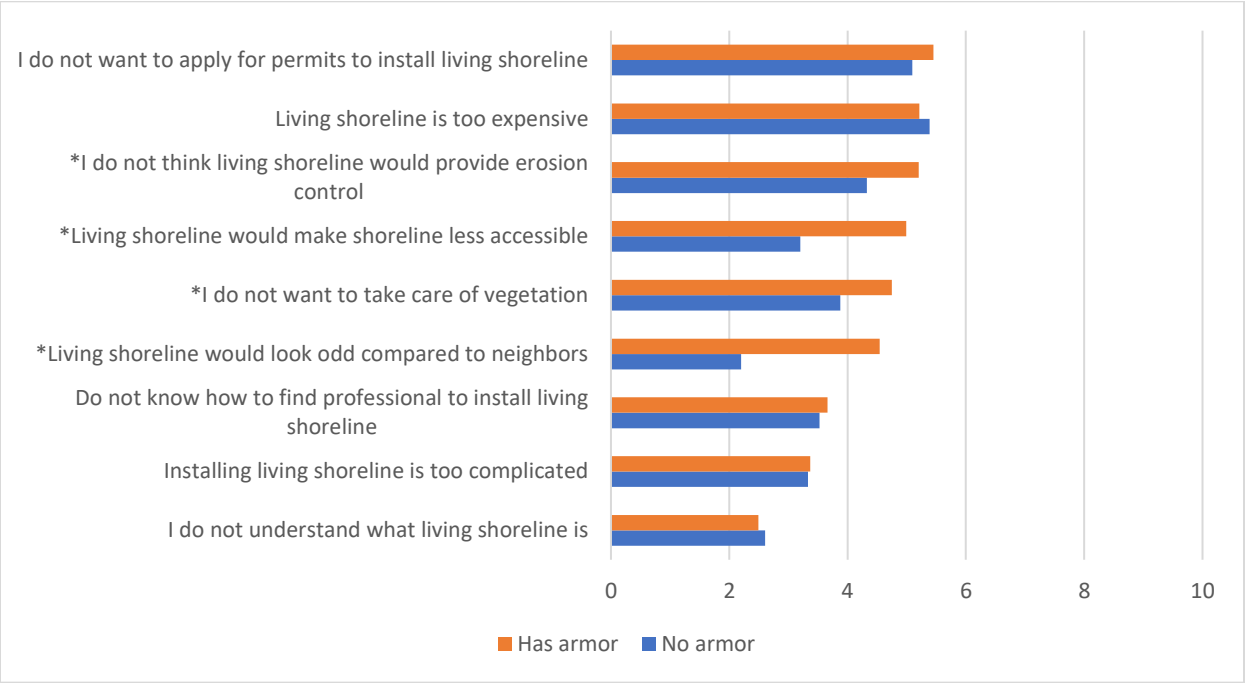


Respondents with armor were more concerned about making the *shoreline less accessible* and *looking odd compared to neighbors.*

Living Shorelines

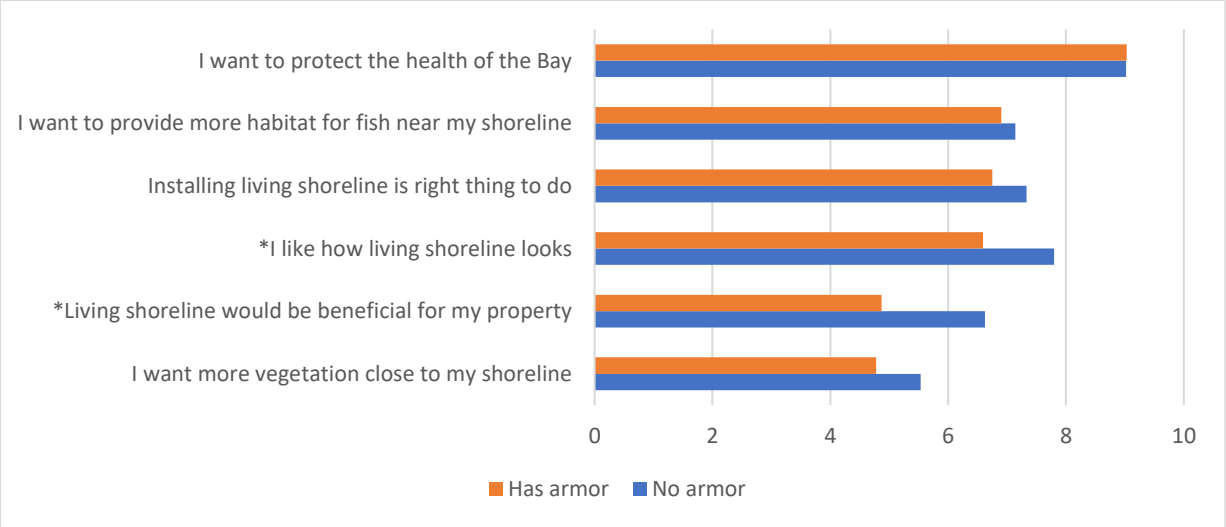
To assess barriers and benefits to installing a living shoreline on their property, respondents were provided a list of statements and asked to rate each one using a scale from *0 (strongly disagree)* to *10 (strongly agree)*. Statements with a statistically significant difference by properties with and without armor are noted with an "*."

Figure 15: Barriers to Installing a Living Shoreline by Armor



Between respondents that do and do not have armor, the largest differences were that respondents with armor had significantly more concerns about *less accessibility* and *looking odd compared to neighbors*. Respondents with armor were slightly more concerned about *sufficient erosion control* and *taking care of vegetation*, but these barriers were still relatively meaningful for both groups.

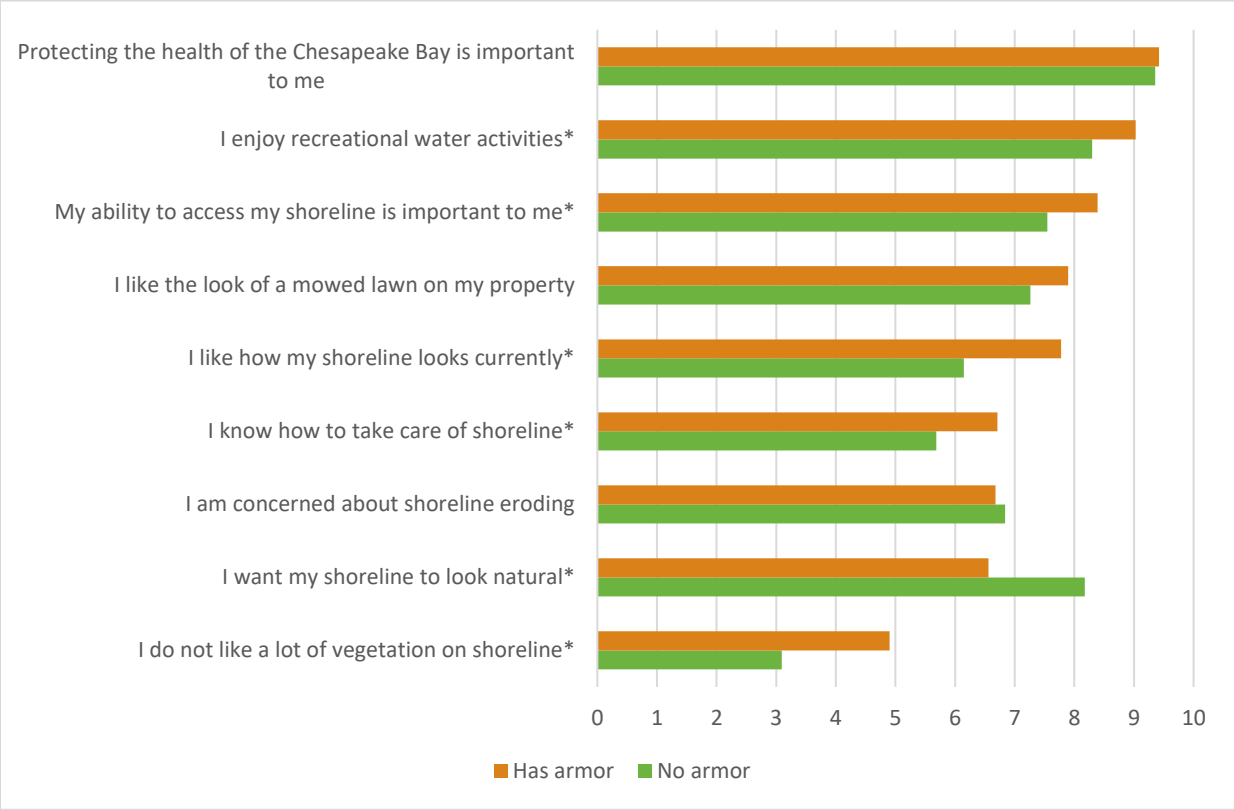
Figure 16: Benefits to Installing a Living Shoreline by Armor



The largest differences in benefits were *liking how a living shoreline looks* and perceiving that a *living shoreline would be beneficial for my property.*

Attitudes

To assess attitudes about their shoreline, respondents were provided a list of statements and asked to rate each one using a scale from *0 (strongly disagree)* to *10 (strongly agree)*. Statements with a statistically significant difference by properties with and without armor are noted using an "*".



Nearly all attitudes were significantly different for properties with armor. The largest differences were in *I like how my shoreline looks, I want my shoreline to look natural,* and *I do not like a lot of vegetation on shoreline.*

Open-ended Responses

Several questions in the survey included an *Other* option, which are listed in in Appendix E. Most of these responses spoke to specific issues for the respondent. In addition, for the communication options, many of the categories had a space to specify which agency, which are listed in Appendix E. Finally, the last question of the survey asked for additional comments. Many of these responses spoke to stories about the respondents property, from the erosion they face to the current structures they have installed. Many requested more information on making decisions or funding projects. These are included in Appendix E.

4: Behavior Selection Table

The survey generated the probability data necessary to complete the behavior selection table. As discussed earlier in the report, the survey item intended to generate penetration data was not used for analysis. It was determined that respondents misunderstood that survey question, as the results were not in alignment with known data (e.g., the number of properties known to have armor)[6]. Final weights were calculated using only the probability data and the weights were updated from the original table. This step involves creating a list of behaviors that are tied to the program goals followed by careful analysis of the extent to which individuals are already engaged in each action (**penetration**), the likelihood of change (**probability**), the associated environmental impact of each behavior (**impact**), along with the proportion of the population to which each behavior applies (**applicability**). The outcome of this step is rank ordering of these behaviors using a weight that considers these four factors.

Table 4: Ranked Behaviors for Further Research

Behavior	Impact[7]	Penetration	Probability	Applicability	Weight[8]
Install buffer (upland/riparian) vegetation	7.39	-	2.72	1	20.12
Living Shoreline - wetland vegetation	7.87	-	1.47	0.8	9.26
Living Shoreline with sills	8.20	-	0.77	0.8	5.06
Leave an unarmored shoreline alone	3.47	-	1	0.8	2.78
Living Shoreline with jetties/groins	7.80	-	0.4	0.8	2.50
Living Shoreline with offshore breakwater	7.94	-	0.39	0.8	2.48

With the addition of the probability data, the installation of upland vegetation moved to the top of the list, followed by living shorelines alone, and living shorelines with sills. Leaving an unarmored shoreline and living shorelines with jetties/groins or with an offshore breakwater were at the bottom of the list. It is important to note there was significant disagreement between experts on the impact on not armoring a shoreline, where some experts rated it as having a high impact and other experts rated it as having no impact.

[6] VIMs GIS data demonstrates that a significant portion of shorelines have armor. Another survey question, which simply asked if respondents do or do not have armor, resulted in two-thirds (68%) of respondents labeled as having armor. Respondents' responses to the penetration question listed that only 17% of respondents had armor. See the Shoreline Management Techniques

[7] Impact = (Erosion*.25) + (Water Quality*.25) + (Habitat*.25) + (Climate Resiliency*.25)

[8] Weight = Impact * (1-Penetration) * Probability * Applicability

5: Conclusions and Recommendations

This research sought to better understand how shoreline property owners perceive and make decisions about their shoreline, as well as their current practices. The results of this research will assist organizations in the Chesapeake Bay region to successfully motivate better shoreline management behaviors. In this section we provide a summary of the findings and associated recommendations for motivating property owners to take shoreline management behaviors that reduce excessive erosion, prevent pollution, enhance habitats, and improve climate resiliency. The most pressing challenge for encouraging each of the behaviors is that property owners reported a fairly low likelihood of engaging in the target behaviors. This suggests that in addition to addressing barriers, any program must have an extra emphasis on enhancing motivation to increase behavioral intentions.

Shoreline Property Owners

To engage in any of the desired behaviors, approximately two-thirds of shoreline property owners will have to first remove armor. Luckily, there was significant overlap between those with and without armor in terms of their barriers and benefits to acting on planting upland vegetation and installing living shorelines. Therefore, we recommend outreach first target unarmored shorelines to keep their shorelines natural, then plant upland vegetation, and finally install a living shoreline. Specific strategies are outline in this section, focusing on building motivation to act through social diffusion and commitment, and reducing barriers to action. At the same time, other groups can begin working on motivating armored property owners to remove their armor. After the programs and outreach for natural shorelines, planting upland vegetation, and installing living shorelines have been piloted and evaluated, they can then be implemented on those properties that have armor that has been successfully removed.

Unarmored Shorelines

While property owners with unarmored shorelines represent a smaller portion of the audience, their shorelines are a lower hanging fruit for promoting behaviors that will lead to significant impact on excessive erosion, water quality, habitat, and climate change resiliency – planting upland vegetation and installing living shorelines. This audience can also easily leave their natural shoreline alone, which respondents reported had significant benefits and few barriers.

First Tier – Leave the Shoreline Alone

The first behavior that can be targeted for unarmored shoreline owners is simply leaving their shoreline alone. The most significant barrier to action is that respondents without armor were *uncertain they have enough erosion control.* Depending on the property and the shoreline management techniques used by neighbors, this may or may not be a misperception.

Research Outcome	Tools	Strategy Options/ Operationalization
Uncertain if they have enough erosion control	Social diffusion	• Work to counter the feeling that armor is the status quo – currently it is the descriptive norm, so work to use principles of injunctive norms. • Identify well-known, well-respected property owners willing to serve as examples of the impacts of not taking action on the shoreline in similar fetch/soil type to customize information for the local community. Use hyper local messaging about projects – show off to that specific community. Where possible focus on properties that are more physically visible. • Most respondents were getting this information through a social contact – such as neighbors or friends and family – suggesting social diffusion will be key, such as through encouraging conversations between neighbors and using phrases such as, “Ask me how.”
Uncertain if they have enough erosion control	Commitment	• Seek public, durable commitments between neighbors, especially contiguous ones, who are interested in leaving their shoreline alone, to commit together.
Uncertain if they have enough erosion control	Education/ Communication	• Provide simple ways to indicate between “normal” and “excessive” erosion that a lay person can understand and notice. • Provide simple, vivid information on how shorelines in their local area can be left alone without causing issues.
Easier and cheaper; Protect health of the Bay	Education/ Communication	• Provide credible, vivid information about how more natural shorelines are the easiest, cheapest choice and protect the Bay, and highlight that many property owners like the look of a natural shoreline.

Second Tier – Plant Upland Vegetation

For those owners who have been willing to keep their shoreline natural, we recommend encouraging those property owners to plant upland vegetation. This behavior also can serve as a "foot-in-the-door" for a living shoreline, the third-tier behavior. When considering adopting a new behavior, particularly a resource-demanding one, individuals are more likely to adopt it if they do not have to fully commit immediately. In a way, planting upland vegetation could be considered a simpler version of a living shoreline. Therefore, upland vegetation could be used as a trial run for a property owner to "test out" more vegetation before committing to a full living shoreline and provide motivation by first getting shoreline property owners to agree to a smaller request.

Research Outcome	Tools	Strategy Options/Operationalization
Look odd compared to neighbors	Commitment	• Obtain further commitment from properties who have committed to keep their shoreline natural, to also plant upland vegetation, and leverage these properties for the social diffusion strategies outlined next.

Look odd compared to neighbors	Social Diffusion	• Identify well-known, well-respected property owners willing to serve as examples of the impacts of planting upland vegetation on the shoreline in similar fetch/soil type to customize information for the local community.
		• Use hyper local messaging about projects – show off to that specific community. Where possible focus on properties that are more physically visible.
		• Most respondents were getting this information through a social contact – such as neighbors or friends and family, suggesting social diffusion will be key, such as through encouraging conversations between neighbors and using phrases such as, "Ask me how."
		• Increase the visibility of the demonstration projects in local areas and providing opportunities for neighbors to talk, such as by creating a publicly shared community shoreline map, divided by geographic sections or neighborhoods, that show where demonstration projects are, with photos of projects and testimonials. As possible, list the characteristics of property – plant types, fetch, soil type.
		• Create a visible component on the property to advertise the action to neighbors and social contacts, such as a lawn sign.
		• To increase the likelihood of success, the project should show how:
		  • It is superior to not having vegetation.
		  • It decreases potential financial loss, such long-term savings.

Perceived lack of need for more vegetation; reduced accessibility; high maintenance	Education/ Communication/ Social Diffusion	• Segment recommended plants by traits of concern (easier maintenance plants, higher impact, more accessible). • Address the other perceived negative impacts (accessibility, maintenance) by making demonstration projects have plants that are low-maintenance and accessible, and

		promote positive impact on the health of the Chesapeake Bay, and create testimonials to pair with project photos that specifically address these concerns.
Protect health of the Bay, right thing to do, prevent erosion	Education/ Communication/ Cognitive Dissonance	• Provide credible, vivid information about how planting upland vegetation is the right thing to do, prevents erosion, and protects the Bay, and highlight that many property owners like the look of a natural shoreline. • Consider framing message as someone who values the shoreline, the Bay, and the services it provides – would you not want to keep your shoreline in a way that promotes that?

Third Tier – Living Shoreline

For those owners who have been willing to plant upland vegetation, we recommend then encouraging those property owners to install a living shoreline. As mentioned above, we recommend that planting upland vegetation serves as a "foot-in-the-door" for installing a living shoreline. Overall, we also recommend that any outreach of programs should consider working more hands-on with shoreline owners rather than broad messaging to assist with motivation through the entire process, given the complexity of and low motivation toward the behavior.

Research Outcome	Tools	Strategy Options/Operationalization
Do not want to apply for permits	Convenience	• Where possible, either simplify the permitting process, provide a step-by-step guide, or provide staff assistance to complete forms. • Consider working more hands-on with shoreline owners rather than broad messaging to guide them through the permitting process.
Expensive	Incentives	• Promote the existing programs or create new programs to provide incentives to cover portions of the cost.
Look odd compared to neighbors	Commitment	• Continue building on the commitments from tier-one and tier-two actions to leverage into self-perception as a property owner who would take these actions.
Look odd compared to neighbors	Social diffusion	• Identify well-known, well-respected property owners willing to serve as examples of the impacts of living shorelines on the shoreline in similar fetch/soil type to customize information for the local community. Build connections between their neighbors, especially contiguous ones, who are interested in living shorelines, to take action together. • Use hyper local messaging about projects – show off to that specific community. • Most respondents were getting this information through a social contact – such as neighbors or friends and family, suggesting social diffusion will be key, such as through encouraging conversations between neighbors and using phrases such as, "Ask me how." • Increase the visibility of the demonstration projects in local areas and providing opportunities for neighbors to talk, such as by creating a publicly shared community

		shoreline map, divided by geographic sections or neighborhoods, that show where demonstration projects are, with photos of projects and testimonials. As possible, list the characteristics of property – plant types, fetch, soil type.
		• Create a visible component on the property to advertise the action to neighbors and social contacts, such as a lawn sign.
		• To increase the likelihood of success, the project should show how:
		  • It is superior to not having vegetation.
		  • It decreases potential financial loss, such as by providing long-term savings.

Living shorelines would not provide sufficient erosion protection	Education/ Communication/ Social Diffusion	• Provide simple ways to indicate between "normal" and "excessive" erosion that a lay person can understand and notice. • Address erosion impacts by making demonstration projects in similar fetch and soil type and use time spaced photos to demonstrate a lack of significant erosion and create testimonials to pair with project photos that specifically address erosion concerns.
Reduced accessibility; high maintenance	Education/ Communication/ Convenience	• Create localized geographic tool to summarize what non-invasive vegetation choices achieve these goals, such as height of growth, spread, root depth, expected maintenance schedule, etc. • Remove step of deciding what plants to use to address these concerns – make a short list of recommendations to make it easier and avoid mistakes that lead to reduced accessibility • Address the other perceived negative impacts (accessibility, maintenance) by making demonstration projects have plants that are low-maintenance and accessible, and promote positive impact on the health of the Chesapeake Bay, and create testimonials to pair with project photos that specifically address these concerns
Protect health of the Bay, create habitats	Education/ Communication/ Cognitive Dissonance	• Provide credible, vivid information about how installing living shorelines creates habitats and protect the Bay and highlight that many property owners like the look of a natural shoreline. • Consider framing message as someone who values the shoreline, the Bay, and the services it provides – would you not want to keep your shoreline in a way that promotes that?

Armored Shorelines

Armored shorelines represent a larger portion of the audience; however, prior to engaging in any of the tiered behaviors, currently armored shoreline property owners must first take a preliminary action, removing their armor, prior to moving through Tier 1 to 3. The action of armor removal on its own presents a significant challenge – participants reported significant barriers, and few benefits, to removing their armor. Moreover, when respondents were compared between armored and unarmored shorelines on their attitudes toward their shoreline, those with armored shorelines were much more likely to agree that they *like how [their] shoreline looks* and *do not like a lot of vegetation on shoreline,* and significantly less likely to agree that they *want [their] shoreline to look natural*. These attitude differences, in addition to the higher rating of several barriers to planting upland vegetation and installing a living shoreline, and the difficulty of armor removal, suggest that this audience will be more challenging to motivate. These difficulties are why we suggest first developing and piloting a program with unarmored shoreline property owners. This will allow for refinement and improvement prior to tackling this more difficult audience. In addition, the currently unarmored properties that are successfully converted will work toward a creating more avenues for social diffusion, and ultimately toward a social norm of keeping shorelines natural, planting upland vegetation, and installing a living shoreline. Overall, we also recommend that any outreach programs should consider working more hands-on with shoreline owners rather than broad messaging to assist with motivation through the entire process, given the complexity of and low motivation toward the behavior.

Tier 0 - Remove Armor

Research Outcome	Tools	Operationalization Options
No reason to remove armor	Social diffusion	• Identify well-known, well-respected property owners willing to serve as examples of the impacts of removing armor on the shoreline in similar fetch/soil type to customize information for the local community. Build connections between their neighbors, especially contiguous ones, who are interested in removing armor to take action together. This will be key both in spreading the action via diffusion and due to the fact that removing armor can have more negative impacts if contiguous neighbors do not take action as well. • Use hyper local messaging about projects – show off to that specific community. • Most respondents were getting this information a social contact – such as neighbors or friends and family, suggesting social diffusion will be key.
Perceived need armor's erosion control	Education/ Communication/ Social diffusion	• Provide simple ways to indicate between "normal" and "excessive" erosion that a lay person can understand and notice. • Address erosion impacts by making demonstration projects in similar fetch and soil types and use time spaced photos to demonstrate a lack of significant erosion and create

		testimonials to pair with project photos that specifically address erosion concerns.
Too expensive	Incentives	• Promote the existing programs or create programs to provide incentives to cover portions of the cost.
Protect health of the Bay	Education/ Communication/ Cognitive Dissonance	• Provide credible, vivid information about how removing armor protects the Bay. • Consider framing message as someone who values the shoreline, the Bay, and the services it provides – would you not want to keep your shoreline in a way that promotes that?

Recommended Next Steps

Based on the strategy tables, we recommend the following to adapt these operationalization options into the context of the Chesapeake Bay Program (CBP) and the diversity of organizations working to improve the health of the Chesapeake Bay.

We recommend that CBP develop a toolkit that various organizations across the watershed can customize and use within their own communities to motivate property owners through the tiered behaviors. This toolkit would serve as an "umbrella" brand, having one overall name and feel that can be customized locally but still exist under this larger brand. For example, the toolkit would have a name such as "Bay Protectors" that is "a division of CBP," but individual communities would be able to call it "[Community Name] Bay Protectors." This is not meant to be a final name recommendation, but an illustration of how this type of branding could work.

Suggested Toolkit Elements

The toolkit could include elements such as:

- Customizable:
    - Outreach materials for residents, such as materials on plant types and erosion identification.
    - Commitment collateral options to engage neighborhoods/neighbors in tiered actions, such as pledge forms or lawn signage.
    - Social media posts.
    - Branding/logo across all material (including a style guide).
- Instructional document on:
    - Identifying early adopters/spokespeople for social diffusion.
        - Including both digital and non-digital options, such as:
            - Social media (such as, how to conduct a FB campaign to collect contact information of interested parties).
            - Talk to permitting agency, local nature/related topic groups, and local government.
        - How organizations can train early adopters to communicate with other property owners about the outreach, commitment, and behaviors, such as language to use ("Ask me how").
    - Framing incentive programs to increase uptake.

    - Using GIS for mapping projects to demonstrate current projects
    - Creating effective testimonials/case studies.
    - General program implementation.
- CBP Website landing page for the "toolkit"
    - It will use visual and brand consistency across the website and the tools.
    - It will include a social media presence to recognize broader community participation and share their results.

We recommend that once these elements are created, they are tested on a small-scale (one to three months) in one to three communities in the Chesapeake Bay region to be further refined prior to larger scale implementation. This pilot could be evaluated through a mail survey of knowledge and behavioral intentions, as well as the level of participation in the program elements, as the small-scale is not long enough for an evaluation of installation of vegetation. Once the toolkit is released more broadly, it should include further, longer-term evaluation of actual behavior change to continue to refine programs, address any additional barriers, and reflect the current context (such as changing recommended vegetation or climate change adaptation needs).

As possible, the toolkit should include low, medium, and higher cost versions of the program – if an organization only has X resources, what are the most important elements to include? Prioritization of these elements could be determined through the small-scale pilot testing.

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Appendix A: *Shoreline Management Literature Review* memo

Purpose

The goal of this literature review is to set the foundation for research to improve shoreline management in the Chesapeake Bay. The review focused on living shorelines, removing existing armoring, planting vegetation, and leaving shorelines untouched/unarmored. The goal of improving shoreline management is primarily reducing erosion and the associates impacts, with secondary emphasis on improving habitat, reducing water pollution, and mitigating the impacts of climate change.

Background

The Chesapeake Bay consists of more than 150 rivers and streams. The watershed covers approximately 64,000 square miles over six states. The Bay itself covers about 200 miles and ranges in width from 3.4 miles to 35 miles, with its widest point near the mouth of the Potomac River (Feather, 2008). The Bay and its tidal tributaries have approximately 11,600 miles of shoreline, the majority of which is privately owned. Over 10 million people are currently living on or near the shoreline, and approximately 150,000 people move into the Bay watershed every year (Chesapeake Bay Program, 2019b). With this increasing population, and the associated development and the impact from increased recreation, shoreline erosion is a significant concern in the region.

Impacts of Erosion

Shoreline erosion is primarily caused by waves and is aggravated by the rate of sea-level rise, though it can also be accelerated by many human activities, such as dredging and coastal population increase (Ator, Brakebill, & Schwarz, 2013; Living Shoreline Summit, 2006a). In addition, the soil composition (e.g., sand, silt, and clay content) and presence of vegetation influence the erodibility of the shoreline (Watershed Technical Work Group, 2017). Erosion reshapes the shoreline, threatening coastal property and the infrastructure on it. According to a Heinz Center study, erosion will claim 25% of all homes within 500 feet of a shoreline by 2060 (Living Shoreline Summit, 2006c). In an economic analysis, Bay shoreline erosion results in up to a 17% decrease in property value (Feather, 2008).

Erosion also negatively affects marine life through sediment pollution. Excess sediment is a key contributor to degraded water quality and damages critical habitats (e.g., oyster bars) and living creatures (shellfish, finfish, and waterfowl). Suspended sediment also reduces the amount of light available to submerged aquatic vegetation (SAV) (Nutrient Subcommittee Sediment Workgroup, 2005). The Army Corps of Engineers has estimated that for every dollar spent to control tidal erosion, up to $1.75 is returned to the economy in the form of improvements to resources, including SAV, fish, benthic organisms, shellfish, waterfowl, and wetland habitat (Nutrient Subcommittee Sediment Workgroup's Tidal Sediment Task Force, 2005).

Mitigating the Impact of Erosion

Property owners are seeking solutions to manage their shorelines and combat erosion. Shoreline management can be defined as any tidal shoreline practice that prevents and/or reduces tidal sediments entering the Bay. Proper management can have other positive impacts, such as habitat improvement and storm protection (Watershed Technical Work Group, 2017). The most common shoreline management technique used is shoreline hardening, through installation of bulkheads, seawalls, and revetments.

The Issue of Shoreline Hardening

Many costal property owners across the Chesapeake Bay have chosen to harden their shoreline, with some estimates suggesting that 1,700 miles of the Virginia and Maryland coastline have already been hardened (Chesapeake Bay Program, 2009a). Armoring the shoreline has myriad negative impacts, from removal of shallow habitat to chemical leeching, that affect both water quality and a variety of aquatic animal populations (Watershed Technical Work Group, 2017). As the percentage of hardened shoreline increases, the populations of aquatic species in the Bay decreases, from blue crabs to Atlantic croakers to various benthic species (NOAA, 2017). In addition, hardened shorelines tend to be less effective at storm protection and erosion control than more natural approaches. The divergent efficacy of these two approaches would be especially noticeable over the long term, as the living shoreline vegetation grows roots and becomes more established, compared to a hard shoreline that requires repairs and ultimately replacement (Gittman, Popowich, Bruno, & Peterson, 2014; NOAA, 2015).

Despite the negative effects, property owners in the Bay continue to harden their shorelines. Some experts believe this is due in part to a greater familiarity with shoreline armoring for both contractors and property owners, as well as a normalization of armoring as the prevalence increases (Living Shoreline Summit, 2006a). If shoreline hardening continues at the current rate of 200 km/year, nearly one third of the contiguous US shoreline is expected to be hardened by 2100 (NOAA, 2015). Organizations around the country are seeking solutions to empower and motivate property owners to adopt methods other than shoreline armoring to prevent erosion while protecting natural resources.

Living Shorelines

Another method for shoreline management is to install a living shoreline, defined as planting vegetation and/or placing using natural materials for stabilization (e.g., rocks, reef balls). On beaches or mudflats, or those with low fetch (wave energy), native grasses can be planted. These techniques work best in areas where marshes and grasses have been found in the past. Where the fetch is greater, man-made structures may be required to lessen wave energy (Living Shoreline Summit, 2006a).

Types of Living Shorelines

Living shorelines can also be called nature-based, green, or soft shorelines. Some living shorelines may be hybrid solutions with a mix of natural (e.g., oyster shell) and nature-based materials (e.g., reef balls or rocks), while others are entirely natural (NOAA, 2015). The primary characteristic is that they do not create an impenetrable barrier between the land and water, meaning they maintain the continuity of the land-water interface. See Figure 1 for the range of living shoreline types.

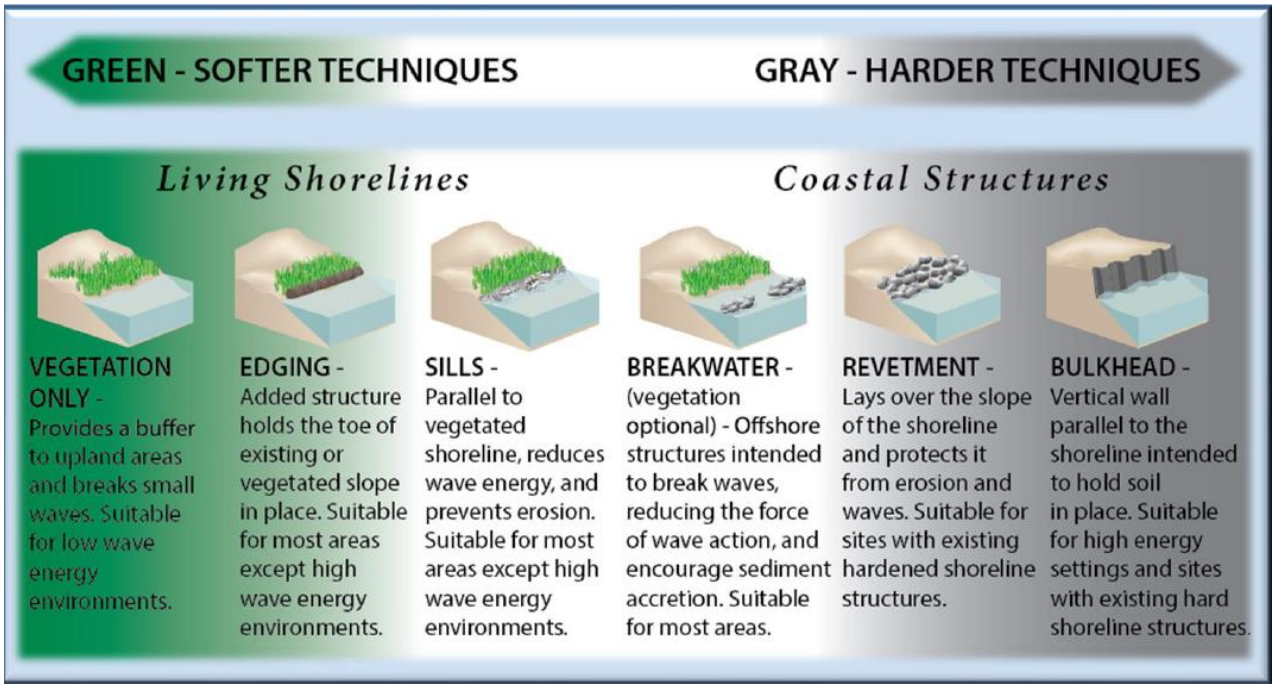

Figure 17: Spectrum of Living Shorelines (NOAA, 2015)

Benefits of Living Shorelines

Living shorelines reduce damage and erosion while providing ecosystem services, including food production, nutrient removal, and water quality improvement (NOAA, 2015). Living shorelines improve water quality by settling sediments and filtering pollution. A living shoreline creates shallow water habitat, which serves as a critical space for aquatic animals and vegetation. Living shorelines also provide shade to keep water temperatures cool, increase oxygen levels for fish and other aquatic species, look natural rather than artificial, and absorb wave energy (Chesapeake Bay Foundation, 2007). Some resources suggest they can be less costly than wooden bulkheads and rock walls, especially in the long term, though this is often property context dependent (Chesapeake Bay Foundation, 2007). During large storms, other research has shown that significant erosion occurred both in front of, and behind bulkheads, while living shorelines experienced a net gain of sediments (NCCCO, 2004).

Challenges with Living Shorelines

However, living shorelines are not appropriate for all properties, and can present challenges for landowners. Living shorelines are not sustainable in some locations, such as those with particularly high fetch. In addition, depending on how they are constructed, living shorelines may not be able to reduce damage from flooding and storm surges to the degree property owners want (NOAA, 2015). Overall, installing a living shoreline can be a complex decision for a property owner, requiring broad understanding of their property or the help of experts, potentially several governmental permits, significant cost, and long-term maintenance.

Complexity

Property owners need to understand many factors and pieces of information to be able to decide if a living shoreline is appropriate for their property, and if so, what type. As outlined by NOAA, the living

shoreline decision-making process has twelve overarching questions, each of which has varying degrees of complexity. For example, to answer question one, "what are the physical site conditions," the property owner must consider factors such as: the fetch, the erosion rate, bank type, current vegetation, boat traffic, current shore use, and other factors (NOAA, 2015; Living Shoreline Summit, 2006b). It is likely that understanding and answering all of these questions is beyond the ability of most property owners. NOAA suggests that a living shoreline design should be developed in consultation with regulatory staff, a coastal contractor, and other coastal specialists (e.g., engineer or biologist) if possible (NOAA, 2015). While these experts can simplify the process, a property owner must find, hire, and pay these experts, which can be a complex process as well.

Permitting

The Chesapeake Bay Foundation also has a stepwise process for installing a living shoreline, which specifically highlights the challenges around getting a permit, which they suggest may take over four months (Chesapeake Bay Foundation, 2007). Permitting for a living shoreline can be complex,-sometimes requiring permits at more than one governmental level, as well as a site visit. Perpetually understaffed government agencies may prevent a timely review, with the permitting process extending into six months or longer (Living Shoreline Summit, 2006b; Virginia Institute of Marine Science, 2017). The state of Maryland does have the New Tidal Wetland Regulations for Living Shorelines, which states that property owners must use nonstructural methods for erosion control unless they obtain a waiver, which could push owners toward a living shoreline, but Virginia and Delaware do not have similar regulations (Maryland Department of the Environment, 2013).

Cost

Moreover, while some living shorelines are more cost effective than hardened shorelines, living shorelines can still be quite costly, depending on what is needed. Grants are available, which can assist with costs but add more burden of effort to the property owner (Chesapeake Bay Foundation, 2007). Work in the Elizabeth River watershed in the Chesapeake showed that cost was the primary concern property owners had about living shorelines, followed by permitting (Shaw, N.d.).

Maintenance

Maintenance can also be a concern for living shorelines. NOAA notes that maintenance is critical for the success of a living shorelines project. This can include tasks such as: replanting vegetation, trimming tree branches, removing debris, removing invasive species, and monitoring the effectiveness and habitat function (NOAA, 2015).

Other Avenues of Shoreline Management

Overall, if the complexity, permitting, cost, and maintenance of a living shoreline is too high, landowners will likely drop out of the process and default to armoring their shorelines. Furthermore, installing full living shorelines may be more than what is necessary for some properties, if their erosion potential is low. Research suggests that there are other behaviors landowners can take to reduce erosion, protect their shoreline, and increase habitat without a full living shoreline. However, less research exists on each of these techniques, and they may have a lower potential to reduce erosion, which is the primary goal of this work.

Action Research

Remove Current Armoring

For properties with current armoring, they may be able to remove the current armoring, even if no further work is done. While armoring a few small sections of shoreline may have only small-scale adverse impacts, armoring larger areas of shoreline causes changes to occur to the coastal ecosystem and services they provided (NOAA, 2015). For example, installing bulkheads usually increases nearshore erosion, and can increase erosion on adjoining properties (Nutrient Subcommittee Sediment Workgroup's Tidal Sediment Task Force, 2005). Therefore, landowners can improve the health of the Bay by removing their property's armoring, if their property has low to moderate erosion potential. For example, properties along tidal creeks, small tributary rivers, and main tributary estuaries, those with a high bank, those with more solid soil, and with average fetch exposures of 5 nautical miles or less, resist erosion (Hardaway & Byrne, 1999). Property owners may be unnecessarily hardening their shoreline as they see other surrounding properties with hardened shorelines not realizing their own shoreline does not need the same level of shoreline protection (Nutrient Subcommittee Sediment Workgroup's Tidal Sediment Task Force, 2005; Colehour + Cohen et al, 2019b). One primary challenge with this behavior is identifying properties where armoring can be removed and understanding before doing so whether a living shoreline or other measure will be needed in its place.

Plant Native Species

As shown in Figure 1, living shorelines can involve a variety of natural and manmade installations, generally with a preference for a greater proportion of natural components, both in their contribution to habitat and in their ability to increase in stability over time, rather than being worn away (NOAA, 2015). However, if a property owner is unwilling or unable to install a full living shoreline project, or if a full project is not appropriate for their property's context, it may make sense for the landowner to simply increase the number of native plants on their property. Installing and maintaining a vegetated buffer along the shoreline can improve strong root systems to prevent erosion and preserves shoreline habitats for fish and wildlife (Amato, et al., 2015; Colehour + Cohen et al., 2019b). Planting native vegetation may increase erosion prevention at a fairly low cost, and no permits are required unless fill is introduced or damaging equipment is required (Chesapeake Bay Foundation, 2007). However, for medium/high wave energy properties, other hard structures, such as sills or breakwaters, may be necessary for any vegetation to survive placement (Chesapeake Bay Foundation, 2007; NOAA, 2015). Overall, planting vegetation may be a technique to reduce erosion, but as with living shorelines and removing shoreline armor, its relevance and effectiveness will be property context dependent.

Do Nothing

For properties where a full living shoreline is not appropriate or desired, and the property is not currently armored, doing nothing to shoreline may be a beneficial behavior. For example, if the erosion is low, simply leaving the property unarmored may provide the most benefit for both the property owner, the property, and the Bay as a whole, as armoring can create more erosion as discussed in the *Removing Armoring* section (Nutrient Subcommittee Sediment Workgroup's Tidal Sediment Task Force, 2005). In fact, depending on the property's level of erosion and other geological and current vegetation contexts, proactive erosion control techniques may not be necessary. For example, if the property has low erosion potential and has existing vegetation, additional investment in erosion techniques may not yield a good return on investment (Chesapeake Bay Foundation, 2007; Hardaway & Byrne, 1999). Maintaining original native vegetation is superior to clearing and planting, as original topsoil and root structure are more

resilient to erosion and provide denser vegetation for habitat (Colehour + Cohen et al., 2019b). Doing nothing can also be related to not overly maintaining or changing the property, such as cutting or removing native vegetation (Amato, et al., 2015).

Research Gaps

After this literature review, the next step is to address research gaps using surveys with local shoreline management experts. These surveys will focus on the following identified gaps.

Applicability of Behaviors

Overall, the best choice of erosion control may be most dependent on the property's characteristics and set up, as well as the erosion, environmental, and shoreline impacts. While there are clear advantages to a living shoreline installation, the project may be beyond the needs of some properties. One research gap is creating a better understanding of how many properties would benefit from the various erosion control actions, which will help guide whether a program would yield a greater on investment from broad outreach or from more targeted communications (e.g., if only a small percentage of properties can install a living shoreline, it may be more advantageous to directly target those properties).

Prioritization of Behaviors

While there are clear and significant erosion control and ecological benefits to a living shoreline, the barriers may prove prohibitive property owners, reducing the probability to act. There are other actions property owners could take to reduce erosion, depending on their property's unique features, such as removing their armoring, planting some native vegetation, and doing nothing. However, it is not well understood what the prioritization of these actions should be, nor whether property owners are likely to, or are already taking these actions. This understanding will increase through surveys of local shoreline management experts.

Additional Methods of Shoreline Management

Finally, there may be other actions property owners could take to reduce erosion that local shoreline management experts would identify that did not show up in this literature review. Input will be requested from experts regarding on any other behaviors they feel property owners could be taking to reduce erosion.

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Appendix B: *Shoreline Management Expert Survey Results* memo

Background

Action Research is working with the Chesapeake Bay Program and other stakeholders to develop community-based social marketing (CBSM) strategies that will engage coastal property owners in shoreline management actions. CBSM brings together knowledge from the field of social marketing with a variety of behavior change "tools" drawn from social psychology, environmental psychology, and other social sciences. CBSM involves five steps:

1. Selecting which behavior(s) to target;
2. Identifying the barriers and benefits to the selected behavior(s);
3. Developing a strategy that reduces the barriers to the behavior(s) while simultaneously increasing the benefits;
4. Pilot testing the strategies; and,
5. Broadly implementing and evaluating the most cost-effective strategies from the pilot tests.

This project is currently at **Step 1: Selecting Target Behaviors**. This step involves creating a list of behaviors that are tied to the program goals followed by careful analysis of the extent to which individuals are already engaged in each action (**penetration**), the likelihood of change (**probability**), the associated environmental impact of each behavior (**impact**), along with the proportion of the population to which each behavior applies (**applicability**). The outcome of this step is rank ordering of these behaviors using a weight that considers these four factors.

Purpose

The present memo summarizes the findings of a research effort to determine the relative **impact** of 11 shoreline management actions on: (1) excessive erosion; (2) water quality; (3) habitat; and (4) climate change resiliency as well as the applicability of each action to shoreline properties. An initial list of 11 shoreline management behaviors was developed using a literature review and the expertise of the steering committee. The behaviors are listed below. The goal was to prioritize 3 to 6 of the most highly impactful and applicable behaviors. The highest ranked behaviors will be promoted for further research to determine their penetration and probability, as well as the barriers (challenges) and benefits (motivators) to action. The data in this report reflects the opinions of multiple experts, averaged together, and presented with standard deviation error bars to reflect the variability of the data. We also had conversations with several experts to better understand their opinions.

Behavior List

We created the following behavior list through a review of shoreline management literature and outreach, as well as consultation with shoreline management experts.

1. Leave an unarmored shoreline alone - let it erode, accrete, or stay neutral
2. Install beach nourishment (non-structural)
3. Install armor – groins with no vegetative component (structural)
4. Install armor – jetties with no vegetative component (structural)
5. Install armor – breakwater with no vegetative component (structural)

6. Install armor - revetment with no vegetative component (structural)
7. Install buffer (upland/riparian) vegetation
8. Install living shoreline (LS)– jetties/groins with wetland vegetation (structural)
9. Install living shoreline (LS) – offshore breakwater with wetland vegetation (hybrid)
10. Install living shoreline (LS)– sills with wetland vegetation (hybrid)
11. Install living shoreline (LS) – slope grading/vegetation (non-structural)

Impact Survey

We administered a survey to shoreline management experts in the Maryland, Virginia, and Delaware regions. The first section of the survey asked about the respondent, including:

- Job title;
- Years of employment;
- Years of expertise in shoreline management;
- States in which they work; and,
- Special shoreline training.

We asked the experts to rate each behavior on its potential impact on excessive erosion, water quality, habitat, and climate change resiliency (defined in Table 1). These impacts were rated on a 0 to 10 scale, with "0" being no impact and "10" being the highest level of impact. The final section focused on other methods of shoreline management and requested data about how many properties can likely take these different actions. The full survey is available in Appendix A.

Table 5: Definition of Impact Types

Impact Type	Definition
Excessive Erosion	Property loss or infrastructure damage caused by or resulting from water and/or wind
Water Quality	Preventing excessive nitrogen, phosphorus, and sediment from entering the watershed
Habitat	Increasing the amount of ecosystem area for birds, fish, and other wildlife
Climate Change Resiliency	Increasing the ability of the shoreline to adjust over time to climate changes and continue providing ecosystem services

Participant Information

There was a total of 15 respondents. Participants had a range of titles which included Natural Resources Planner, Restoration Coordinator, Director, and Professor. They had worked in their job for an average of 8.3 years (range: 3 years to 21 years), with an average of 13.5 years of experience in shoreline management (range: 3 years to 34 years). The majority (75%) had received some specific shoreline management training, including webinars, seminars, and courses. Most of the participants worked in Maryland (69%), followed by Virginia (13%), the Mid-Atlantic (6%), and Delaware (6%).

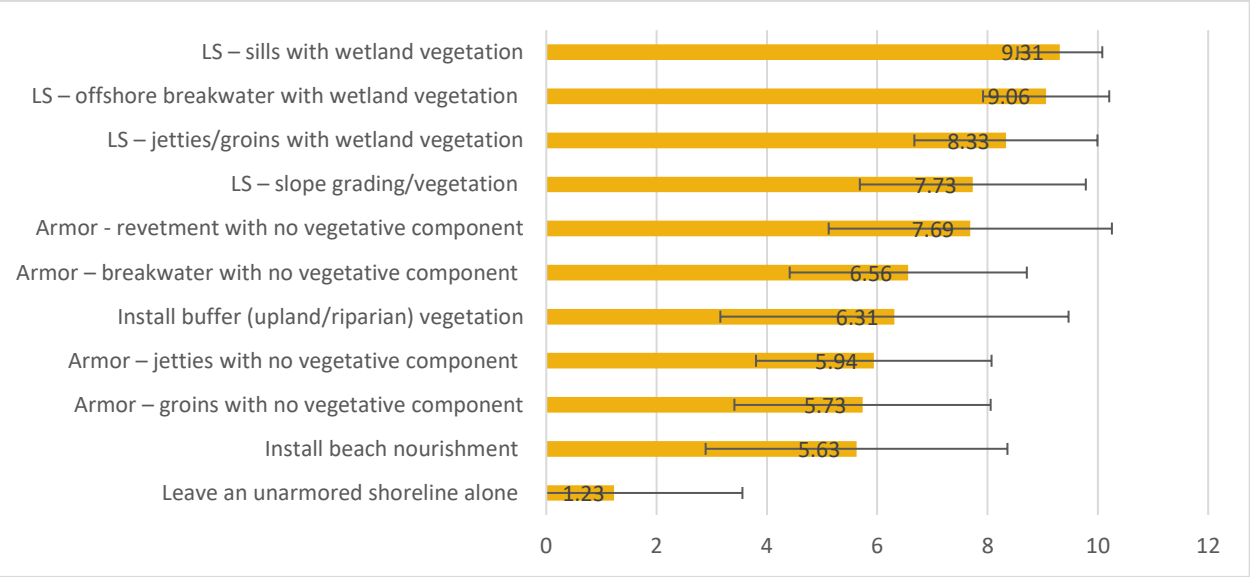
Erosion

Using a scale from 0 to 10, where "0" means *no impact* and "10" means *significant impact*, participants rated the impact of each of the actions would have on **reducing excessive erosion** of a shoreline property.

Action Research
Participants were instructed to assume that for each action the location was appropriate, and the project was well designed.

It is important to note that erosion is a particularly complex impact to assess. Erosion is a natural process, where some degree of erosion is necessary for the health of the property and the Chesapeake Bay. Furthermore, what is considered "**excessive erosion**" is open to interpretation and varies by context. Therefore, participants may have rated each of the actions differently, depending on their assumptions. This is true for any assessment of impact and underscores the importance of averaging the views of multiple experts rather than relying on only one perspective or a group consensus.

Figure 18: Mean Rating for Erosion Impact

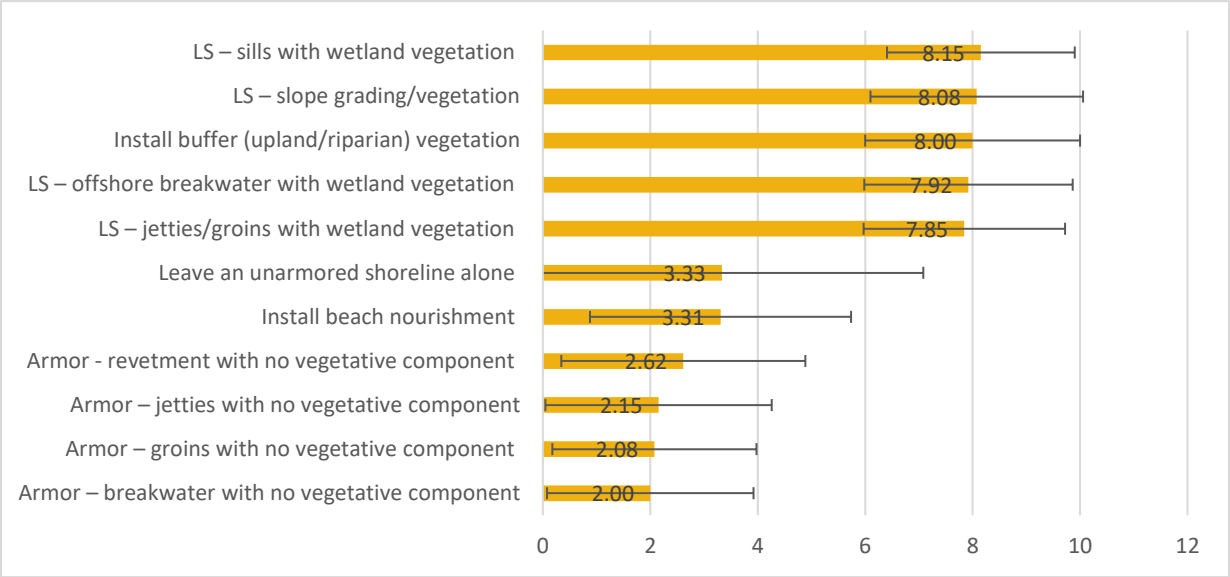


All living shoreline behaviors were at the top of the excessive erosion impact list, with the *LS – sills with wetland vegetation* and *LS – offshore breakwater with wetland vegetation* also having lower variability (shown through the standard deviation error bars). The suite of armoring behaviors fell in the middle, with beach nourishment and unarmored shorelines rated least impactful on erosion control. As is seen in the chart, the ratings for most behaviors were highly variable, which speaks to the challenges with assessing erosion.

Water Quality

Using a scale from 0 to 10, where "0" means *no impact* and "10" means *significant impact*, participants rated the impact of each of the actions would have on **improving water quality**. Participants were instructed to assume that for each action the location was appropriate, and the project was well designed.

Figure 19: Mean Rating for Water Quality Impact

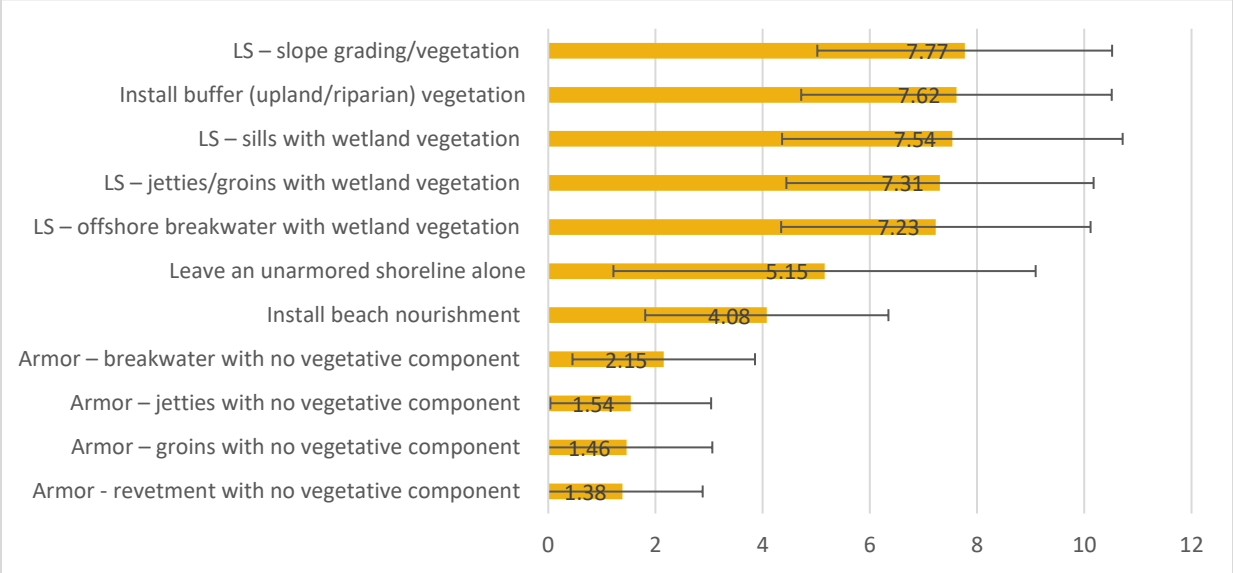


As with erosion, the living shoreline behaviors were rated most highly, with upland/riparian vegetation placing in the top grouping. All armor-related behaviors were at the bottom for water quality impact. *Leaving the shoreline alone* and *installing beach nourishment* increased to the middle as compared to their rating for erosion control, with greater variability for leaving the shoreline alone.

Habitat

Using a scale from 0 to 10, where "0" means *no impact* and "10" means *significant impact*, participants rated the impact of each of the actions would have on **improving habitat.** Participants were instructed to assume that for each action the location was appropriate, and the project was well designed.

Figure 20: Mean Rating for Habitat Impact



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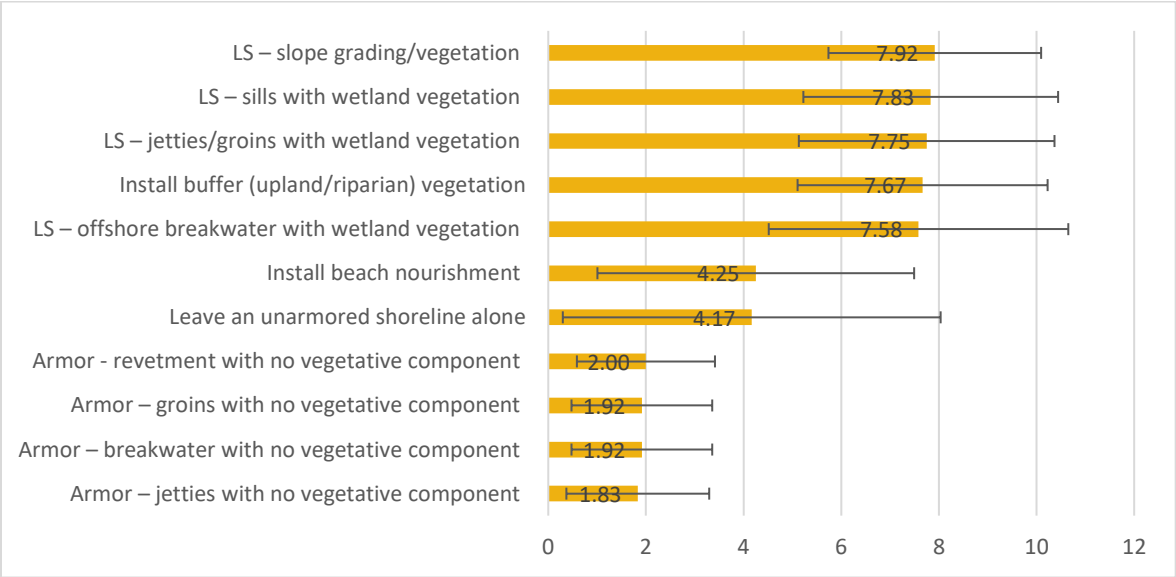
Again, reflective of the patterns with water quality impact, the living shoreline behaviors were at the top of the habitat impact ratings, with upland/riparian vegetation also in the top grouping. However, the living shoreline behaviors and the upland/riparian vegetation behaviors were more variable for habitat impact than they were for water quality. All armor behaviors were at the bottom. Leaving the shoreline alone and installing beach nourishment were in the middle, with greater variability for leaving the shoreline alone.

Climate Resiliency

Using a scale from 0 to 10, where "0" means *no impact* and "10" means *significant impact*, participants rated the impact of each of the actions would have on **climate resiliency**. Participants were instructed to assume that for each action the location was appropriate, and the project was well designed.

Figure 21: Mean Ratings for Climate Resiliency Impact



Again, reflective of the patterns with all other impacts, the living shoreline behaviors were at the top of the climate resiliency impact ratings. Upland/riparian vegetation was also in the top grouping and armor-related behaviors were in the bottom, which follows the pattern of water quality and habitat impacts. Leaving the shoreline alone and installing beach nourishment again fell in the middle, again with greater variability for leaving the shoreline alone.

Open-ended Questions

Finally, respondents were asked several open-ended questions for comment. The comments are summarized and discussed below.

Biotic Shoreline Features

Respondents were asked if they would recommend adding oyster castles, shell bags, and other biotic structures to the shoreline. Most of the respondents would recommend the technique but cautioned that it was not applicable to many shorelines, as the fetch would need to be lower and it would be best in areas that already have some of these structures prior to installation.

Other Behaviors

Respondents were asked if there were any shoreline management behaviors missing from the list. Most said no or skipped the question, though some suggested the following:

1. "Using biological technique such as the use of coconut fiber biologs, tree trunks, etc"
2. "Shingle beaches and headland structures"
3. "[Reducing] boat wakes"
4. "Adjacent property alterations"
5. "[Reducing] upland stormwater runoff"
6. "Coir logs or matting"
7. "Woody debris or logs anchored along the shoreline as a natural wave break or sill in the place of stone"
8. "Thin layer placement builds up saturated and fragmented marshes."

These suggestions will be taken into consideration when refining the behavior list.

Other Comments

Finally, respondents were asked about applicability resources (discussed in the next section) and any other comments. The three primary additional comments were:

1. "The first question asks us to consider the effectiveness of each activity at reducing significant erosion, but to assume that each activity would be appropriate for the site. Some of the management techniques, i.e., vegetative stabilization only or beach nourishment, would not be appropriate for areas with excessive erosion. However, if the activity were truly 100% appropriate for the site, each of them should be 100% effective at controlling erosion"
2. "I struggled with saying that taking no action would provide a certain amount of improvement to the shoreline. Taking no action seems like the baseline but may be the best thing to do in some cases. Unfortunately, sometimes shoreline projects are proposed for reasons other than shoreline erosion control (like aesthetics or credits)."
3. "Improvements to the permitting coordination between state and federal agencies and availability of studies related to co-benefits of living shorelines is needed."

As mentioned in the first two comments and earlier in the report, erosion is a complex impact – it should not be completely prevented and is highly dependent on contextual factors. Additionally, permitting around projects presents challenges to implementing any of these shoreline management techniques. This emerged as a concern in the literature review.

Applicability

Shoreline management, particularly in the context of excessive erosion, is a highly context-dependent set of actions. While there are the eleven distinct behaviors listed, shoreline experts have emphasized that any installation on a specific property must be chosen based on a variety of factors, and designed by a knowledgeable expert, in order to be effective.

Action Research

GIS Data

In considering how to determine what percentage of the audience can complete each behavior, the shoreline management experts and steering committee suggested a variety of resources, primarily related to GIS mapping. Many of these resources provide highly useful information for understanding specific areas, but do provide broad information, such as what percentage of the shoreline could adopt each practice. The challenge remains that what behavior is best for a property ultimately requires a site visit. As commented by one survey respondent, "Most of these data sets are very generalized based on GIS layers at much too coarse a scale. Most of these solutions require site-specific application."

Fetch Data

In discussions with the steering committee, fetch (wave energy) and the resulting erosion rate were suggested as factors to approximate applicability. Living shorelines and leaving the shoreline alone likely need lower baseline erosion rates to be potentially appropriate techniques, while armoring can be installed at higher baseline erosion rates. According to Maryland Department of Natural Resources,[9] more than half of the state's shoreline has slight (0 to -2 feet a year) or less erosion (87%) (Figure 22).

Figure 22: Maryland DNR Erosion Rate

Rate of change	Shoreline Length	
	Miles	%
Accretion	2,006	30
No Change	75	1
Slight erosion 0 to -2 feet/year	3,740	56
Low erosion -2 to -4 feet/year	618	9
Moderate erosion -4 to -8 feet/year	173	3
High erosion Over -8 feet/year	48	1
Total	6,659	100

For Virginia, a 1980 data set on erosion rates is shown in Figure 23. While this is an older data set, it is referenced by more recent publications[10] as one of the best available data sets for shoreline erosion.

[9]Subramanian, B. (2015). Maryland's Living Shorelines Program. Maryland Department of Natural Resources.

[10] Watershed Technical Work Group (2017) Removal Rates for Shoreline Management Projects. Recommendations of Expert Panel on Shoreline Management

Figure 23: Average Shoreline Erosion Rates Tidewater Virginia

YORK RIVER

NORTH SIDE	EROSION RATES	AVERAGE
Gloucester Co.	- 0.5 ft/yr	- 0.4 ft/yr
King and Queen Co.	- 0.3 ft/yr	- 0.4 ft/yr
SOUTH SIDE	**EROSION RATES**	**AVERAGE**
York Co.	- 0.9 ft/yr	
James City Co.	- 1.8 ft/yr	- 1.2 ft/yr
New Kent Co.	- 0.9 ft/yr	

JAMES RIVER

NORTH SI DE	EROSION RATES	AVERAGE
Newport News	- 0.8 ft/yr	
James City	- 0.1 ft/yr	- 0.45 ft/yr
SOUTH SIDE	**EROSION RATES**	**AVERAGE**
Isle of Wight Co.	- 1.8 ft/yr	
Surry Co.	- 1.2 ft/yr	- 1 .5 ft/yr

RAPPAHANNOCK RIVER

NORTH SIDE	EROSION RATES	AVERAGE
Lancaster Co.	- 0.6 ft/yr	
Richmond Co.	- 0.6 ft/yr	- 0.6 ft/yr
SOUTH SIDE	**EROSION RATES**	**AVERAGE**
Middlesex Co.	- 1.0 ft/yr	
Essex Co.	- 1.2 ft/yr	- 1.1 ft/yr

CHESAPEAKE BAY

WESTERN SHORE	EROSION RATES	AVERAGE
Gloucester Co.	- 0.6 ft/yr	
Hampton	- 1.0 ft/yr	
Lancaster Co.	- 1.4 ft/yr	
Mathews Co.	- 0.8 ft/yr	
Northumberland Co.	- 1.0 ft/yr	
York Co.	- 1.5 ft/yr	- 0.9 ft/yr
EASTERN SHORE	**EROSION RATES**	**AVERAGE**
Accomack Co.	- 1.5 ft/yr	
Northampton Co.	- 0.7 ft/yr	
Fisherman's Is.	+ 11 ft/yr	- 1.0 ft/yr*
SOUTHERN SHORE	**EROSION RATES**	**AVERAGE**
Virginia Beach	- 1.7 ft/yr	
Norfolk	- 1.2 ft/yr	
Nansemond	- 1.2 ft/yr	- 1.4 ft/yr

*Does not factor in Fisherman's Island.

After Hardaway and Anderson, 1980.

As seen in this figure, the majority of VA shorelines have an average of less than -1.5 ft/year of erosion, which would likely allow for the installation of living shorelines or that the shoreline can be left alone.

Action Research

Data were not available for Delaware on fetch or erosion rates broadly across shorelines.

Weight Table

The goal with this research is to create a rank ordering of these behaviors using a weight that considers four factors: impact, penetration, probability, and applicability. In this research, we looked at impact and applicability. In the table below, we summarize the findings based on these two factors. In this table, the impacts are each given the same weight and multiplied. The applicability represents the audience (100%), with the percentage of audience that cannot participate removed (e.g. 80% can participate). The weight is the impact multiplied by the applicability. The behaviors are ordered by their weight.

Table 6: Weight Table (Impact and Applicability)

Behavior	Impact[11]	Penetration	Probability	Applicability	Weight
Install buffer (upland/riparian) vegetation	7.40			1	7.40
Living Shoreline with sills	8.21			0.8	6.57
Living Shoreline with offshore breakwater	7.95			0.8	6.36
Living Shoreline - slope grading/wetland vegetation	7.87			0.8	6.30
Living Shoreline with jetties/groins	7.81			0.8	6.25
Install beach nourishment	4.31			0.8	3.45
Armor - revetment with no vegetative component	3.42			1	3.42
Armor – breakwater with no vegetative component	3.16			1	3.16
Armor – jetties with no vegetative component	2.87			1	2.87
Armor – groins with no vegetative component	2.80			1	2.80
Leave an unarmored shoreline alone	3.47			0.8	2.78

Recommendations

Based on the literature and the interviews, we provided the following recommendations for additional research for the next project phase, the audience research to shoreline property owners in Maryland and Virginia to gather data on the extent to which individuals are already engaged in each action (**penetration**), the likelihood of change (**probability**), and the barriers and benefits for each behavior.

1. **Prioritize behaviors related to living shoreline for additional research**. Within each impact area, the suite of behaviors around living shorelines scored high for impact, resulting in a higher final weight. Based on the erosion rate data alone, the actions may be applicable to 80% of shorelines.

[11] Impact = (Erosion*.25) + (Water Quality*.25) + (Habitat*.25) + (Climate Resiliency*.25)

If additional data was available, it might demonstrate that the estimate of 80% is too high. Despite these concerns, we recommended prioritizing this suite of behaviors for the next survey to understand the perspective of shoreline property owners.

2. **Prioritize the behavior, "install buffer (upland/riparian) vegetation" for additional research**. While this behavior was rated lower on the excessive erosion impact, it was rated highly for all other impacts. Additionally, this behavior is likely applicable for most, if not all, shoreline properties. Given this pattern, we recommended prioritizing this behavior for the next survey to understand the perspective of shoreline property owners.
3. **Prioritize the behavior, "leaving an unarmored shoreline alone" for additional research**. Experts were divided on their impact ratings related to leaving a shoreline alone, likely due to varying assumptions about the site context. Furthermore, leaving the shoreline alone will likely have the fewest barriers to action due to the low complexity. Finally, this behavior is applicable to most shorelines. Therefore, we recommended prioritizing this behavior for the next survey to understand the perspective of shoreline property owners.
4. **Remove the suite of armor-related behaviors and beach nourishment from the list.** Armor-related behaviors were either in the middle or bottom for impact. Beach nourishment was higher ranked, given the larger impact on erosion. However, this behavior likely has more barriers to action, while not achieving the higher weights of the living shoreline behaviors. While the armor-related and beach nourishment behaviors are broadly applicable, we did not believe that they warranted further research in this project.

Next Steps

The next steps for this work are to create a survey that assesses the penetration, probability, barriers, and benefits for the chosen actions. We will continue to work with shoreline experts to ensure the prioritized behaviors are impactful and applicable.

Updated Behavior List

1. Leave an unarmored shoreline alone - let it erode, accrete, or stay neutral
2. Install buffer (upland/riparian) vegetation
3. Install living shoreline (LS) – slope grading/vegetation (non-structural)
4. Install living shoreline (LS)– jetties/groins with wetland vegetation (structural)
5. Install living shoreline (LS) – offshore breakwater with wetland vegetation (hybrid)
6. Install living shoreline (LS)– sills with wetland vegetation (hybrid)

Action Research

Full Impact Survey

Thank you for taking the time to complete this brief survey. Action Research is working with the Chesapeake Bay Program and other stakeholders, to learn more about engaging owners of coastal properties in shoreline management actions. You have been asked to complete this survey because of your technical knowledge and professional experience in the shoreline management field. Your participation will help us determine the relative impact on excessive erosion, water quality, habitat, and climate change resiliency of a series of actions.

The survey contains five sections. The first four sections are about each of the impact types defined below. The final section asks for your opinions about other methods of shoreline management and any data about how many properties can likely take these different actions.

Please rate each item on its potential impact on erosion, water quality, habitat, and climate change resiliency. These impacts will be rated on a 0 to 10 scale, with 10 being the highest level of impact. **Note that our goal is to prioritize a list of behaviors based on their relative impacts.** The items include a range of behaviors which we expect to have varying impacts.

Impact Type	Definition
Excessive erosion	Property loss or infrastructure damage caused by or resulting from water and/or wind
Water Quality	Preventing excessive nitrogen, phosphorus, and sediment from entering the watershed
Habitat	Increasing the amount of ecosystem area for birds, fish, and other wildlife
Climate Change Resiliency	Increasing the ability of the shoreline to adjust over time to climate changes and continue providing ecosystem services

First, a few general questions about you.

What is your current job title? _____

How many years have you been in your current position? _____

How many years of experience do you have in shoreline management? _____

In what state(s) do you primarily work? _____

Have you received any special training related to shoreline management?

1. Yes → Please describe: _____
2. No

Section 1: <u>Erosion Impact</u>

Using a scale from 0 to 10, where 0 means *no impact* and 10 means *significant impact*, how much of an impact do you feel each of the following actions would have on **<u>reducing excessive erosion</u>** of a shoreline property (property loss or infrastructure damage caused by or resulting from water and/or wind)? For example, a rating of 10 would mean that the action would significantly reduce excessive erosion.

When rating each action, assume that it is being installed in a location where the chosen action is appropriate for the shoreline, and the project is well designed. As a reminder, **our goal is to prioritize a list of behaviors based on their relative impacts.**

1. Leave an unarmored shoreline alone – let it erode, accrete, or stay neutral

0	1	2	3	4	5	6	7	8	9	10	Not Sure	N/A

2. Install armor – revetment with no vegetative component (structural)
3. Install armor – jetties with no vegetative component (structural)
4. Install armor – breakwater with no vegetative component (structural)
5. Install armor – groins with no vegetative component (structural)
6. Install beach nourishment (non-structural)
7. Install living shoreline – offshore breakwater with wetland vegetation (hybrid)
8. Install living shoreline – sills with wetland vegetation (hybrid)
9. Install living shoreline – jetties/groins with wetland vegetation (structural)
10. Install living shoreline – slope grading/vegetation (non-structural)
11. Install buffer (upland/riparian) vegetation

Section 2: <u>Water Quality Impact</u>

Using a scale from 0 to 10, where 0 means *no impact* and 10 means *significant impact*, how much of an impact do you feel each of the following actions would have on **<u>water quality</u>** (preventing excessive nitrogen, phosphorus, and sediment from entering the watershed)? For example, a rating of 10 would mean that the action would significantly improve water quality.

When rating each action, assume that it is being installed in a location where the chosen action is appropriate for the shoreline, and the project is well designed. As a reminder, **our goal is to prioritize a list of behaviors based on their relative impacts.**

1. Leave an unarmored shoreline alone – let it erode, accrete, or stay neutral

0	1	2	3	4	5	6	7	8	9	10	Not Sure	N/A

2. Install armor – revetment with no vegetative component (structural)
3. Install armor – jetties with no vegetative component (structural)
4. Install armor – breakwater with no vegetative component (structural)
5. Install armor – groins with no vegetative component (structural)
6. Install beach nourishment (non-structural)
7. Install living shoreline – offshore breakwater with wetland vegetation (hybrid)

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8. Install living shoreline – sills with wetland vegetation (hybrid)
9. Install living shoreline – jetties/groins with wetland vegetation (structural)
10. Install living shoreline – slope grading/vegetation (non-structural)
11. Install buffer (upland/riparian) vegetation

Section 3: <u>Habitat Impact</u>

Using a scale from 0 to 10, where 0 means *no impact* and 10 means *significant impact*, how much of an impact do you feel each of the following actions would have on **<u>habitat</u>** (increasing the amount of ecosystem area for birds, fish, and other wildlife)? For example, a rating of 10 would mean that the action would significantly improve habitat.

When rating each action, assume that it is being installed in a location where the chosen action is appropriate for the shoreline, and the project is well designed. As a reminder, **our goal is to prioritize a list of behaviors based on their relative impacts.**

1. Leave an unarmored shoreline alone – let it erode, accrete, or stay neutral

0	1	2	3	4	5	6	7	8	9	10	Not Sure	N/A

2. Install armor – revetment with no vegetative component (structural)
3. Install armor – jetties with no vegetative component (structural)
4. Install armor – breakwater with no vegetative component (structural)
5. Install armor – groins with no vegetative component (structural)
6. Install beach nourishment (non-structural)
7. Install living shoreline – offshore breakwater with wetland vegetation (hybrid)
8. Install living shoreline – sills with wetland vegetation (hybrid)
9. Install living shoreline – jetties/groins with wetland vegetation (structural)
10. Install living shoreline – slope grading/vegetation (non-structural)
11. Install buffer (upland/riparian) vegetation

Section 4: <u>Climate Resiliency Impact</u>

Using a scale from 0 to 10, where 0 means *no impact* and 10 means *significant impact*, how much of an impact do you feel each of the following actions would have on **<u>climate resiliency</u>** for a shoreline property (increasing the ability of the shoreline to adjust over time to climate changes and continue providing ecosystem services)? For example, a rating of 10 would mean that the action would significantly improve climate resiliency.

When rating each action, assume that it is being installed in a location where the chosen action is appropriate for the shoreline, and the project is well designed. As a reminder, **our goal is to prioritize a list of behaviors based on their relative impacts.**

1. Leave an unarmored shoreline alone – let it erode, accrete, or stay neutral

0	1	2	3	4	5	6	7	8	9	10	Not Sure	N/A

2. Install armor – revetment with no vegetative component (structural)
3. Install armor – jetties with no vegetative component (structural)
4. Install armor – breakwater with no vegetative component (structural)
5. Install armor – groins with no vegetative component (structural)
6. Install beach nourishment (non-structural)
7. Install living shoreline – offshore breakwater with wetland vegetation (hybrid)
8. Install living shoreline – sills with wetland vegetation (hybrid)
9. Install living shoreline – jetties/groins with wetland vegetation (structural)
10. Install living shoreline – slope grading/vegetation (non-structural)
11. Install buffer (upland/riparian) vegetation

Section 5: <u>Comments</u>

A newer shoreline management technique is adding oyster castles, shell bags, and other biotic structures to the shoreline. Would you recommend using these techniques to someone considering protecting their shoreline? Why or why not?

1. _____

Are you aware of any other actions not included in this survey that would have a significant impact on excessive shoreline erosion? Please list any actions below.

1. _____

Are you aware of any resources that speak to the amount of shoreline properties that can take the listed actions (e.g., % of shoreline properties that could install types of living shorelines)? Please list any resources below.

1. _____

Do you have any other comments on this work or shoreline management?

1. _____

If you would be willing to talk more about your answers or provide additional information about shoreline management, please include your contact information below:

Name:

Email:

Phone:

Thank you for your participation!

Appendix C: Barrier and Benefit Survey

Dear Resident,

This survey was sent to you from the Chesapeake Bay Program and the Chesapeake Bay Trust to better understand how you manage and care for your property's shoreline. This information will assist us in developing outreach to help residents successfully protect their property's shoreline for years to come. We would appreciate it if you would complete this short survey. It should take no more than 10 minutes to complete.

Your household is one of only a select number of Chesapeake Bay region households being asked to complete this important survey, so your participation is very important to us.

Please return your completed survey by using the postage-paid envelope provided. If for some reason you prefer not to respond, kindly return the blank survey and we will remove you from future mailings regarding this survey.

Along with this survey is a separate photo sheet of shoreline structure images. Please use this sheet as a reference when answering the survey questions.

Please call Rebecca Chillrud at (410) 267-5747 with any questions. Thank you for your time.

Sincerely,

Rebecca Chillrud

Communications Staffer

Section A. This section is about the shoreline at the address where this survey was received. The shoreline is the area where your property meets the water. If your property does not have a shoreline, please check this box and return the survey. ☐ **No Shoreline**

1. What structures do you have on the property where this survey was received? Please check all that apply.

☐ House (primary dwelling)
☐ House (vacation/rental property)
☐ Other type of building
☐ Dock
☐ Other in water structure

2.	Using a scale from 0 (*not at all likely*) to 10 (*extremely likely*) in the next five years, how likely is your household to…	Already Completed or In Progress ↓	Not at All Likely										Extremely Likely
a.	Install new or replacement sills? (Photo 1 – **see photo sheet**)	☐	0	1	2	3	4	5	6	7	8	9	10
b.	Install new or replacement groins or jetties? (Photo 2)	☐	0	1	2	3	4	5	6	7	8	9	10
c.	Install new or replacement offshore breakwater? (Photo 3)	☐	0	1	2	3	4	5	6	7	8	9	10
d.	Install new or replacement revetment or riprap? (Photo 4)	☐	0	1	2	3	4	5	6	7	8	9	10
e.	Install a new or replacement bulkhead/seawall? (Photo 5)	☐	0	1	2	3	4	5	6	7	8	9	10
f.	Install a living shoreline (plants in the water or very close to the shoreline) with no rock or structural elements in the water? (Photo 6)	☐	0	1	2	3	4	5	6	7	8	9	10
g.	Install a living shoreline with a sill? (Photo 6 and Photo 1)	☐	0	1	2	3	4	5	6	7	8	9	10
h.	Install a living shoreline with a groin or jetties? (Photo 6 and Photo 2)	☐	0	1	2	3	4	5	6	7	8	9	10
i.	Install a living shoreline with a breakwater? (Photo 6 and Photo 3)	☐	0	1	2	3	4	5	6	7	8	9	10
j.	Plant vegetation near the shoreline, but not on it? (Photo 7)	☐	0	1	2	3	4	5	6	7	8	9	10
k.	Remove any existing armoring? (Photo 4 and Photo 5)	☐	0	1	2	3	4	5	6	7	8	9	10

Section B. These next statements are about reasons you **may or may not** install a living shoreline (Photo 6, plants in the water or very close to the shoreline).

3.	Using a scale from 0 (*strongly disagree*) to 10 (*strongly agree*) please rate your agreement with each of the following statements about living shorelines (Photo 6).	Strongly Disagree										Strongly Agree
a.	I do not know how to find a shoreline professional to install a living shoreline.	0	1	2	3	4	5	6	7	8	9	10
b.	Installing a living shoreline is too complicated.	0	1	2	3	4	5	6	7	8	9	10
c.	I do not want to apply for permits to install a living shoreline.	0	1	2	3	4	5	6	7	8	9	10
d.	I want to protect the health of the Bay.	0	1	2	3	4	5	6	7	8	9	10
e.	Installing a living shoreline is the right thing to do.	0	1	2	3	4	5	6	7	8	9	10
f.	I do not understand what a living shoreline is.	0	1	2	3	4	5	6	7	8	9	10
g.	A living shoreline would be beneficial for my property.	0	1	2	3	4	5	6	7	8	9	10
h.	A living shoreline is too expensive.	0	1	2	3	4	5	6	7	8	9	10

i.	I do not want to take care of vegetation.	0	1	2	3	4	5	6	7	8	9	10
j.	I like how a living shoreline looks.	0	1	2	3	4	5	6	7	8	9	10
k.	I want more vegetation close to my shoreline.	0	1	2	3	4	5	6	7	8	9	10
l.	I do not think a living shoreline would provide enough erosion control.	0	1	2	3	4	5	6	7	8	9	10
m.	A living shoreline would look odd compared to my neighbors' shorelines.	0	1	2	3	4	5	6	7	8	9	10
n.	It would make my shoreline less accessible.	0	1	2	3	4	5	6	7	8	9	10
o.	I want to provide more habitat for fish near my shoreline.	0	1	2	3	4	5	6	7	8	9	10
p.	Other:											

Section C. These next statements are about reasons you **may or may not** plant on the land near, but not on, your shoreline (Photo 7).

4. Using a scale from 0 (*strongly disagree*) to 10 (*strongly agree*), please rate your agreement with each of the following statements about planting vegetation near, but not on, your shoreline (Photo 7).

		Strongly Disagree										Strongly Agree
a.	I do not know how to find a shoreline professional to install vegetation.	0	1	2	3	4	5	6	7	8	9	10
b.	I do not need more vegetation on the land near my shoreline.	0	1	2	3	4	5	6	7	8	9	10
c.	I do not want to take care of vegetation.	0	1	2	3	4	5	6	7	8	9	10
d.	More nearshore vegetation would look odd compared to my neighbors.	0	1	2	3	4	5	6	7	8	9	10
e.	Installing more vegetation is too complicated.	0	1	2	3	4	5	6	7	8	9	10
f.	More vegetation would make my shoreline less accessible.	0	1	2	3	4	5	6	7	8	9	10
g.	I want to protect the health of the Bay.	0	1	2	3	4	5	6	7	8	9	10
h.	Planting more vegetation is the right thing to do.	0	1	2	3	4	5	6	7	8	9	10
i.	More nearshore vegetation would prevent erosion damage.	0	1	2	3	4	5	6	7	8	9	10
j.	More vegetation would look good.	0	1	2	3	4	5	6	7	8	9	10
k.	I want to provide more habitat for animals on my property.	0	1	2	3	4	5	6	7	8	9	10
l.	Other:											

Section D. These next statements are about reasons you **may or may not** have armoring on your shoreline (Photo 5 or Photo 6).

5. Do you have any type of armoring on your shoreline (Photo 4 or Photo 5)? ☐ No - **answer Q6** ☐ Yes - **answer Q7**

IF NO TO HAVING SHORELINE ARMOR:

6. Using a scale from 0 (*strongly disagree*) to 10 (*strongly agree*), please rate your agreement with each of the following statements about why your shoreline **does not** have armor installed.

		Strongly Disagree										Strongly Agree
a.	Doing erosion control projects is too expensive.	0	1	2	3	4	5	6	7	8	9	10
b.	I have enough erosion control right now.	0	1	2	3	4	5	6	7	8	9	10
c.	My natural shoreline does not need much care.	0	1	2	3	4	5	6	7	8	9	10
d.	I want my natural shoreline to help protect the health of the Bay.	0	1	2	3	4	5	6	7	8	9	10
e.	Installing erosion control shoreline projects is too complicated.	0	1	2	3	4	5	6	7	8	9	10
f.	I do not want to go through a permitting process.	0	1	2	3	4	5	6	7	8	9	10
g.	Other:											

IF YES TO HAVING SHORELINE ARMOR:

7. Using a scale from 0 (*strongly disagree*) to 10 (*strongly agree*), please rate your agreement with each of the following statements about why you **may or may not** remove armor from your shoreline.

		Strongly Disagree										Strongly Agree
a.	Removing armoring is too expensive.	0	1	2	3	4	5	6	7	8	9	10
b.	I need the amount erosion control than I currently have.	0	1	2	3	4	5	6	7	8	9	10
c.	I cannot find a shoreline contractor to remove armor.	0	1	2	3	4	5	6	7	8	9	10
d.	Removing armor is a complicated process.	0	1	2	3	4	5	6	7	8	9	10
e.	I have no reason to remove the armor on my shoreline.	0	1	2	3	4	5	6	7	8	9	10
f.	I want to remove my armor to help the Bay.	0	1	2	3	4	5	6	7	8	9	10
g.	Other:											

Section E. These next statements are about attitudes and opinions you have about your shoreline.

8. Using a scale from 0 (*strongly disagree*) to 10 (*strongly agree*) please rate your agreement with each of the following statements.

Strongly Disagree Strongly Agree

a.	I am concerned about my shoreline eroding.	0	1	2	3	4	5	6	7	8	9	10
b.	My ability to directly access my shoreline is important to me.	0	1	2	3	4	5	6	7	8	9	10
c.	I want my shoreline to look natural.	0	1	2	3	4	5	6	7	8	9	10
d.	I do not like a lot of vegetation on my shoreline.	0	1	2	3	4	5	6	7	8	9	10
e.	I know how to take care of my shoreline.	0	1	2	3	4	5	6	7	8	9	10
f.	I enjoy recreational water activities (boating, kayaking, fishing, etc.)	0	1	2	3	4	5	6	7	8	9	10
g.	Protecting the health of the Chesapeake Bay is important to me.	0	1	2	3	4	5	6	7	8	9	10
h.	I like the look of a mowed lawn on my property.	0	1	2	3	4	5	6	7	8	9	10
i.	I like how my shoreline looks currently.	0	1	2	3	4	5	6	7	8	9	10

Section F. The next question is about your communication preferences.

9. When you have questions about managing your shoreline, where do you look for information? Please check all that apply.

- ☐ Contractor
- ☐ Friends and family
- ☐ Neighbors
- ☐ County or city government, please specify: _____
- ☐ State Environmental or Natural Resources Agency, please specify: _____
- ☐ University, please specify: _____
- ☐ Non-profit, please specify: _____
- ☐ Other, please specify: _____

Section G. Other Household Information. These questions are used for classification purposes only.

10. In what year were you born? _____

11. Do you own or rent your shoreline property? ☐ Own, for _____ years ☐ Rent, for _____ years

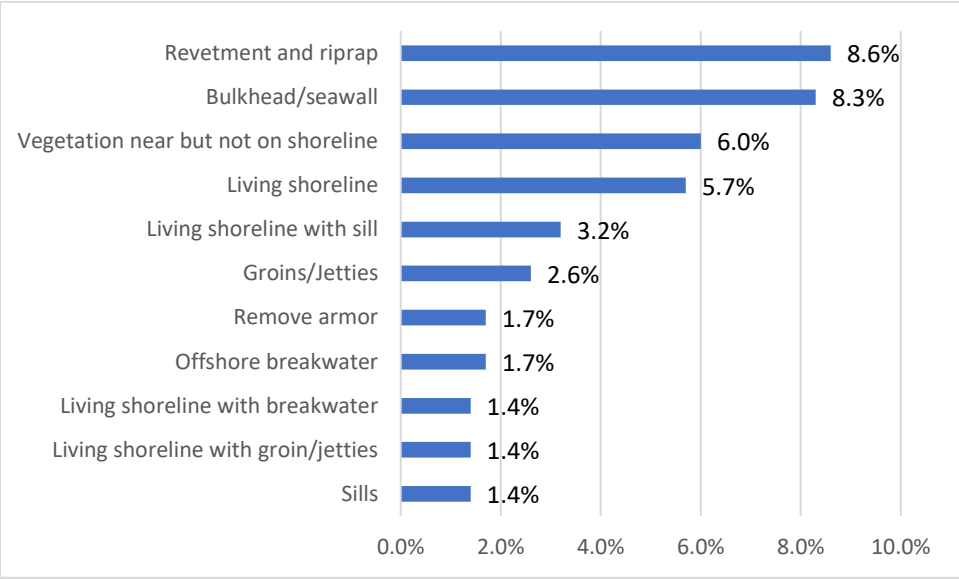
12. Including yourself, how many people live in your household? _____ How many are children under 18? _____

13. If you have any other comments about the management of your shoreline or living shorelines, please write them below.

Appendix D: Question 2 Survey Results

The graph below reflects the responses to question 2, which were not used for analysis given the concerns outlined in the results section. The graph below is only presented for the purposes of complete data.

Figure 24: Frequency of Shoreline Management Structures - Not Used for Analysis



Appendix E: Survey Comments

Q3. Please rate your agreement with each of the following statements about living shorelines ("other" responses).
A living shoreline would be a possibility if the Chesapeake Bay Program could fund and install it. We are not as young and strong as we used to be.
Already have a living shoreline.
Bulkhead is not conducive for a living shoreline.
Can't afford it.
Cost and maintenance are prohibitive for me.
Cost prohibitive, otherwise would consider.
Grass in water has died out since I moved in 32 years ago, I think in part due to runoff from Mt. Trashmore into the Indian River.
Have no idea of cost of living shoreline.
I am on a canal - cannot plant.
I am encouraging volunteer plants along the shoreline.
I do not wish to deal with Wetlands Gestapo.
I have a bulkhead and do not need/want a living shoreline.
I have shore grass along my shoreline where it will go.
I have wall with rock in front.
I put in riprap two years ago.
Live on navigable creek with dredged channel. Bulkheads are mandatory.
Living shoreline won't work with my revetment.
My home is 15 feet from the water. There is no room to install a living shoreline.
N/A - we have a wooden bulkhead.
No space out front.
Our wall and riprap prevent it.
Part of my shoreline is deteriorating. I need financial assistance to prevent further erosion.
The rules are onerous on a land owner who wants to protect the shoreline, not to mention inflated costs of plans, permitting, and installation.
The town owns the land from the bluff in front of my house. People purchase their tract to install a dock.
The water is too deep at our shoreline.
There is no shoreline
Tried living shoreline and storms washed it away each time.
Tried to save shoreline from erosion years ago and was told to take it away or be fined.
We already have a majority of our shoreline as living shore and will not change.
We already have tuckahoes on shoreline.
We have a living shoreline, not sure about native plants.

We have too much vegetation and were told when we moved here to not touch it. I'm not financially able to do this.
We like grasses on the shore - have some.

Q4. Please rate your agreement with each of the following statements about planting vegetation near, but not on, your shoreline ("other" responses).
Already have a landscaped slope leading to bulkhead on river.
Cost and maintenance are prohibitive to me.
County process TOO complicated!
I do not wish to deal with Wetlands Gestapo.
I have plenty of plant/veg near my shoreline.
I have vegetation, but storms have washed away trees over 100 years old.
Living shoreline won't work with my revetment.
N/A - we have a wooden bulkhead that ties into our neighbors to the left and right.
Not enough property to plant.
Property more marsh when low tide.
Shoreline is already naturally overgrown.
This section makes little sense given my answer to 2j.
Too much shade is affecting the spartina.
Unable to get plant material to grow on bank.
Vegetation draws rats.
We are constantly fighting an overpopulation of geese near and on our property. Trying to deter them from pooping on our property.
We would continue to plant native plants.

Q6. Please rate your agreement with each of the following statements about why your shoreline <u>does not</u> have armor installed ("other" responses). [Asked of those who reported not having armor.]
Don't really care.
HELP!!
I have approval, but contractor bid was $45,000.
I have been through the permitting process and it is ridiculously expensive and onerous.
I think they are ugly and need replacement frequently.
I want shoreline armor but don't have the money or the ability to do the work.
Non riparian.

Permitting process too complicated.
Too expensive - would love to install riprap.
We just rebuilt our bulkhead.

Q7. Please rate your agreement with each of the following statements about why you <u>may or may not</u> remove armor from your shoreline ("other" responses). [Asked of those who reported having armor.]
80' of shoreline, all bulkhead, house close to water.
Armor stone protects the access to our home. Cannot remove.
Can't afford to do what I want to.
Can't afford to remove/replace.
Existing is somewhat of a living shoreline.
Existing riprap holds good bait fish, juvenile crabs, and attracts water fowl.
How does removing armor help the Bay? This is not explained in your document.
I do not wish to deal with Wetlands Gestapo.
I have a bulkhead in great shape with marsh grasses in front of it.
I have a concrete bulkhead.
I have to add to return wall because neighbor has erosion.
I want to help the bay, but I'm happy with the riprap I just installed.
It's riprap. Vegetation grows in it.
My bulkhead is brand new but only covers 80% of my shoreline. Need living shoreline for the other 20%.
My riprap has been in place for 30+ years and has become integrated with living plants too. It holds my embankment together from erosion.
Removing armor would be suicide. Property erosion would be non-stop and dry land would become uninhabitable and disappear.
Riprap has natural plantings covering it.
The armor protects my property from erosion.
The armoring keeps my hill from falling into the water.
The US Navy installed shoreline armoring about 45 years ago to protect a tracking station from being lost due to excessive erosion on the VA side of the Potomac River.
Very minor armor/piled rock.
We have riprap stone that has been flattened out by storms.
We have some riprap, would like more on bank.
We have tall east facing bank/shoreline. Nothing will grow along the shore so we put riprap so the high tides and boat traffic will not continue to erode the shoreline.
We lost 12 vertical feet to Isabel, the armor hopefully prevents further damage.

We need ours removed and replaced with a living shoreline. We are losing land from the tides filling up behind the structure then pulling it out when low tide is in progress. Money is the problem to have this fixed.
Wood bulkhead was here when I moved in. Not sure if it's essential to erosion control or not.

Q9. Where do you look for information? County or city government, specified.
AACO
Agriculture, Parks, not Public Works
Anne Arundel and Federal guidelines
Anne Arundel
Anne Arundel County
Anne Arundel County online
Anne Arundel County websites
Baltimore County
Baltimore County Government
Calvert County
Cecil Co
Cecil County Planning & Zoning
Chesapeake Bay Commission, Environmental Office
City of Virginia Beach, CBPA
Colonial Beach controls shoreline unless I purchase for $25K-$30K.
County
County Env. Department
County permits
County Planning
DNR, permitting
Dorchester County
Dorchester County Planning
Fairfax County
For permits
Hampton City
Jennifer Fisher of AA Co. has been very helpful.
Kent County planning office

Q9. Where do you look for information? County or city government, specified.
Laws
Norfolk, VA
Northumberland
Northumberland County
Poquoson City, York County
Permits/Inspections
Permitting Department
Permitting when required.
Planning Office
Portsmouth
QAC
Queen Anne
Queen Ann’s, County Extension Office
Somerset County
St Mary's website
Talbot
Talbot County
VA Tech
Virginia Beach
Web
Westmoreland County
Wetlands Board
York
York County

Q9. Where do you look for information? State agency, specified.
Agencies such as yours.
Army Corps of Engineers
Army Corps of Engineers
B + Ho Co SE Agency (state)

CBA
Chesapeake Bay Foundation and Nature Conservancy
Chesapeake Bay Foundation, VA Dept of Environmental Quality
DNA, Army Corps of Engineers
DNR
DNR, etc. online
DNR, environmental websites
Elizabeth River Project
For permits
I've picked up brochures, etc.
Maryland DNR
Master gardeners, shoreline management people
MD
MD DNR
MDE
MDE, DNR - both big help
NRCS, Wetlands, DCR
Riverkeepers.org
SEAS
St Mary's County
State folks have visited and agree that serious erosion needs action!
UMRC
VIMS
VIMS, VMRC, DCR
VMRC
Web

Q9. Where do you look for information? University, specified.
Maryland
Old Dominion University
U of D, U of M
U of MD
UMD
UMD online
University of Maryland
VA Tech Extension Service
VIHS
VIMS
VIMS, VA Tech Extension
VIMS, W&M
W&M. VIMS

Q9. Where do you look for information? Nonprofit, specified.
CBA
CBF
Chesapeake Bay Foundation
Chesapeake Bay Trust
Clear Creeks/Gunpowder Conservation
Elizabeth River Conservancy
Elizabeth River Project
Elizabeth Rivers Project, Wetlands Watch
Friends of Indian River, LRNow, Elizabeth River Project
Living classrooms
Shore Rivers
Sierra Club
South River Federation, Arundel Rivers Federation
South River Restoration
Wetlands watch, LRN, CBF, Nature Conservancy

Q9. Where do you look for information? Other, specified.
Bay Ridge Civic Assoc.
Books, magazines, internet searches
Don't have questions.
Erosion Control Construction
General online web searches
Google
Google search
Have not needed any
HOA
I don't have any questions.
I have a lot of experience with waterfront shoreline maintenance.
I'm more able than most.
Internet
Internet - local bay websites
Internet (Google)
Internet search
Internet searches
Internet sources.
Internet.
John Flood/planted living shoreline/riprap.
Local engineering firms
Master gardeners
Never looked for info.
No need.
No questions at this time.
Northern Neck Shoreline Evaluation Program
Not interested.
Not sure.
Online
Online info
Online information

Online resources
Online searches
Online websites
Online
Self
The Google
Townhouse Association
USGS
Watershed Stewards, Magoth River Association
Web
Wetlands consultant friend

Q13. If you have any other comments about the management of your shoreline or living shorelines, please write them below.
A healthy lawn is most important as long as nutrients are well managed. Neighbors only cut their grass and they are suffering erosion due to poor sod coverage. My lawn gets a small amount of fertilizer in the spring and fall. I am a Certified Nutrient Management Planner.
After years of trying to work with Prince George County and state of MD to stop the eroding of my shoreline, I was forced on my own to hire a contractor who did an excellent job. Built large limestone into the shore - looks very natural. For 25 years, no erosion.
An influx of additional money would help!
Are there any grants available?
Are there programs to help with the costs? What is being considered for rising sea level?
Because of my land/hill I need a strong sea wall.
Camp Occohannock on the bay where we have a living shoreline was bought in 1958.
Conflicting information/unclear recommendations/huge expenses to control erosion. Ex: trees on slope were good, now bad?
Cost prohibitive. Need a lower cost alternative to any current erosion solution.
Enforce current laws - I see people chain-sawing down all their trees along the shoreline without permits.
Erosion is a concern and my bulkhead protects my property from this. To save the bay, pollution control is an easier thing to address. Baltimore County does a terrible job preventing and assisting in pollution control. I have reported violators many times with no follow-up - sunken boats, plastic pollution from stores, lack of trash cans at waterside gathering places. County government doesn't see pollution as a priority at all!
Erosion is under control and nature takes care of the vegetation.

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Half of my property is non-tilled wetlands. We cannot afford to maintain the shoreline yet still pay taxes on land the state will not let us utilize. If the state wants to pay for any help, we would deeply appreciate it. We have lived here for over 30 years and are unable to use half of it. So, since you have half ownership, please come fix it!!
House on stilts, surf under house on regular basis, living shoreline probably not viable option. Perhaps breakwater/riprap are options, however these should be funded same as salt ponds breakwaters and ripraps, not by individual property owner. I cannot, nor would I consider expense for breakwater or riprap. This should be an investment of local, state, and federal government to protect streets and property inland. If my property were further inland I would pay for a living shoreline, but I'm too close.
How about dredging and silt removal?
How about taking care of the developers like Craftsman at Quiet Waters and others who were allowed to build 62 homes within close proximity to 2 creeks and had daily runoff? Fix the permit process for developers if you want to make a difference.
Hurricanes and flooding (and Canadian Geese) cause the natural shoreline to be compromised and erosion began. Installed filtering stone structure uphill and vegetation to stop erosion. Also allowed part of the lawn to go wild.
I am concerned with the health of the Bay. Your survey has opened my eyes a bit more. I appreciate your work with this survey. Thank you very much, Rebecca.
I am interested in shoreline resources and information so I can make good decisions, not more regulations.
I am looking to do an oyster set-up.
I am pro living shoreline, however, the house we purchased already had a bulkhead and is less than 1/4 acre with very little elevation and house very close to water. This would not be allowed by today's standards. We do have substantial natural living grasses in the shallows off our bulkhead which are home to many fish, turtles, fowl and unfortunately, nutria.
I am requesting information on how to apply for funds or grants to improve my shoreline and protect it from further erosion.
I currently do not know who to contact about my shoreline. I like the look of the living shoreline and would appreciate getting some info on doing that to my property.
I have 75' of waterfront which needs attention. Do not know what is the best thing to do, cannot afford to do anything.
I have a mix of living shoreline and riprap. My marsh shoreline was invaded by phragmites. I am working to eradicate them to restore the marsh with the help of the Chesapeake Bay Foundation. PS - Funds awarded to combatting "climate change" should be diverted to real conservation work, like living shorelines.
I have a riprap sea wall with about 3 to 4 feet of buffer sedge grass along the whole length of the wall.
I have riprap, my neighbor has a natural shoreline. His shoreline is eroding rapidly and will impact my property if my armor is removed. We need to help people protect their investments by allowing armor when necessary and not making it so incredibly expensive to get permits to maintain shoreline and protect property.
I have vegetation along my shoreline, with stone behind it. I would like to put in a dock but have not really investigated that due to all the wetlands protections.

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I installed a living shoreline 5-6 years ago at great expense, with difficulty working with the permitting. The sills and breakwater have done nothing to curb erosion and all plantings have been taken over. Erosion will continue and I will need to now install (stone?) riprap to attempt to stop it.
I know I need to replace the bulkhead and a small pier, but money is the biggest issue. My wife and I simply cannot afford this work.
I live in condo building with 12 owners. They have recently pulled up a lot of shoreline vegetation and I am concerned about erosion. Are they breaking any laws regarding wetlands?
I live on a backwater lagoon feeding into Dogue Creek in Mount Vernon. Am exploring how to better protect adjacent, commonly-owned waterfront property under management of Mount Vernon Yacht Club - seeing erosion.
I own the two adjacent properties west of the property listed for this survey. I have lost 10 to 15 feet of shoreline since I purchased 10 years ago. I just finished building a single family home for my son and have lost 4 to 5 feet on that property over two years. Shoreline is 5 to 15 feet above beach. Storms destroy the bank and undermine planted area. I have had professional marine builders evaluate and draw up plans. County and state agree and approved the plan. However, the cost of $45,000 is a problem. Any help would be appreciated.
I think I should be able to add more riprap and maintain what is there without all the red tape!
I want my two pieces of property to blend and look natural. I'm very concerned about erosion. I want to be able to use both pieces of property.
I want to do what's best for environment, but my property is very small with a large drop-off so living shoreline doesn't seem too beneficial. Would be interested in more info.
I want to fix my seawall and maybe 2 jetties, but I cannot really afford it.
I worked with Jennifer Fisher at AA Co and she was extremely helpful. She issued a permit to cut some trees, stack them against the shoreline. Now I need grasses. I contacted Ms. Chillrud who responded promptly, and I am now on list for Haley Dentin to receive grasses. If possible, I would like contacts or volunteers to help plant the grasses. I am excited about creating a living shoreline. Kevin Kimball 1687 Kingsbridge Ct Annapolis, MD 21401
I would allow the county to naturally preserve my shoreline, but I am not in a position to pay for it.
I would like to learn more about managing shoreline and its effect on the Bay.
I would like to plant a rain garden near my shoreline but can't afford a landscape expert to help me locate it properly. It would be nice to have access to this type of service for free through state/county and then me and my friends could do all the labor. Liza Ryner 619.887.5030
I would like to plant plants in the creek without a permit. I would like a grant to pat for the plants.
I would love to learn what affordable plants or structures will help stabilize shoreline.
I would prefer a living shoreline but riprap (existed when I bought the property) is in good shape - I have no idea of the cost involved in removing it and planting the shoreline
I'm so glad you sent this. We just moved here and have seen marked erosion but have no idea how to safely control erosion in a way to promote Bay health. Thanks for raising the concept of living shorelines - where can I learn more?
In years to come I believe riprap will be required for all residential shoreline properties. It is more stable, won't rot, etc.

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Installed living shoreline a decade ago in front of wooden bulkhead. Partially (~30%) successful long-term since spartina plantings sensitive to water depth and sun exposure. Not appropriate or practical for all properties! Also permitting process was difficult and labor-intensive. Replacing wooden bulkhead with successful living shoreline would be very expensive and risk of failure due to sup-optimum (or changing) conditions too high. In our case, used coco logs secured plus sand to get planting depth right (hard to sustain!). Was a lot of work with only limited erosion control benefit. May re-try it if permitting made easier and could DIY most of it again. Marsh success also depends on bay oxygen levels and algae blooms year to year.
Just moved in and have not considered this at all.
Law prevents me from bulkheads/seawalls.
Laws need to be made about blocking/obstructing water-front views with plants. Plants such as bamboo should not be allowed on water-front property. Pier codes should be enforced for all shore properties.
Low energy shoreline, erosion control not a concern. Small section of riprap.
Many neighbors have concerns about permitting requirements and legal restrictions on use of their property.
Many thanks to the ERC for their help in the design permitting and installation of our living shoreline. They are the best!!
My cove is silting from mud due to clear cutting of timber and not replanting. 2" in less than 3 years of timber harvesting. Cove water is muddy all year long now. Why are the land owners not required to replant the clear cut land?
My grandfather built the house in 1935.
My home is situated 15 ft from my shoreline, which is a riprap sea wall. I only have about 100 ft of shoreline on 1/10 of an acre. I currently have an issue with one area of grass collapsing into the riprap. We need repairs but don't know how to proceed.
My house at Harborside in Alexandria, VA faces the Potomac River. City manages every aspect of the shoreline. Lots of debris lines the shoreline in front of our houses because the riprap is not high enough to keep it from depositing behind the riprap—very unsightly.
My shore looks like photo 6 with a mud oyster and mussel bank. I just add an old water-logged log just out of reach of the bank and the natural grasses grow to it. An old pile works great.
My shoreline for the past 38 years has been lovely! Rarely water covering the riprap.
My shoreline is a 3 to 4 foot embankment, all natural. There are two mature deciduous trees that have tree roots exposed in the embankment. I'm concerned that his erosion over time will undermine the stability of these trees.
My shoreline is in good shape and conducive to wildlife nesting and access. I take great care to ensure it does not erode or inhibit wildlife. It is used by waterfowl all throughout the year to come up from the water and nest in vegetation we have been careful to preserve.
My wife and I are concerned about the impact of global warming on rising water levels. We are not sure of the best way to protect the shoreline on the Little Magothy from rising sea levels. Asking a question about fear of global warming impact may help pinpoint outreach efforts.
My yard is a corner lot and floods easily with heavy rainfall.
Need to do something about shoreline erosion due to high speed boats / large wake boats. I don't want to have to spend a lot of money for my shore so that others can speed up and down when changing their behavior (no wake zone) will suffice.

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Not enough access to shoreline because of erosion and vegetation is overgrown. Community hasn't tried to correct the erosion or maintain the shoreline properly.
Permitting is complicated, work is expensive. Education for DIY - how to - is lacking.
Put more trash booms in areas that dump out from city!
Recommendations always welcome.
Shoreline erosion is important but managing it depends upon your neighbors' actions and constructions as much as what you do yourself.
Shoreline is non-riparian.
Since it is living, it is ever-changing. VB talked the neighbors into a special tax for dredging. It doesn't seem to have harmed the creek, but I would have preferred to leave the creek alone and let sea level rise provide extra depth.
Since we are on marsh lands, we just leave them alone. We were told by the DNR not to touch it. Not too happy dealing with snakes though. Have had some copperheads in my yard. The politicians do nothing to help the residents who live on a shoreline. All talk, no action.
Small amount of shoreline, ~ 10' elevation w/ bulkhead + wrapped w/ stone, small lot, no chance or room to do other types of shoreline protection.
Summer home, not primary residence.
The greatest enemy to our shoreline (which is eroding) is the enormous timbers that come down from the Conewingo dam and slam into the shoreline with great force during storms that include high winds and tides. They often wash up, leaving us with the job of removing timbers as long as telephone poles and 2-3x as wide. As residents who do not have commercial equipment to deal with the aftermath of these timbers and other wood of various sizes, this is a HUGE problem. While I have read about a living shoreline and its benefits, I don't see how it would prevent these timbers from washing up. We would need a sea wall made of stones the size of the ones used on Cape Cod to stop it, or a high bulkhead which would cost a fortune and not be permitted. Any reworking of the shoreline would pose an expense beyond our means.
There is a vacant lot adjoining our that is not maintained with shoreline eroding annually that is starting to undermine our property and causing erosion. Would like to receive information on any assistance on how to rectify this.
There is zero chance that I will remove the thousands of pounds of riprap from my very long shoreline. I've got to budget for a new roof, HVAC, etc. Removing existing riprap makes no sense.
There needs to be higher penalties for people littering. Communities along waterways need to do a better job policing their neighborhoods. I pull trash out of my river weekly. Make a new PSA or TV ad to educate people.
This has been a concern of ours since we moved in 8 months ago. We would like to improve our shoreline but do not have any information and are worried it will be costly and time consuming. Are there any grant funds available? Thank you, Emily Callahan - emilyhope30@gmail.com
To aid the bay and prevent erosion there should be low-cost programs to assist when erosion is imminent.
Very difficult trying to keep our little creek clean. Too much debris from waste on the roads that empty out to our creek. City needs to take care of this problem.
We are extremely frustrated and are begging for help. We first put breakwaters in with a living shoreline 5ish years ago. Relying on the state and our contractor, John Flood, we constructed to their recommendations. Our shoreline continued to erode BADLY! We switched to using Doug Musser who still

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has not been able to obtain permits from the state, we started in April! We have sent pictures showing our Extreme erosion - we are losing chunks of our bank at a time. We are desperate for help before we run out of land. You would think the state would want to work with us as them dredging the gut by our home has caused this extensive damage. If the state is concerned with bay health, why are they okay letting our shoreline continue to erode!
We are noticing erosion with the riprap and loss of soil from the yard.
We are working with a landscape designer on plant selections for property.
We do not have the money to change our shoreline, but we would be happy to do it if someone would pay for it.
We have 35 feet from the top to the shoreline. It is covered with trees such that we have deer along the length of my shoreline.
We have 55' of shoreline, all bulkhead.
We have a completely natural shoreline along the creek (channel) behind our home. In 2000 the channel was dredged to a depth of 31 feet at mean low water allowing a deep water ecology. We have enjoyed kayaking on this water, but the channel has now degraded to almost no water at low tide and is becoming a mudflat ecology. The permitting process and mud mitigation fee imposed by Army Corps of Engineers makes it prohibitively expensive for middle income property owners to maintain these channels for boating of any kind. However, with the impending rise in sea levels all property owners may need to bulkhead shorelines to prevent flooding of residential property.
We have beaches with sand and need to protect the shore behind the beach. Our shorelines were repaired following Hurricane Isabel in 2003 and seawalls have been in place since the late 1970's to protect the shoreline and from eroding into the river.
We have just completed an extensive living shoreline.
We have just hired a contractor to install riprap combined with a living shoreline. He will take care of the permit process. It will be beautiful! We estimate the whole process will take about a year. It was something we should have done years ago but it’s so expensive.
We have some riprap. Only recently was I able to talk my husband into allowing some marsh grasses to grow near the water. Planted several trees near the water last summer. He is beginning to understand that more vegetation will protect our property from erosion.
We have taken grief from our neighbors because other than the dock, we have left our shoreline "natural". We have been members of CBF since before we moved here. Forgive the writing, I've had two strokes.
We would be interested in some information on the living shoreline. Currently, fragmites cover the shoreline up to our yard which is roughly 5' above high tide level. This is new to us, and we certainly want to do the 'right thing' to protect it.
Wetlands employees are illogical and non-negotiable. Some wetlands regulations were taken from guidelines and officials were too lazy to apply common/scientific sense. Wetlands commissions have confiscated my land without payment. Obviously, land owners are not happy.
Where is shoreline armor defined? Is it all photos? Or certain photos? How does removing armor help the Bay?
Who should I contact for more information?
Would be interested in discussing a living shoreline.
Would like advice on native/non-native plants. Need regular assistance maintaining steep bank to prevent erosion and continue health of ground cover.
Your survey assumes prior knowledge of a lot. The pictures help. I know nothing about permitting.