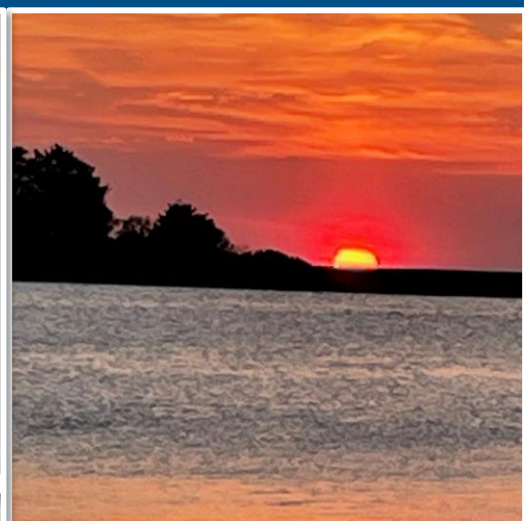
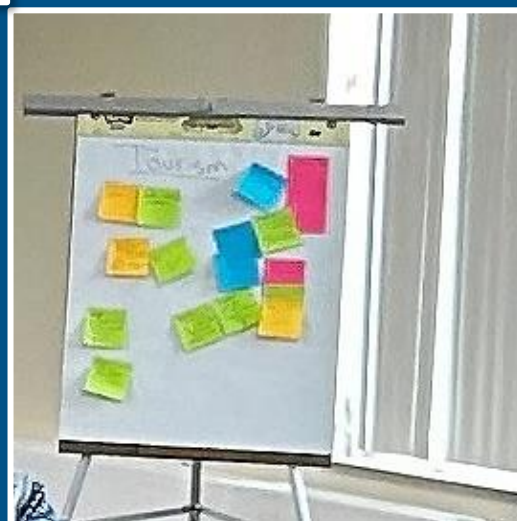




# Supporting Coastal Community Resilience through Natural Infrastructure

## Crisfield, MD Stakeholder Meetings

April 19 & 20, 2024



# **Supporting Coastal Community Resilience through Natural Infrastructure**

Crisfield, MD Stakeholder Meetings  
April 19 & 20, 2024

U.S. Environmental Protection Agency  
Office of Research & Development  
Washington, DC 20460

## **NOTICE AND DISCLAIMER**

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This report is a contribution to the EPA ORD Safe and Sustainable Water Resources (SSWR) Research Program under project SSWR 402.1.1 “Coastal Community Resilience Through Blue Carbon Resources (Chesapeake SDR)”.

The information generated in this report was performed under the Quality Assurance Project Plans (QAPPs) L-ICSD-0033667-QP-1-02023-03-23 and J-GEMMD-0032706-QP-1-1. This report has been reviewed by the ORD/CEMM Quality Assurance Manager and it has been determined to be consistent with EPA Category B quality assurance requirements. This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication.

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# Executive Summary

Like many coastal communities, the City of Crisfield, Maryland is experiencing increased inundation due to sea level rise, land subsidence, and intensifying storms. The U.S. EPA Office of Research and Development (ORD) has partnered with the Crisfield community to explore the potential of natural infrastructure, or nature-based strategies (NBS), to help decrease storm surge, wave water heights, and erosion under ongoing sea level rise, in addition to providing other environmental, social, and economic co-benefits to the Crisfield community.

The goal is to design and conduct this research to directly inform on-the-ground decisions about what types of NBS could be built in which locations around Crisfield. To be able to truly co-develop this research with the Crisfield community, EPA ORD needs to better understand community values to ensure that the research is designed to measure and model the things Crisfield cares about. The research also needs to take into account local considerations to ensure proposed strategies are implementable. Research co-production is an iterative and on-going process, adapting research as more information is learned about community values, and more is understood about the science and engineering capabilities of natural infrastructure strategies.

In April 2024, EPA ORD conducted two stakeholder meetings to inform research goals and project design: 1) a meeting of institutional partners to get feedback on the proposed research plan and 2) a public natural spaces discussion with community residents to better understand how communities use and benefit from coastal habitats.

On April 19, 2024, EPA ORD hosted a meeting of institutional partners about “*Supporting Coastal Community Resilience through Natural Infrastructure*” to solicit input and feedback for moving forward with the research. At this meeting EPA shared the history, goals and status of EPA ORD research with Crisfield. Most importantly, EPA ORD engaged participants in an interactive discussion about what had been learned so far and plans for next steps, including:

- Understanding and identifying which specific NBS projects might be most effective for the Crisfield community at reducing the severity of storm impacts, wave impacts, and related flooding and erosion, and
- Identifying what are the other types of co-benefits of interest to the Crisfield community that these different NBS projects will simultaneously provide that contribute towards achieving Crisfield’s broader coastal resilience goals.

On April 20, 2024, EPA ORD hosted a public discussion with community residents on “*How do the People of Crisfield Feel about their Coastal Natural Spaces?*”. Meeting participants were asked to provide their thoughts and insights on:

- Where are some of Crisfield’s most important natural or outdoor places and why?
- Who uses or cares about Crisfield’s coastal natural spaces?
- What is it about coastal spaces that matters to people?
- How do changes in coastal spaces affect people?

Information learned from these two meetings will be used to help EPA ORD focus research on NBS around what matters most to Crisfield stakeholders. ORD plans to engage a technical working group to get intermittent feedback as the research data collection and analysis progresses. Future institutional partner and public meetings are planned for EPA to present and discuss research results with all interested parties.



# Institutional Partners Meeting - April 19, 2024

“Supporting Coastal Community Resilience through Natural Infrastructure”

## MEETING PURPOSE

The US Environmental Protection Agency Office of Research and Development (EPA ORD) is working together with the City of Crisfield, Maryland, and a growing community of partners, to explore whether natural infrastructure options, such as salt marsh restoration or living breakwaters, can help address storm flooding issues and other community resilience concerns<sup>1</sup>.

On April 19, 2024, EPA ORD held a meeting to solicit input and feedback from institutional partners for moving forward with the research. Participants were identified from various institutions in the Crisfield and Chesapeake Bay area as having an interest, expertise, or role to play in decisions about potential natural infrastructure strategies for Crisfield, Maryland. The meeting was held at the Crisfield Public Library, with a virtual option for remote participants. Fourteen participated in person and 18 virtually. Participants included federal, state, and local government agencies, elected officials or their staff, and university and non-governmental organization (NGO) representatives.



Figure 1. Public wall art in Crisfield, MD (Photo credit: EPA ORD).

Table 1. List of organizations represented at the April 19 Meeting.

In Person Participants	Virtual Participants
<ul style="list-style-type: none"> <li>City of Crisfield</li> <li>Somerset County</li> <li>Janes Island - Maryland Department of Natural Resources</li> <li>Lower Shore Land Trust</li> <li>Maryland Department of Planning</li> <li>Maryland State Senate</li> <li>US House of Representatives</li> <li>EPA Chesapeake Bay Program Office</li> <li>The Nature Conservancy</li> </ul>	<ul style="list-style-type: none"> <li>Maryland Department of Emergency Management</li> <li>Maryland Governor’s Office</li> <li>Eastern Shore Regional GIS Cooperative</li> <li>National Oceanic and Atmospheric Administration (NOAA) - Fisheries</li> <li>US Army Corps of Engineers</li> <li>EPA Region 3</li> <li>Maryland Department of Natural Resources – Chesapeake and Coastal Service</li> <li>University of Maryland Environmental Finance Center</li> <li>Consulting companies supporting EPA and Federal Emergency Management Agency (FEMA) (Tetra Tech, LimnoTech, CDM Smith)</li> </ul>

At this meeting EPA shared the history, goals and status of ORD research with Crisfield. Most importantly, ORD wanted to engage in an interactive discussion with the key decision makers and advisors about what had been learned so far and plans for next steps.

<sup>1</sup> [www.epa.gov/water-research/coastal-community-resilience-research](https://www.epa.gov/water-research/coastal-community-resilience-research)



The information was presented and discussed in two major sections, structured according to two major research objectives:

1. Understanding and identifying **which specific types of nature-based strategies (NBS) might be most effective** for the Crisfield community at reducing the severity of storm impacts, wave impacts, and related flooding and erosion.
2. Identifying **the other types of environmental, social, and economic co-benefits** that these different types of NBS will simultaneously provide that the Crisfield community is interested in because they contribute towards achieving Crisfield's broader coastal resilience goals.

ORD presented how the research team envisions moving forward on each focus area and solicited feedback from community institutional partners.

## RESEARCH PROJECT OVERVIEW

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### WHY NATURE-BASED STRATEGIES FOR CRISFIELD?

The ORD team began the meeting by presenting an overview of the research project and goals. EPA ORD conducts research coastal community resilience, and works with EPA Regional offices and other partners to identify research projects that help meet local needs. In 2022, ORD connected with The Nature Conservancy who was leading a project funded by the NOAA Adaptation Science Program to develop coastal resilience strategies with Crisfield<sup>2</sup>. Through this collaboration, EPA ORD learned about Crisfield's concerns around tidal flooding and possible infrastructure strategies and saw an opportunity to investigate options for nature-based strategies (NBS) to help with storm flooding and erosion prevention, as well.

There is a lot of promising research in this area, many successful examples around the country of communities implementing these kinds of strategies, and a lot of current funding available at the state, federal, non-profit and even private level to invest in natural or green infrastructure. For Crisfield, NBS may make sense given the abundance of historical and current natural systems, such as the salt marshes and seagrasses surrounding Crisfield, as well as extensive and historical oyster reefs.

Moreover, nature is deeply interwoven with Crisfield's community resilience goals because tourism and recreation are tied to water access (providing boating, fishing, hunting, natural beauty), economic development is associated with commercial fisheries and a working waterfront, and Crisfield celebrates and values cultural preservation of the shared environment. And these values are held not just for the City of Crisfield but also the surrounding unincorporated areas, and others that live, work, and play here that are all considered part of the Crisfield community.



Figure 2. Crisfield, MD at sunset (Photo credit: EPA ORD).

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<sup>2</sup> [Van Dolah, E., Galarraga, J., Specht, J., Bailey, S., Sharif, H., Ferreira, C., de Souza de Liza, A., Egan, J., Dalke, S., Espinola, B. NOAA AdSci Report: Flood Adaptation Assessment for Enhanced Community Resilience. June 2024.](#)

### ***Project History, Coordination, and Partnerships***

For EPA ORD, part of the draw of this kind of collaboration was the understanding that technical assistance and project implementation are complex, and really benefit from the involvement of multiple types of skillsets and teams working together to tackle different parts of the challenge.

In 2022, EPA ORD partnered with **The Nature Conservancy (TNC)** and their existing NOAA-funded project working with **George Mason University** and the **University of Maryland Environmental Finance Center** exploring flood modeling scenarios and better understanding the flood reduction benefits of different land-based strategies, including both hard and green infrastructure options<sup>3</sup>. TNC led a series of workshops with a Community Advisory Committee made up of leaders of local non-profit organizations, faith communities and businesses who provided feedback and input for the modeling scenarios and identified six broader community resilience goals: resilient infrastructure, safe and affordable housing, business and job opportunities, recreation and tourism investments, youth development, and enhanced community spaces. Simultaneously, out of **EPA's Office of Water**, the Creating Resilient Water Utilities (CRWU) team helped Crisfield explore different ditch system versus piping drainage management options now and in the future based on different scenarios of extreme weather events. **FEMA** was then able to build on information learned through both of these projects, as part of a Building Resilient Infrastructure and Communities (BRIC) Direct Technical Assistance (DTA) grant to the City of Crisfield, to design essentially hard infrastructure flood reduction strategies such as raising roads and installing pumps, while also incorporating green infrastructure water storage components in the form of constructed wetlands and wetland restoration, and TNC is helping support these efforts.

EPA ORD has been working on complementing these land-based efforts by helping Crisfield explore offshore or nearshore NBS to help reduce storm surge, waves, and erosion before the water gets to Crisfield. The research team has been coordinating with **EPA Region 3** and **Chesapeake Bay Program Office** to ensure implementation considerations such as feasibility are addressed throughout the research process to the extent possible. The ORD project team is also coordinating with **Audubon's Marshes for Tomorrow**<sup>4</sup> initiative who are working on local marsh restoration opportunities from an ecological perspective, including protecting the saltmarsh sparrow (*Ammodramus caudacuta*).

### ***Research Project Goals***

In working together with the TNC team and other partners over the first year of the project in 2022, EPA ORD has been able to better understand the Crisfield community, challenges, and needs. In response to those needs, and to make sure ORD is not duplicating efforts of related projects, the ORD-Crisfield project established the following goals to help explore with Crisfield how nature-based, or green infrastructure, strategies can potentially help protect Crisfield and the natural spaces they value:

- Investigate **nature-based strategies (NBS)** like saltmarshes or living breakwaters for addressing **coastal resilience** issues in and around Crisfield;
- Assess **economic, social and environmental co-benefits** of nature-based strategies that the Crisfield community may get from the locations where NBS are implemented;

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<sup>3</sup> <https://storymaps.arcgis.com/stories/fbe0ca80c30c44b5a94dfc4c8da32cc1>

<sup>4</sup> <https://www.delmarvarcn.org/marshesfortomorrow>

- **Co-develop information** with the community that is useful for decision making about Crisfield's future; and
- Help increase **community awareness** about resilience and environmental issues and **community capacity** to help address them, including through educational opportunities, per the City's request, co-created around topics of interest to the Crisfield community.

### Research Co-Production

The goal of this co-production process is that research is formulated and conducted to directly inform on-the-ground decisions by community partners about what type of NBS should be built where. Once decisions are made, then the implementation activities of funding, design, permitting and construction can take place. Although eventual implementation of NBS is not a research goal, it is important to consider implementation in research to make sure information provided on NBS is practical and feasible.

To be able to truly co-develop this research with the Crisfield community to inform decisions and implementation, EPA ORD has been and needs to continue to closely coordinate with the City of Crisfield, community members and other partners to ensure that vital elements of those future processes (such as community values and logistical considerations) feed into the research design itself.

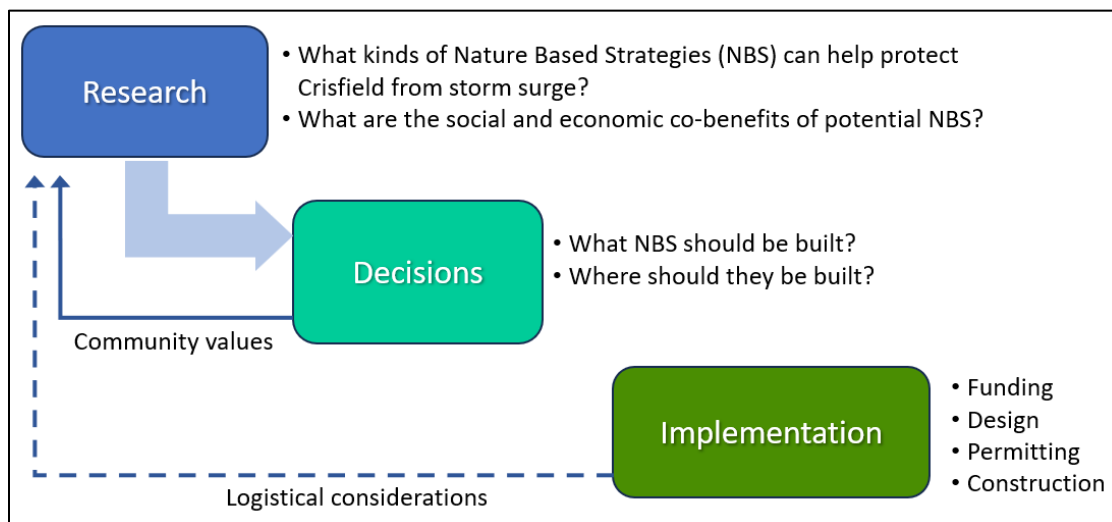


Figure 3. Diagram of the overall EPA research approach and driving research questions. Research on nature-based strategies (NBS) to protect Crisfield from storm surge and identify other potential co-benefits of NBS to fishing and recreation is intended to help inform Crisfield decision-making on what and where to build NBS (large light blue right-ward pointing arrow). For research to be most useful for decisions, it requires ongoing interaction with community partners to understand and address values the community cares about (thin blue upward pointing arrow). Although eventual implementation of NBS is not a research goal, logistical considerations such as funding, design, permitting, and construction (dashed blue upward pointing arrow) will also be integrated into research to make sure information provided on NBS is practical and feasible.

## NATURE-BASED STRATEGIES FOR STORM IMPACTS

### WHAT ARE NATURE-BASED STRATEGIES AND HOW DO THEY WORK?

The ORD team presented an overview and examples of nature-based strategies (NBS). NBS are ways to use nature to achieve desired community outcomes. For this project, the primary desired outcome is improved coastal resilience and less storm and wave flooding impacts. This outcome can be achieved by decreasing incoming storm wave energy, which will decrease wave heights by the time those waves reach the shoreline.

Natural obstructions can act to buffer against wave energy through different mechanisms, such as:

- Increasing roughness with vegetation, because more vegetation slows down waves and dissipates wave energy;
- Raising marsh elevation relative to sea level to obstruct and interact with waves and break up their energy, as well as support persistence of the marsh;
- Protecting marsh edges so that wave energy does not erode away the buffering ability the marsh provides; and
- Creating underwater barriers to wave energy where there were none before, such as artificial reefs.

The goal of designed natural infrastructure is to mimic the protections of natural systems.

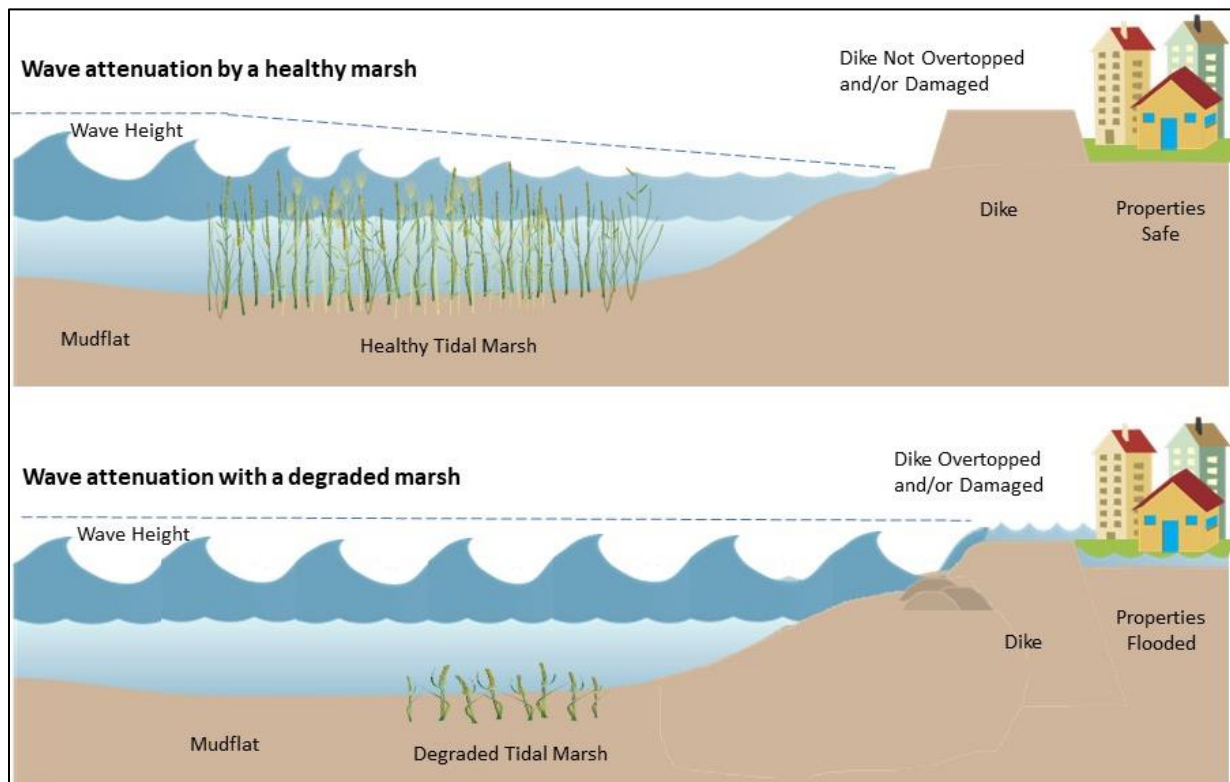


Figure 4. Illustration of wave attenuation by a healthy marsh that prevents a dike from being overtopped, and wave attenuation by a degraded marsh that fails to prevent storm waves from overtopping the dike and flooding properties. Figure modified from The Nature Conservancy's Coastal Resilience Network <https://www.esri.com/about/newsroom/arcnews/gis-helps-integrate-coastal-hazard-risk-and-sea-level-rise>. Clip art images were obtained from University of Maryland Center for Environmental Science Integration and Application Network ([ian.umces.edu/media-library](http://ian.umces.edu/media-library)).



Examples of different types of NBS that can create natural obstructions to protect a community against waves and storm surge are described below. Note the categories are not mutually exclusive. For example, living breakwaters could serve as artificial reefs (or vice versa), and breakwaters along the shoreline or restoration of marsh edging could be considered living shorelines.

**Salt Marsh Restoration** restores the physical, chemical, and biological conditions of a salt marsh back to a healthy state, before parts of it eroded or drowned, and to receive the full protections and benefits that the historical marsh used to provide. These benefits include dissipating wave energy, storing water in marsh areas higher than the tidal regime, and preventing erosion.

**Artificial Oyster Reefs or Living Breakwaters** are structures constructed from natural materials like rocks or oyster shell bags which are placed offshore to break up incoming wave energy. Reefs are typically submerged and can be seeded with spat to create oyster habitat. Breakwaters are typically partially submerged, with some portion of the structure above water. Because they create areas of calm water behind them and capture sediment, they can also be planted with submerged aquatic vegetation and marsh grasses, creating juvenile fish and crab habitat, preventing erosion, and filtering pollutants.

**Sand Dune Restoration** is a strategy for shoreline edge protection and erosion prevention in areas with existing sand dunes that prevents sand loss from wind and water. Restoration includes reestablishing dunes and protecting them by planting vegetation, constructing fences, and covering sensitive areas. Sand dunes can protect beaches from erosion during storms and can dissipate wave energy, protecting marshes behind them.

**Living Shorelines** are another way to prevent erosion and actually accumulate sediment deposited from dampened waves. They are stabilized shoreline edges created from natural materials and vegetative plantings that are designed to grow over time. They reduce incoming wave energy, allowing sediment to drop out and plants to grow, and that vegetation is then able to stabilize existing sediment and trap additional sediment in a positive feedback loop.



Figure 5. From top to bottom: Salt marsh restoration. Credit: C. Comber/USFWS; Living breakwater. Credit: Matt Whitbeck/USFWS; Dune restoration. Credit: NASA/Kim Shiflett; Living shoreline. Credit: Partnership for the Delaware Estuary.

## FEASIBILITY ANALYSIS OF NATURE-BASED STRATEGIES FOR CRISFIELD

Next the ORD team presented preliminary results from a feasibility analysis of nature-based strategies (NBS) in different locations around Crisfield. For full details and final report see EPA 2025<sup>5</sup>; preliminary results were summarized at the meeting.

To better understand which specific strategies might work best for Crisfield, EPA ORD conducted a literature review to identify existing natural infrastructure projects that are already successful at storm surge and wave attenuation and erosion prevention in areas like Crisfield. ORD then extracted and summarized environmental criteria associated with the success of these existing projects, and identified conditions required for them to be successful. Success criteria were then matched to spatial data layers of local environmental conditions for each location around Crisfield.

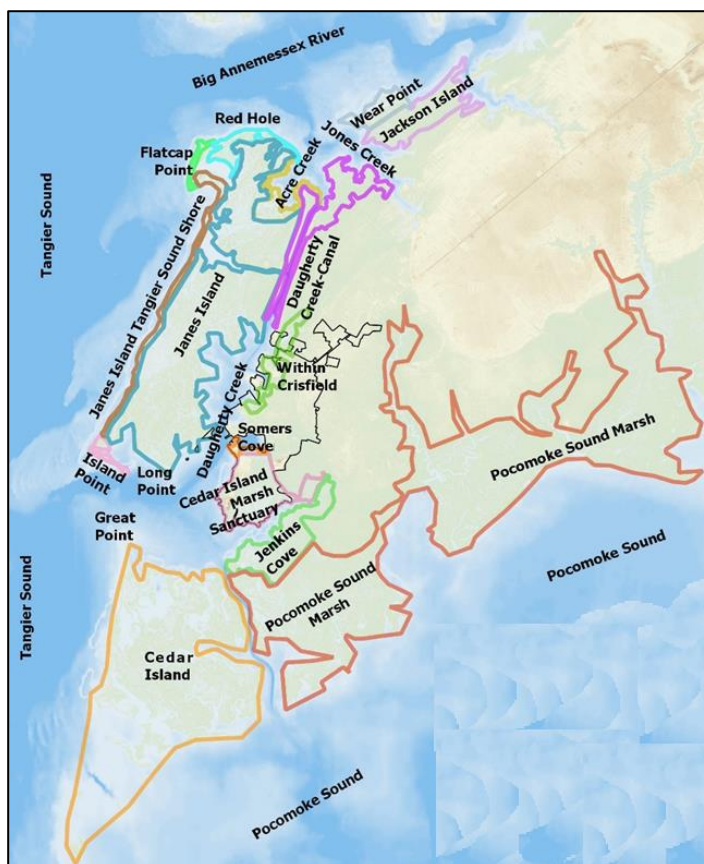


Figure 6. Locations around Crisfield where local environmental conditions were used to evaluate feasibility of different nature-based strategies.

Table 2. Criteria associated with successful natural infrastructure projects for storm surge and wave attenuation.

Environmental criteria	Effects on natural infrastructure success and siting
Shallow water	Natural infrastructure is not effective in deep water
Historical erosion demonstrates natural feature previously existed there	Can restore eroded areas if conditions are similar to historical conditions, but more challenging to restore where there are now greater stressors than before
Vegetation supported	Physical, chemical, and biological conditions allow for vegetation to grow and persist
Lower wave height	High wave height can overtop low elevation natural infrastructure
Lower wave energy	High wave energy can scour out sediments and erode coastlines
Gentle coastal land slope	Natural infrastructure is not effective where shore is steeply sloped
Presence of submerged aquatic vegetation (SAV)	Vegetation prevents marsh and living shoreline erosion, and creates more stable, healthy, and complex vegetated ecosystems
Bottom (underwater) substrate type	Marsh reeds can grow in clay soils, and other types of natural infrastructure require sand or silt to grow and function

<sup>5</sup> EPA 2025. Literature Review and Initial Scoping of Nature Based Solutions for Coastal Resilience in Crisfield, Maryland. U.S. Environmental Protection Agency, Washington, DC. EPA/600/R-25/XX.



Nature-based strategies can help restore some of the features that were historically present within the Crisfield area and preserve the natural ecosystems that already exist. NBS types were scoped as feasible for a particular location if:

- 1) Local environmental conditions were favorable,
- 2) The solution was likely to decrease storm surge in that location,
- 3) The solution was likely to decrease coastal erosion in that location, and
- 4) The location was not on private land, existing hard infrastructure, or high traffic areas that create disturbances (such as boat wakes) that could destabilize the NBS.

For this initial feasibility analysis, strategies were excluded for a location if minimum success criteria were not met at that location. The general conditions for each type of NBS are summarized below.

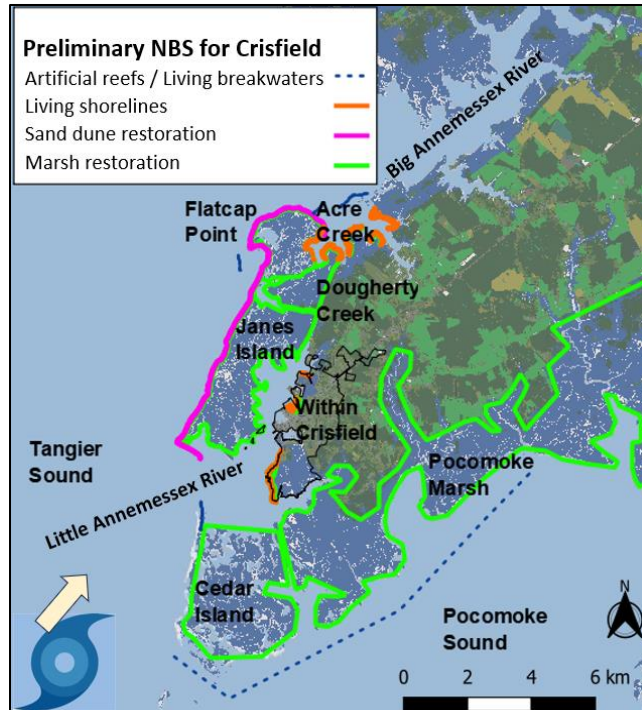


Figure 7. Preliminary results of NBS scoping analysis presented at the meeting, showing locations where artificial reefs or living breakwaters (blue dashed), living shorelines (orange), dune restoration (pink), or marsh restoration (green) may work around Crisfield. Hurricane icon (lower left) illustrates a typical direction of major storms over the past 30 years.

**Marsh restoration** is not effective in areas with a high erosion rate, steep slope, or with no existing high marsh. Marsh restoration does make sense in areas where marshes are native, without high boat traffic, where elevation is relatively flat, and bottom substrate is composed of clay, sand, or silt. In the Crisfield community vicinity, such areas include Janes Island, Cedar Island, and Cedar Island Marsh Sanctuary.

**Sand dune restoration** makes sense where sand already exists, where the elevated shoreline is the primary defense against storm surge and where there is appropriate habitat for marsh vegetation and birds. It does not make sense to introduce sand where historically there was no sand. Potential locations for sand dune restoration around Crisfield include the existing, but eroding, sand dunes on the Tangier Sound side of Janes Island, as well as along Cedar Island. Sand dune restoration here can protect the marsh behind it.

**Artificial reefs** make sense in environments where there is a local history of commercial fisheries and aquaculture. They are not effective where the water is too deep or where they obstruct boat traffic, like the ferry route. Artificial reef structures can be placed at the edges of marshes around Janes Island or Cedar Island to protect marshes from degradation and erosion.

**Living shorelines** make sense in areas where the shoreline has eroded, that are relatively protected from high energy wave action, in shallow water, and have mild slope. Living shorelines may not be effective on Bay-side edges of Crisfield marshes where high wave energy could scour them out, or in water too deep for shoreline vegetation to grow. Lower wave energy areas around Acre Creek or along the borders of Crisfield or Cedar Island Marsh Sanctuary may be good candidates.

## PROPOSED SUBSET OF STRATEGIES FOR FURTHER ANALYSIS

The preliminary results presented at the meeting were based on matching environmental conditions at various locations around Crisfield with NBS success criteria identified in the literature review. To identify which strategies might be most effective at reducing waves and storm surge, hydrodynamic modeling is needed, which EPA intends to do as the next piece of the research project. For the timeline and limited resources of the project, it is not practical to model all possible locations and all possible combinations of NBS. Therefore, EPA ORD plans to narrow down – based on expert opinion, “back-of-the-envelope” coastal engineering calculations, and review of available data – a subset of strategies likely to be the most effective at creating obstructions that decrease incoming wave energy toward Crisfield. Once a subset of NBS and locations are selected using this initial screening approach, EPA ORD will utilize hydrodynamic modeling to further assess them.

### *Marsh Restoration at Janes Island, Cedar Island, and Cedar Island Marsh Sanctuary*

A preliminary review of storm direction data<sup>6</sup> shows that the majority of Crisfield’s large storms over the last 35 years generally come from the southwest direction, from the Bay up into Crisfield. This means the Pocomoke Marsh to the southeast of Crisfield is not likely to provide as much storm surge and wave attenuation protection to Crisfield as the marshes of Janes Island or Cedar Island since storms are generally not coming from the southeast direction towards Crisfield.

So, the next question is, based on existing information, are the marshes to the northwest and southwest of Crisfield worth exploring as the most potentially effective NBS options, since these are the marshes that are located in between historically incoming storms and Crisfield?

This cannot be answered without more detailed hydrodynamic modeling evaluating potential storm attenuation across a variety of storms that EPA will address in a future report. At this time, USACE and NOAA provide initial data on storm surge for consideration. Results from 100-year storm modeling in open water conducted by the Army Corps in 2017<sup>7</sup> (North Atlantic Coast Comprehensive Study) show that peak tropical storm surge gets as high as 7 feet above the average level of the highest tide each day<sup>8</sup> immediately off the coasts of Janes Island and Cedar Island. A different model that includes overland storm surge, the NOAA National Hurricane Center model called SLOSH<sup>9</sup> (Sea, Lake, and Overland Surges from Hurricanes), runs several thousand hypothetical hurricanes under different storm conditions and calculates worst case snapshots of storm surge heights. SLOSH shows that storm surge height in the Janes Island marshes would be around 4 feet above ground level, and a little lower in Cedar Island. The

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<sup>6</sup> Summary of storm directions from 42 named storms that passed through the Chesapeake Bay or Delmarva Peninsula region between 1990 and 2024 compiled from data sources:

MARISA. (2019). Chesapeake Bay Watershed climate impacts summary and outlook: fall 2019. Retrieved from <https://www.midatlanticrisa.org/climate-summaries/2019/12.html#part-4-hurricanes-and-tropical>.

National Hurricane Center. (2024). NHC data archive. Retrieved from <https://www.nhc.noaa.gov/data/>.

National Weather Service. (2024). NWS weather forecast offices. Retrieved from <https://www.weather.gov/>.

<sup>7</sup> Cialone, M.A., T.C. Massey, M.E. Anderson, A.S. Grzegorzewski, R.E. Jensen, A. Cialone, D.J. Mark, et al. 2015. North Atlantic Coast Comprehensive Study (NACCS) coastal storm model simulations: waves and water levels. Vicksburg, MS: Technical Report (Engineer Research and Development Center (U.S.)); no. ERDC/CHL TR-15-14, 252p. [https://www.northeastoceandata.org/files/metadata/NACCS/NACCS\\_FileGeodatabase\\_metadata.pdf](https://www.northeastoceandata.org/files/metadata/NACCS/NACCS_FileGeodatabase_metadata.pdf).

<sup>8</sup> Mean Higher High Water (MHHW); defined: <https://www.weather.gov/media/phi/CFWTableWeb.pdf>

<sup>9</sup> National Weather Service ; <https://vlab.noaa.gov/web/mdl/slosh>. Jelesnianski, C. P., J. Chen, and W. A. Shaffer, 1992: SLOSH: SEA, Lake, and Overland Surges from Hurricanes. NOAA Tech. Rep. NWS 48, 71 pp.

two models are not directly comparable because they are reported relative to different vertical reference points and under different sets of storm scenarios. Moreover, SLOSH models overland surge based on changes in ground elevation or slope, and does not account for wave attenuation due to added friction from marsh vegetation<sup>10</sup>. However, studies conducted in other locations suggest that salt marshes such as these are capable of reducing storm surges that pass through them<sup>11</sup>, and recent modeling by George Mason University has explored the ability of marshes to attenuate waves in the face of marsh migration and sea level rise<sup>12</sup>. It therefore seems reasonable to proceed with modeling the storm surge and wave attenuation capabilities of the large marshes in the area to the northwest and southwest that could potentially protect Crisfield in the direction of incoming storms if they are maintained or restored through NBS actions.

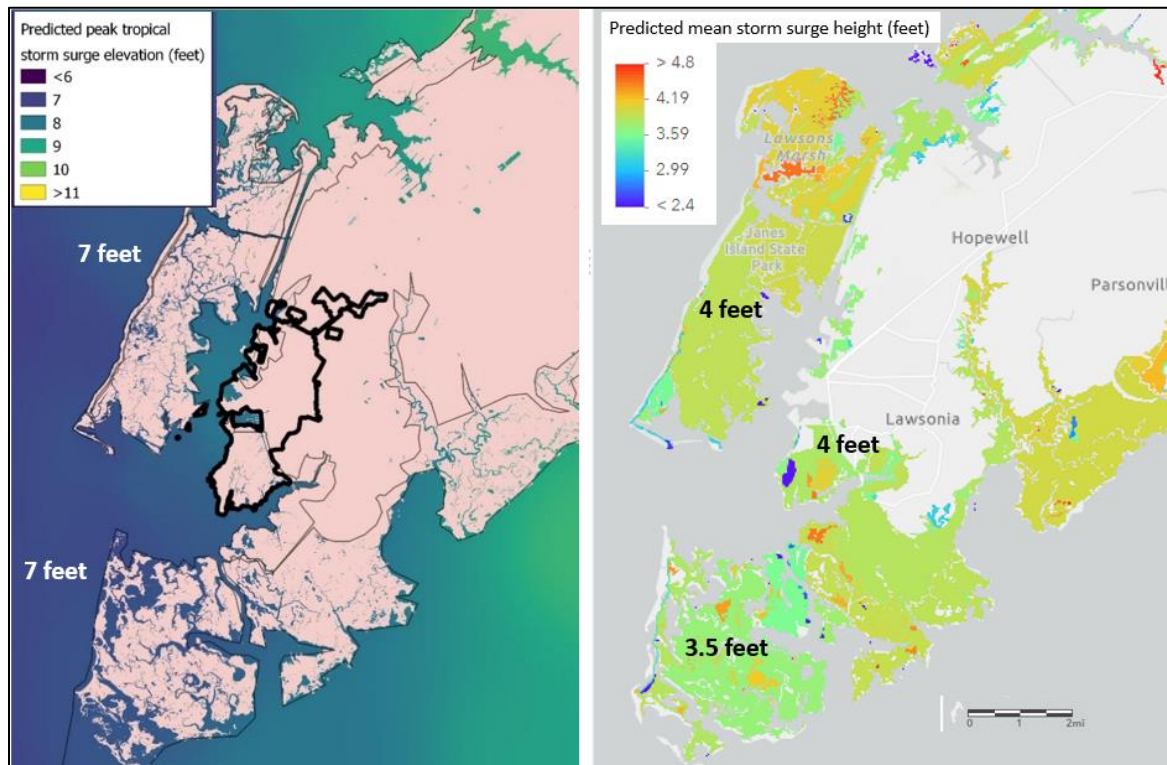


Figure 8. Peak storm surge height above high tide in open water from Army Corps 2017<sup>13</sup> modeling (Left) and storm surge height above ground in the marshes from NOAA SLOSH<sup>14</sup> Models (Right).

<sup>10</sup> <https://www.hurricanescience.org/science/forecast/models/modeltypes/stormsurge/>

<sup>11</sup> "Storm surge attenuation rates range from 1.7 to 25 cm/km depending on marsh and storms characteristics"; Leonardi, N., Carnacina, I., Donatelli, C., Ganju, N.K., Plater, A.J., Schuerch, M. and Temmerman, S., 2018. Dynamic interactions between coastal storms and salt marshes: A review. *Geomorphology*, 301, pp.92-107. <https://www.sciencedirect.com/science/article/pii/S0169555X17304579>

<sup>12</sup> Cassalho, F., A. de S. de Lima, C. M. Ferreira, M. Henke, G. de A. Coelho, T. W. Miesse, J. Johnston, and D. J. Coleman. "Quantifying the effects of sea level rise driven marsh migration on wave attenuation." *Environmental Monitoring and Assessment* 195, no. 12 (2023): 1487.

<sup>13</sup> Cialone, M.A., T.C. Massey, M.E. Anderson, A.S. Grzegorzewski, R.E. Jensen, A. Cialone, D.J. Mark, et al. 2015. North Atlantic Coast Comprehensive Study (NACCS) coastal storm model simulations: waves and water levels. Vicksburg, MS: Technical Report (Engineer Research and Development Center (U.S.)); no. ERDC/CHL TR-15-14, 252p. [https://www.northeastoceandata.org/files/metadata/NACCS/NACCS\\_FileGeodatabase\\_metadata.pdf](https://www.northeastoceandata.org/files/metadata/NACCS/NACCS_FileGeodatabase_metadata.pdf).

<sup>14</sup> National Weather Service ; <https://vlab.noaa.gov/web/mdl/slosh>.

### ***Dune Restoration and Living Shorelines in Combination with Marsh Restoration***

Larger marshes with higher elevation and dense vegetation are more likely to create substantive obstructions for storm waves than small scale projects, such as a few hundred feet of living shoreline or dune restoration. Therefore EPA ORD does not plan on using hydrodynamic modeling to individually evaluate small scale living shoreline or dune restoration projects at this time. However, sand dunes and living shorelines can provide useful edge protection for marshes, and could still be evaluated in potential combinations with marsh restoration at Janes Island, Cedar Island, or Jersey Island (Cedar Marsh Island Sanctuary) toward preserving the longevity of marsh restoration.

### ***Living Breakwaters in the Little Annemessex River Area***

Storms are apt to head for Crisfield without a marsh in their path, by passing through the open water between Janes Island and Cedar Island, which is also a ferry path. The original feasibility analysis did not propose many options in that area because being on a ferry path was one of the exclusion criteria. But EPA ORD has heard substantial local knowledge about erosion patterns along the marsh edges, especially Long Point on the south coast of Janes Island, where camping platforms have eroded, and also Great Point at the north coast of Cedar Island, where a duck blind from the 1970s is now up to a quarter mile out in the river. Therefore, another option for an offshore NBS, also raised by community members in prior community meetings, might be a set of wave barriers and erosion prevention strategies in the Little Annemessex River area.

At the meeting, EPA ORD also raised an idea the Army Corps proposed in 2012<sup>15</sup> to address storm surge issues, and had already started conversations with community members about the history of the project and why it did not end up getting implemented. The Army Corps had suggested three different breakwaters with options for them to be living breakwaters, specifically at the eroded areas of Great Point and Long Point, and a third one off Jersey Island. According to Army Corps preliminary calculations, this set of living breakwaters may be able to reduce storm surge height by 3.5 feet. Similar to the idea of restoring marshes to their historic conditions, living breakwaters such as these could build back some areas where the natural shoreline and marsh edge have eroded, to restore some of the protections that they had historically provided by extending into the open water gap between Janes Island and Cedar Island where they may have formed partial barriers to advancing storms. As living breakwaters, these structures could also create oyster habitat, water quality improvement, or other benefits that Crisfield might be interested in.

There are a lot of possible ways to design this kind of project – the original Army Corps proposal is just an example – and there are a lot of possible places to put these kinds of structures as barriers to incoming waves (possibly on Island Point at the south side of Janes Island or even stand-alone options in Tangier Sound). The design could be revisited and developed interactively with modeling of the effectiveness of different locations, and incorporating the community's receptivity to different modifications to this strategy.

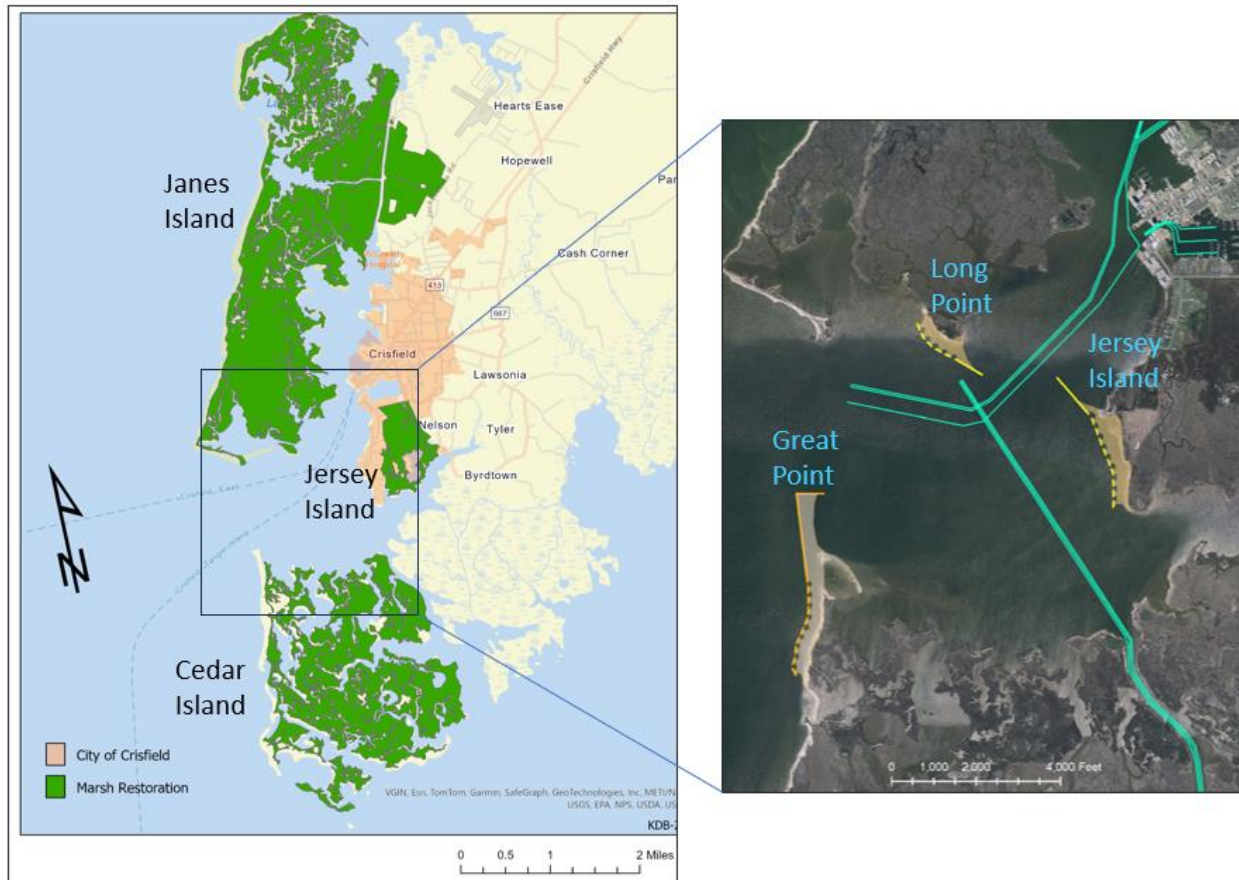
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<sup>15</sup> US Army Corp, Baltimore District. "Janes Island, Somerset County, MD. Initial Assessment Fact Sheet. CAP Section 103." December 2012.



### ***Next Steps for Hydrodynamic Modeling of Wave and Storm Surge Attenuation***

Next steps through summer 2025 are to better understand how much wave and storm surge water level reduction might be possible from these different types of strategies, tentatively identified as i) marsh restoration at Janes Island, Cedar Island, and/or Jersey Island, ii) marsh restoration at these location in combination with dune restoration or living shorelines, and iii) living breakwaters or artificial reefs in the Little Annemessex River or other locations (Tangier Sound).



*Figure 9. Proposed nature-based strategies most likely to attenuate waves and storm surge for Crisfield to be further evaluated with hydrodynamic modeling: marsh restoration at Janes Island, Cedar Island, and Cedar Island Marsh Sanctuary to the right of Jersey Island (Left) and living breakwaters in the Little Annemessex River such as those considered in an Army Corps 2012 analysis<sup>16</sup> (Right). Living shorelines and dune restoration proposed as ancillary edge protection implemented in combination with marsh restoration. Goals of such potential projects would be to protect and restore marshes so that the Crisfield community can benefit from their natural, protective, wave attenuation properties and/or to restore historic protections of eroded areas by building living breakwaters.*

Storm surge and wave attenuation under the current existing natural conditions for average and worst-case storms will be modeled in order to compare total water levels in the open water of the Bay heading towards Crisfield, compared to water levels at the coastline of Crisfield. The difference between them will be compared to a “do nothing” scenario by the years 2050 and 2100 to understand how much water height at the coastline of Crisfield will increase during storms over time if no solution is implemented.

<sup>16</sup> Continuing Authorities Program Section 103, Hurricane and Storm Risk Management Feasibility Phase: COASTAL ENGINEERING APPENDIX: Janes Island, Somerset County Maryland. 2015. U.S. Army Corps of Engineers (USACE) Baltimore District (NAB)

These future scenarios will include estimated water height increase due to sea level rise, including its effects converting marsh to flooded marsh or open water. Storm surge attenuation would then also be modelled assuming implementation of different NBS strategies to identify which are likely to be most successful.

## DISCUSSION AND FEEDBACK

After presenting an overview of nature-based strategies (NBS) for Crisfield and the proposed subset of options for hydrodynamic modeling, EPA ORD solicited feedback from meeting participants on the following:

- Do the proposed strategies and locations make sense?
- Should other strategies or locations be considered for hydrodynamic modeling?

Participants requested more details on **how living shorelines could be constructed**, such as by using Geoweb<sup>17</sup> or honeycomb with stone and sand, especially given concerns as to whether there is **too much wave action for a living shoreline** to work effectively in Crisfield. It was mentioned that Geoweb might be better for lakes. At this time, the ORD research project is focused on the degree to which a 'generic' living breakwater could attenuate storm surge, to understand whether more detailed engineering design questions are worth pursuing. Those would be questions for engineers as part of a future design process.

Participants wondered why the **US Army Corps of Engineering (USACE) proposed living breakwater project** from 2012 was never implemented and whether it may have been due to funding or a high Cost to Benefit ratio that did not take into account co-benefits in addition to storm attenuation. Participants also wondered whether a dike study that USACE began and halted was part of the living breakwater project. EPA ORD will engage with USACE to better understand the history of these projects.

Participants asked whether **natural accretion by healthy marshes would be able to keep pace with sea level rise**. George Mason University (GMU) did some preliminary modeling of marsh restoration on Cedar Island and Janes Island<sup>18</sup> in partnership with The Nature Conservancy (TNC) project. EPA ORD plans to do an expanded version of the GMU modeling to evaluate whether marsh restoration could have a near-term benefit, and the degree to which it may be impacted over time by sea level rise.

Participants mentioned that some **areas of Jersey Island are already elevated**, and asked whether the modeling would include making those elevated edges higher or restoring the open marsh behind the edges. EPA ORD will consider how to approach this question when designing the specific modeled scenarios.

Participants mentioned that channels (such as Daugherty Creek or the ferry path) might be dredged often, and whether the **local dredge material could be used for restoration projects**. Participants wondered whether lack of dredge material stalled the USACE project. Collaboration with the State of Maryland on implementing marsh restoration projects requires matching dredging schedules with timing of need for dredge material beneficial reuse. Participants mentioned upcoming plans and timing for

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<sup>17</sup> <https://www.prestogeo.com/applications/roads-highways/>

<sup>18</sup> Cassalho, F., A.S. de Lima, C.M. Ferreira, M. Henke, G. de A. Coelho, T.W. Miesse, J. Johnston, D.J. Coleman. "Quantifying the effects of sea level rise driven marsh migration on wave attenuation." *Environmental Monitoring and Assessment* 195, 12 (2023): 1487.



Janes Island marina dredging and whether it could be aligned with a marsh restoration project. Ferry channel thought to be last dredged in 1990s. Dredging needs in Somerset County may provide sediment needs for restoration projects.

It was mentioned that **Deal Island<sup>19</sup> was a good example** of an NBS where an artificial reef and living breakwater were recently implemented. EPA ORD is reviewing this restoration to identify whether there are options or lessons learned that may work for Crisfield.

Participants raised a **concern about the ferry path** being in close proximity to restored marsh or breakwaters, and whether moving the ferry path was an option. The set of strategies for which EPA plans to conduct hydrodynamic modeling would generally be positioned outside the path of the ferry, but potential impacts to the ferry could certainly be considered as one of many criteria influencing any ultimate decision-making about NBS.

*Table 3. Information sources and tools mentioned or shared by participants during discussions.*

Description of Tool	Website
USACE Goals for the beneficial use of dredge material	<a href="https://www.usace.army.mil/Portals/2/Increasing%20Beneficial%20Use%20of%20Dredged%20Material%20in%20USACE.pdf">https://www.usace.army.mil/Portals/2/Increasing%20Beneficial%20Use%20of%20Dredged%20Material%20in%20USACE.pdf</a>
Beneficial Use: Identifying Locations for Dredge (BUILD) Tool	<a href="https://dnr.maryland.gov/ccs/Pages/beneficial-use.aspx">https://dnr.maryland.gov/ccs/Pages/beneficial-use.aspx</a>
Maryland Coastal Atlas	<a href="https://dnr.geodata.md.gov/CoastalAtlas/">https://dnr.geodata.md.gov/CoastalAtlas/</a>
Eastern Shore Regional GIS Cooperative (ESRGC) modeled data using USACE Sea Level Rise projects, storm events using FEMA Hazus models, and 2020 LIDAR data	<a href="https://geoservices.salisbury.edu/arcgis/rest/">https://geoservices.salisbury.edu/arcgis/rest/</a>
Deal Island Restoration	<a href="https://www.dealislandpeninsulapartners.org/deal-island-shoreline-project">https://www.dealislandpeninsulapartners.org/deal-island-shoreline-project</a>
City of Crisfield Flood Mitigation	<a href="https://www.crisfieldfloodmitigation.com/">https://www.crisfieldfloodmitigation.com/</a>

## SOCIAL & ECONOMIC BENEFITS OF NATURE-BASED STRATEGIES

### IDENTIFYING BENEFITS RELEVANT TO CRISFIELD

In the first part of the meeting, EPA ORD presented potential nature-based strategies (NBS) that might be effective at attenuating storm surge and waves. Next, EPA ORD presented an overview of current research plans for assessing additional social and economic co-benefits of NBS for the Crisfield community.

<sup>19</sup> <https://www.dealislandpeninsulapartners.org/deal-island-shoreline-project>

### Linking NBS to Resilience Goals

As part of The Nature Conservancy (TNC)'s NOAA AdSci project on tidal flooding<sup>20</sup>, TNC worked with Crisfield partners to identify a number of community resilience goals, including:

- Improve city infrastructure
- Build safe & affordable housing
- Grow business & job opportunities
- Invest in youth development
- Enhance recreational amenities
- Protect community gathering spaces



Figure 10. Public mural in Crisfield, MD (Photo credit: EPA ORD).

TNC also heard interest in community retention and cultural preservation, tourism tied to the waterfront, and fisheries.

EPA ORD is interested in trying to better understand how NBS might contribute to achieving these resilience goals from Crisfield's perspective. For example, creation of living breakwaters In addition to helping attenuate storm waves, may also provide habitat for fish and shellfish, helping to maintain and support jobs in the fishing industry. As another example, salt marsh, in addition to helping attenuate storm waves, provides important habitat for plants and animals, that recreational hikers or birdwatchers may enjoy, or can also help to buffer water movement creating calm waters for recreational kayaking.

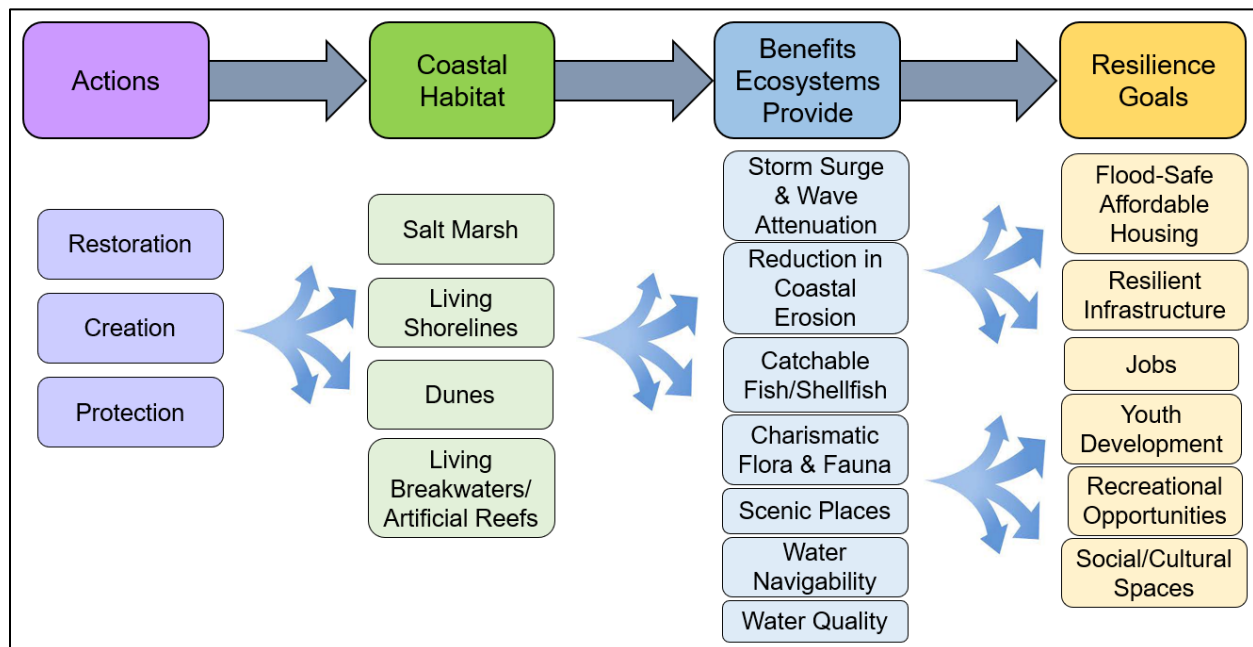


Figure 11. Actions to restore, create, or protect coastal habitats, such as salt marsh or living shorelines, can provide benefits in addition to storm surge and wave attenuation, such as catchable fish, charismatic fauna, and water navigability, that contribute to Crisfield's resilience goals, including jobs or recreational opportunities.

<sup>20</sup> Van Dolah, E., Galarraga, J., Specht, J., Bailey, S., Sharif, H., Ferreira, C., de Souza de Liza, A., Egan, J., Dalke, S., Espinola, B. NOAA AdSci Report: Flood Adaptation Assessment for Enhanced Community Resilience. June 2024. <https://storymaps.arcgis.com/stories/fbe0ca80c30c44b5a94dfc4c8da32cc1>

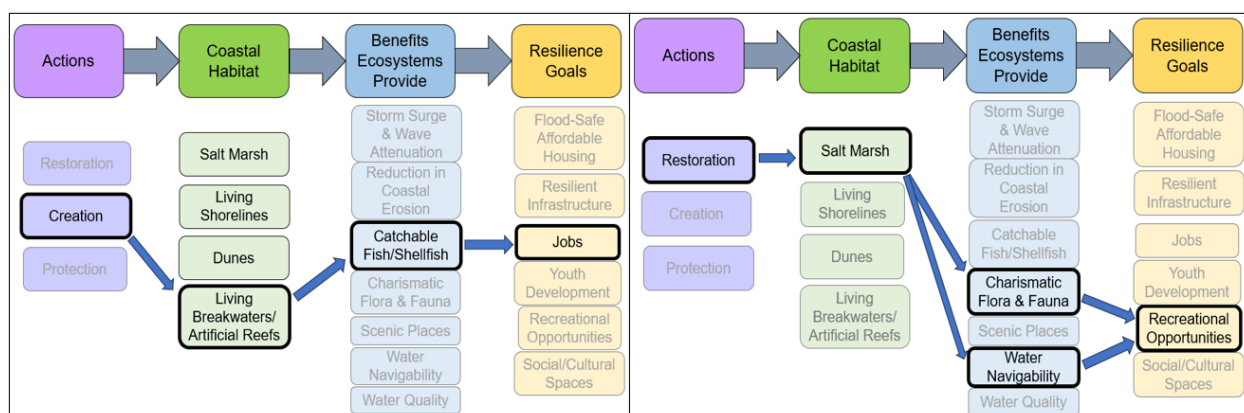


Figure 12. Example pathways by which creation of living breakwaters can provide habitat for fish and shellfish contributing to fishing jobs (Left) or restoration of marsh can provide habitat for charismatic fauna like waterfowl or calm waters for boating contributing to recreational opportunities (Right).

### Analysis of Crisfield Area Planning & Management Documents

EPA ORD did a preliminary document-based assessment<sup>21</sup> to get a better understanding of the kinds of social and economic benefits that may be important to the Crisfield community and the Crisfield area. For the assessment EPA reviewed over 30 Crisfield area planning, management, visioning, and outreach documents<sup>22</sup> that had the potential to mention some type of benefit that people in the Crisfield area derive from their coastal habitats. Sentences were reviewed for language that conveyed a benefit of coastal habitats to people, such as *“The revived number of some waterfowl has created opportunities for photographers, birdwatchers, artists, and nature enthusiasts.”*<sup>23</sup>

<sup>21</sup> For technical details on document analysis methods see Yee, S.H., R.S. Ennis, L.M. Sharpe, M.C. Harwell, T. Newcomer-Johnson. 2024. Final Ecosystem Goods and Services (FEGS) Document Reader. U.S. Environmental Protection Agency, Gulf Breeze, FL. EPA/600/R-24/336.

<sup>22</sup> Addendum to Community Visioning Summary City of Crisfield (2023), Blue Crab Scenic Byway Corridor Management Plan, Lower Shore Eastern Heritage (2004), Charter of the City of Crisfield, Somerset County Maryland (2014), Chesapeake Bay Foundation Smith Island Environmental Education Program (2022), City of Crisfield Drainage Assessment Report (2023), Community Visioning Report City of Crisfield (2023), Community, Culture, and Economic Development: Continuity and Change in Two Small Southern Towns (2013), Crisfield Housing Authority, Crisfield, Maryland, Public Housing Program Operating and Capital Funds (2018), EPA Region 3 Stories of Progress in Achieving Healthy Waters: Crisfield, Maryland (2015), Executive Report 2016-17 Forty Years of Saving and Sharing the History and Culture of Crisfield, MD - the Heart of Chesapeake Bay (2017), Feasibility Study Crisfield Downtown (2020), Janes Island State Park Water Trails (2021), Janes Island, Somerset County, Maryland Initial Assessment Fact Sheet (2012), Local Foods Local Places Community Action Plan Crisfield Maryland (2016), Lower Shore Tidal Marsh Climate Adaptation Project (2014), Maryland Department of Natural Resources Wildlife Management Plan for Cedar Island Wildlife Management Area (2014), Maryland Traveler: Smith Island Maryland (2008), Pass it On Cultural Traditions of the Lower Eastern Shore (2011), Public Notice Somerset County Recreation and Parks MD 413 Bike Path (2018), Regenerating the Chesapeake: An Underwater Approach (2012), Smith Island Vision Plan (2015), Somerset County Hazard Mitigation Plan Update (2017), Somerset County Maryland Visitor's Guide (2022), Somerset County Nuisance Flooding Plan (2020), Somerset County Trail Mix: Janes Island State Park (2016), Somerset County Trail Mix: Little Annemessex River Small Boat Harbor Crisfield (2016), Southeast Crisfield Somerset County Maryland Initial Assessment Report (2014), US Army Corps of Engineers Crisfield Harbor, Maryland Fact Sheet (2016), US Army Corps of Engineers Janes Island Somerset County Maryland Fact Sheet (2014), US Army Corps of Engineers Smith Island Environmental Restoration Somerset County MD Fact Sheet (2021), US Army Corps of Engineers Southeast Crisfield Fact Sheet (2015)

<sup>23</sup> Pass it On: Cultural Traditions of the Lower Eastern Shore (2011)

Sentences in documents were counted if they mentioned three things: 1) a type of coastal habitat, such as ‘salt marsh’, or nature in general, such as ‘water’, 2) a type of natural resource user or beneficiary’, such as ‘birdwatchers’, and 3) a type of ecological attribute that user cares about or wants to see, such as seeing charismatic species of ‘waterfowl’. The relative importance of different types of benefits were then ranked based on the frequency at which they were mentioned across documents.

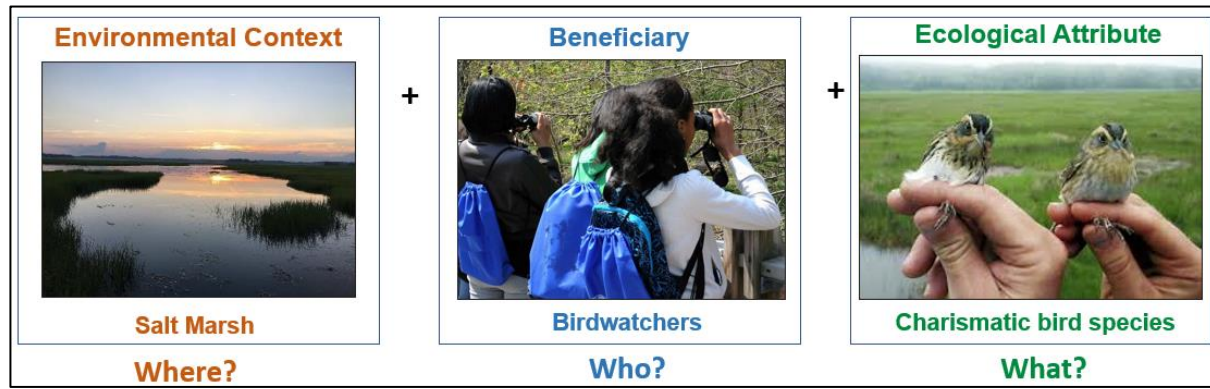


Figure 13. Three pieces of information extracted from document sentences: i) the environment people are visiting or care about, ii) the type of resource user or “beneficiary”, and iii) the ecological attributes they care about.

The type of user mentioned most frequently across documents was just “People Who Care”. This could reflect wanting to conserve and protect habitats ‘just because’ or for ‘future generations.’ These are people who may never physically visit or use these habitats for a specific reason, but still care about them. Landowners, homeowners, residents, and the general public were also commonly mentioned. Recreational uses such as wildlife viewing, scenic viewers such as hikers, and recreational boaters were often referenced. Educators and students were also important, along with transportation uses such as stable dry land for roads or open calm water for ferries. Other beneficiaries of coastal habitats included artists and inspirational users, such as photographers, recreational and commercial fishermen, water and energy utilities, and commercial businesses.

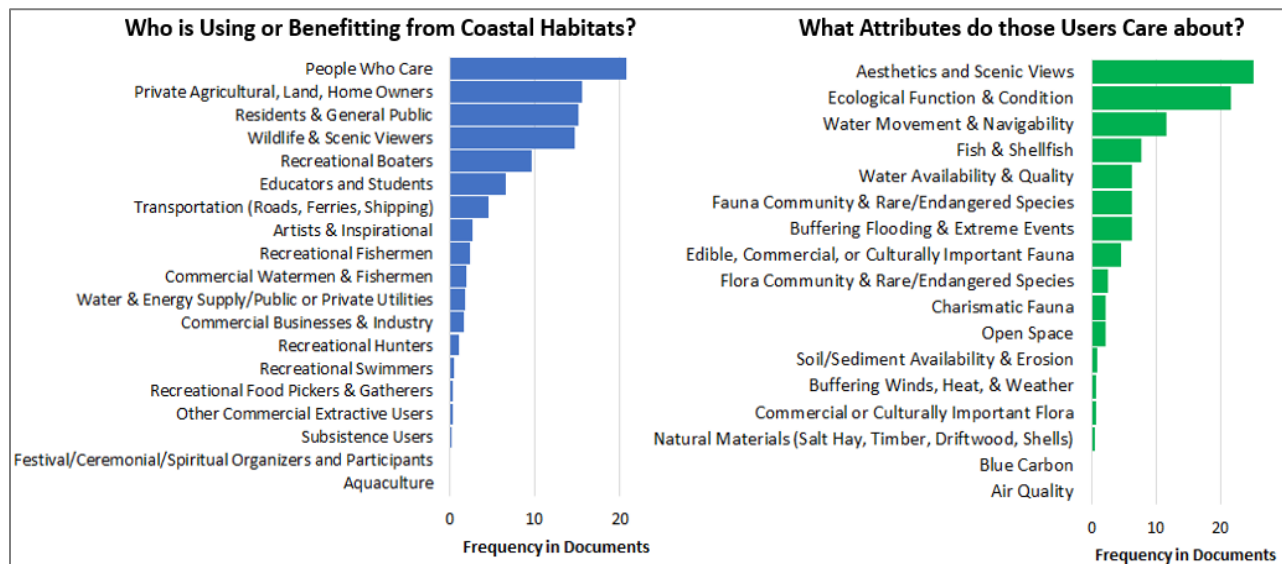


Figure 14. Frequency by which different types of resource users or “Beneficiaries” (Left) and the ecological attributes those users care about (Right) were mentioned in reviewed documents.

The document analysis then looked at the attributes that each of those users of Crisfield's coastal habitats cares about. Overall, across all types of users, aesthetics and scenic views (the beauty of the area), were most commonly mentioned. Ecological function and condition, that is, wanting healthy ecosystems, was also commonly mentioned. Water flow and water navigability for boating were also common. Other stated attributes included: fish and shellfish; water availability, access and quality; having a healthy, diverse fauna and flora community, and protecting rare or endangered species; protection from flooding and storm events; commercial or culturally important fauna, such as for hunting; charismatic fauna (attractive and popular animals); open natural spaces; and protection from erosion and wind.

The document analysis was intended only as a starting point for brainstorming discussions with meeting participants – to illustrate kinds of resource users and kinds of characteristics of coastal habitats that could be important to Crisfield. EPA ORD will continue to work with the Crisfield community to identify the most important co-benefits to consider as part of the research to implement NBS.

### ***What are Important Co-Benefits to Consider when Evaluating Nature-Based Strategies for Crisfield?***

Meeting participants were asked to brainstorm what they think are “**Some of the most important social and economic co-benefits that should be considered when evaluating nature-based strategies for Crisfield?**”. Individual responses were organized live during the meeting in a word cloud. Tourism, preserving cultural history, ferry potential, storm protection and flood abatement, local businesses, fisheries and seafood industry, natural beauty, wildlife habitat, flora and fauna, education, economy, and safe housing were all mentioned.



*Figure 15. Word cloud generated by participants during the meeting of important social and economic co-benefits that EPA ORD might consider when evaluating nature-based strategies for Crisfield. Larger font size indicates a word provided by multiple participants.*

## **IDENTIFYING WHAT TO MEASURE TO COMPARE NATURE-BASED STRATEGIES**

Once EPA ORD has worked with institutional and community partners to identify top potential benefits of nature-based strategies (NBS) that the Crisfield community cares about, the next step will be to identify ways to measure these benefits in order to evaluate and compare the pros and cons across different NBS options. As previously mentioned, hydrodynamic modeling will be used to compare benefits of storm surge and wave attenuation under current and NBS implementation conditions. Similarly, additional modeling will be used to evaluate co-benefits of NBS, such as increased fishing, recreation and tourism.



Meeting discussions so far have focused on NBS in terms of their 1) effectiveness at attenuating storm surge and waves and 2) their potential additional social and economic benefits, but the EPA ORD research project recognizes that decisions to implement NBS are more complicated than just maximizing benefits and often include other kinds of criteria like project cost and complexity.

A useful framework<sup>24</sup> for identifying important criteria to consider when planning and designing restoration projects includes five elements:

- **Effectiveness** – How well can the NBS attenuate storm surge and waves, and will the NBS be resilient to future stressors, i.e., how long will its protections last?
- **Social and Economic Co-Benefits** – What are the additional potential socio-economic benefits the NBS can provide (beyond storm protection), and is the NBS perceived as fair or will only certain people benefit?
- **Feasibility** - Is the NBS feasible from the perspective of cost, regulatory or other hurdles, and the City's technical capacity to implement it?
- **Flexibility** - Is the NBS flexible, e.g., easy to maintain or modify in the future?
- **Urgency** - Are some NBS options more urgent than others for addressing an immediate threat at a particular location, for requiring more lead time, or for producing tangible benefits quickly?

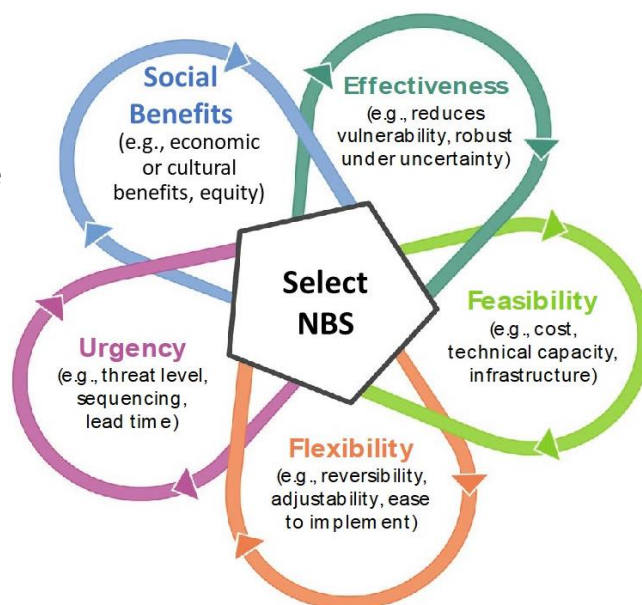


Figure 16. Decisions to select nature-based strategies (NBS) are influenced by criteria such as the effectiveness, feasibility, flexibility, urgency, and social benefits of NBS.

Ultimately, as part of the project, Crisfield will compare criteria selected based on conversations with the community across a set of potential NBS so that the pros and cons can be evaluated across these different options. At the meeting, EPA ORD shared a preliminary draft example table (Table 4) that could be used for this type of comparison. EPA ORD asked meeting participants to provide feedback on a table with example criteria that could be evaluated for NBS storm surge and wave attenuation functions, and other desired co-benefits such as increases in fisheries and tourism, and discuss which criteria make sense for Crisfield.

<sup>24</sup> Adapted from Shaver E C, Courtney C A, West J M, Maynard J, Hein M, Wagner C, Philibotte J, MacGowan P, McLeod I, Boström-Einarsson L, Bucchianeri K, Johnston L, Koss J. 2020. A Manager's Guide to Coral Reef Restoration Planning and Design. NOAA Coral Reef Conservation Program. NOAA Technical Memorandum CRCP 36, 128 pp.



Table 4. Example criteria that the Crisfield community might use to compare pros and cons of nature-based strategies. Criteria were discussed at the workshop and updated based on participant feedback.

	<b>Option 1</b>	<b>Option 2</b>	<b>Option 3</b>	<b>Option 4</b>	<b>Option 5</b>	<b>Option 6</b>
<b>Criteria</b>	Status Quo	Janes Island Marsh Restoration	Cedar Island Marsh Restoration	Little Annemessex Living Breakwaters	Marsh Restoration + Dunes/ Living Shorelines	Other Locations? Other NBS?
<b>Effectiveness for Storm Surge &amp; Wave Attenuation</b>						
Wave height reduction						
Rates of coastal erosion						
Resilience (Risk of Failure, Lifespan)						
<b>Additional Social &amp; Economic Benefits</b>						
Fish/Oyster/Crab Abundance						
Charismatic or Other Important Birds/Mammals/Reptiles						
Native/Rare Plants						
Seagrass/Marsh (Area & Quality)						
Aesthetics/Viewscales						
Water Navigability (Boating)						
Water Clarity						
Access for Recreation/Fishing/Education						
Fairness/Equitability of Benefits						
<b>Urgency</b>						
Time to implement						
Time to see tangible benefits						
Addresses an urgent threat at location						
<b>Feasibility</b>						
Project cost/Funding Opportunities						
Permitting or Other Hurdles						
Capacity/Ease to Implement						
<b>Flexibility</b>						
Ease of maintenance						
Ability to reverse/remove						
Ability to move/adjust						

Across the top are example options based on the subset of NBS potential projects that EPA ORD identified earlier (see [Proposed Subset of Strategies for Further Analysis](#)) as most likely to provide storm protection benefits: Restoring Janes Island marsh (Option 2), Restoring Cedar Island marsh (Option 3), or living breakwaters in the Little Annemessex River (Option 4). Other potential NBS options to evaluate could include an Option 1 of not doing anything, or Option 5 of implementing multiple projects simultaneously, or an Option 6 of other potential locations or other NBS projects the community might suggest.

The table illustrates an example of how the EPA ORD research team could compare different criteria across different NBS options, ultimately using modeling results to fill out the table. For example, some of

these options may be better for storm surge and wave attenuation but not as good for fishing or recreation, and vice versa. A structured evaluation process will help decision makers determine which combination of benefits justifies the corresponding level of project cost and complexity.

Using the table as a preliminary starting point for discussion, EPA ORD facilitated a discussion with the meeting participants on each of the five categories (effectiveness for storm protection, additional social or economic benefits, feasibility, urgency, and flexibility) for feedback on the example metrics or any other metrics or criteria that might be important to consider when evaluating nature-based strategies for Crisfield. Proposed metrics in each category were briefly reviewed and participants were asked “Which of these metrics or criteria might be most important to compare nature-based strategies, and are there others?”.

### ***Effectiveness for Storm Surge and Wave Attenuation***

EPA ORD plans to use hydrodynamic modeling to evaluate attenuation of storm surge and wave height along the coastline of Crisfield for various NBS. EPA ORD is also considering effects of NBS on rates of coastal erosion, particularly in terms of whether dune restoration or living shorelines may help to protect restored marsh habitats from erosion. Another important factor to consider is the resilience of these strategies to future stressors. In addition to modeling long-term ability of these strategies to attenuate storm surge in 2050 and 2100, including under sea level rise, EPA ORD plans to evaluate design elements that can help improve the longevity of the implemented strategies<sup>25</sup>.



Figure 17. Flooding in Crisfield, MD in 2012 after Hurricane Sandy (Photo credit: Maryland National Guard)

Participants emphasized that it will likely be important to evaluate implementing options in combination. For example, living shorelines by themselves may do little during a storm if the water overtops them, so it is important to do them in combination with marsh restoration. One might **expect combinations of options to be more protective**, but the hydrodynamic modeling in specific locations is needed to know with greater certainty given the complexity of water movement during storms. Of course, combinations of multiple NBS options are also likely to be more expensive.

Participants also noted that protection from erosion and longevity might be tied to maintenance and emphasized **evaluating the maintenance component** of project costs as part of the feasibility criteria.

Participants also raised the issue of the City’s drainage problem, and **whether NBS could help with drainage issues**. Although the EPA ORD project is focused offshore, the City indicated constructed wetlands are being considered as part of the FEMA project.

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<sup>25</sup> West, J.M., Courtney, C.A., Hamilton, A.T. et al. Adaptation Design Tool for Climate-Smart Management of Coral Reefs and Other Natural Resources. Environmental Management 62, 644-664 (2018).  
<https://link.springer.com/article/10.1007%2Fs00267-018-1065-y>

Participants spent a little time brainstorming what ‘other locations’ (other than those currently specified in the table) could be considered. Issues about accessibility to and by the community during storm flooding were raised, and whether there were high risk areas where Crisfield could be cutoff. The proposed storm surge and wave attenuation modeling is focused on protecting Crisfield on the coastal western side, but what is **protecting Crisfield on the east and south** where roads could be inundated by flood waters cutting of access routes to outside the City? Attendees from the city noted that, although the EPA ORD project is focused on coastal habitat restoration, there are several other projects being investigated, such as with the Federal Emergency Management Agency (FEMA) and The Nature Conservancy (TNC) that may more directly address inland flooding, and the City is focused on identifying multiple solutions that can work together<sup>26</sup>.

### ***Additional Social and Economic Co-Benefits***

In addition to providing storm protection, NBS also provide other functions related to desired community goals and priorities such as fisheries and tourism. For instance, effectiveness of different NBS for supporting fisheries benefits could be evaluated using criteria such as increase in fish, oyster, and crab abundance; amount and quality of fisheries habitat, and accessibility and navigability of fisheries areas. For tourism benefits, effectiveness criteria might include increased presence of attractive and popular birds and mammals; water navigability for boating or kayaking; and aesthetic measures of viewsapes and water clarity. Evaluations of potential benefits such as these could help to compare the pros and cons of different NBS options that support other valued co-benefits in addition to storm protection.



Figure 18. Public library and marsh boardwalk in Crisfield, MD. (Photo credit: EPA ORD)

EPA ORD posed that another important social consideration may be the distribution of the benefits; for example, depending on the type and spatial placement of an NBS, not all members of the community may benefit equally. In the prior discussion about effectiveness of storm protection, participants had already noted that proposed NBS options tended to favor the western side of Crisfield, and that flooding can also cutoff roads and people to the east and south, but noted that **multiple strategies working together in combination** could have overall broader benefits for people in the area.

Participants noted that **storm impacts are a deterrent for economic development**, including attracting businesses and tourism, attracting new residents because of concerns about property values and safety, and costs to the city to deal with frequent flooding that could be better spent elsewhere.

Participants noted that Crisfield has a great deal of **community cohesiveness**, which includes working together and really caring to improve the community, and discussed whether that perception can help attract more people.

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<sup>26</sup> <https://www.crisfieldfloodmitigation.com/>

### ***Feasibility, Urgency, and Flexibility***

Next, EPA ORD presented some other criteria that may be important to consider when deciding whether and which NBS option to implement. Feasibility includes criteria such as cost, regulatory or other hurdles, and the capacity of the City for implementation. Urgency speaks to the degree to which an NBS addresses an urgent threat at a location, takes advantage of an immediate funding or partnership opportunity, does not require substantial lead time to implement, or achieves tangible benefits within a short time frame. Flexibility of NBS can be expressed in terms of frequency and intensity of maintenance required, or the ease of ability to reverse, expand, move, or re-adjust it across space and time.

Participants noted that **dredging and availability of dredge material** is a huge maintenance issue, for some strategies more than others.

Participants noted alternative project options are required to be evaluated in light of **impacts to certain resources** (e.g., marsh, seagrasses) considering the project purpose under the Clean Water Act Section 404(b)(1). It was highly recommended to understand those potential impacts as part of the feasibility analysis.

### ***Additional Feedback on Potential Benefits and Challenges of Nature-based Strategies***

After soliciting feedback for each of the five categories of criteria above, EPA ORD posed the following questions for any additional feedback or discussion that could help further refine the evaluation criteria (rows in [Table 4](#)) and NBS options (columns in [Table 4](#)) on which the research team should focus their analysis:

- Do you think marsh restoration in these locations would benefit Crisfield and the surrounding community (in terms of storm surge protection or other co-benefits)? Living breakwaters?
- Do you see any potential challenges or disadvantages associated with marsh restoration in these locations? With living breakwaters?
- Is there anything else that might affect these projects in these areas to be aware of?
- Are there any other proposed strategies that should be considered? Do you know of any similar efforts that have been studied or tried in the past?
- Are there any locations or options that we should prioritize or de-prioritize for evaluation, and why?

Participants recommended also including **potential impacts to the ferry path** as another important criterion, particularly a living breakwater option in the Little Annemessex River. Participants wondered whether there would be appetite for modifications to the ferry operations, including within the context of bigger ideas for a bay-wide ferry route. Participants wondered whether changes to the ferry route might also create less waves and help with erosion and noted it would be important to do an assessment of impacts that changes to the ferry route would create.

Participants also raised the question of whether **extending the marshes into the Little Annemessex River**, rather than or in addition to the living breakwaters, was another option that could be considered. This is a possibility EPA will consider including as part of the hydrodynamic modeling.

## DISCUSSION AND NEXT STEPS

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### CO-PRODUCTION PROCESS

EPA ORD wrapped up the meeting by giving a brief overview of the research co-production process in four steps:

1. **Preliminary Research and Relationship Building** - In 2022-2023, ORD partnered with TNC, participated in meetings with and listened to the TNC advisory committee, and conducted local interviews to better understand the issues facing Crisfield.
2. **Research Goals and Design** – In April 2024, EPA ORD conducted the institutional partners meeting described here and public natural spaces discussions (described in the next section) to get feedback on the proposed research plan.
3. **Data Collection and Analysis** – From 2024-2025, EPA ORD plans to engage a technical working group to get intermittent feedback as the research progresses. The technical group will work in close collaboration with, and may overlap with, a related regulatory working group focused on logistical and permitting considerations of implementation.
4. **Results and Decision Framework** – Research results will be presented in a second round of institutional partner and public meetings (tentatively in the fall of 2025).

The final discussion addressed the following questions with meeting participants:

- Who should be on the Technical Working Group?
- How should stakeholders be kept updated?
- What kind of community involvement is needed?
- Are there other potential uses for the research the next 1,2,3 years?

Interested meeting participants **volunteered for the technical working group and recommended** additional subject matter experts and community members with extensive local knowledge. Participants noted that the broader public might be less engaged with technical details of the research, but would have a much larger engagement if projects moved toward implementation. Ideas such as time-lapse photo stands, being used on Deal Island by the Maryland Department of Natural Resources, may be **creative ways to get the community engaged**.

Participants noted **user groups that particularly likely to be engaged in implementation** include: fishing groups, duck groups, tour guides, water trail users (kayakers), local watermen. Participants noted it will be important to get their input and ensure that it is considered, valued, and included. Community partners, such as **high schools or youth groups**, may be able to be directly involved in implementation, if there are planting projects, for example. **Educational classes** may be another way to get youth involved.

EPA ORD announced plans to host a Crisfield Resilience Academy<sup>27</sup> in Fall 2024 and Spring 2025, as an **environmental education and leadership opportunity**. The goal is to help increase community understanding of resilience and environmental issues, and provide opportunities to interact with researchers and experts and gain practical knowledge of environmental challenges, policies, and programs that participants can share with their community networks.

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<sup>27</sup> <https://www.epa.gov/gcx/crisfield-resilience-academy>



## Public Natural Spaces Discussions April 20, 2024

### “How do the People of Crisfield Feel about their Coastal Natural Spaces?”

#### MEETING OVERVIEW

The U.S. Environmental Protection Agency held discussions on April 20, 2024 with residents of Crisfield and the surrounding area to learn how people use and feel about Crisfield’s natural coastal spaces. The discussions are part of a research effort to identify the potential impacts and co-benefits of nature-based strategies (NBS) on the Crisfield community, such as marsh restoration, living shorelines, sand dune restoration, and artificial reefs. The objective of the meeting was to get thoughts and insights from residents of the Crisfield area on:

- Where are some of Crisfield’s most important natural or outdoor places and why?
- Who uses or cares about Crisfield’s coastal natural spaces?
- What is it about coastal spaces that matters to people?
- How do changes in coastal spaces affect people?

The meeting was held at the TidalHealth Alice B. Tawes Nursing and Rehabilitation Center in Crisfield. The meeting was publicly advertised via the city newsletter and social media accounts, with participants asked to preregister due to space limitations at the meeting location. There were 23 participants at the meeting, people who live and work in the Crisfield area. Upon arrival at the meeting, participants were asked to place a sticker on a poster map indicating the general neighborhood where they live. Participants identified as being residents within the Crisfield city limits; the Crisfield area neighborhoods of Marion Station, Hopewell, Sackertown, Byrdtown, and Lawsonia; Smith Island; and further outside the Crisfield area.

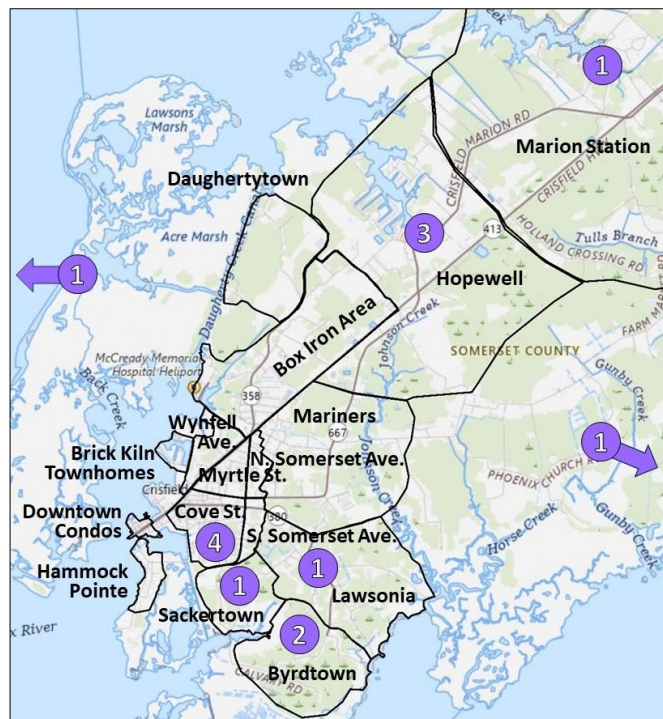


Figure 19. Circles indicate number of participants who placed a sticker within that neighborhood. Neighborhood boundaries were delineated as part of The Nature Conservancy tidal flooding project<sup>28</sup>.

<sup>28</sup> Van Dolah, E., Galarraga, J., Specht, J., Bailey, S., Sharif, H., Ferreira, C., de Souza de Liza, A., Egan, J., Dalke, S., Espinola, B. NOAA AdSci Report: Flood Adaptation Assessment for Enhanced Community Resilience. June 2024. <https://storymaps.arcgis.com/stories/fbe0ca80c30c44b5a94dfc4c8da32cc1>



## WHERE ARE CRISFIELD'S MOST IMPORTANT NATURAL PLACES?

Prior to starting the meeting, participants were also asked to place a sticker on a poster map of the Crisfield area to identify “What are Crisfield’s Most Important Natural or Outdoor Places?”. These could include favorite places to spend time outdoors or that are considered particularly unique or important. Two poster maps were available for stickers – one of the greater Crisfield area and one zoomed in on the area directly around the city. Participants could put stickers on either or both.

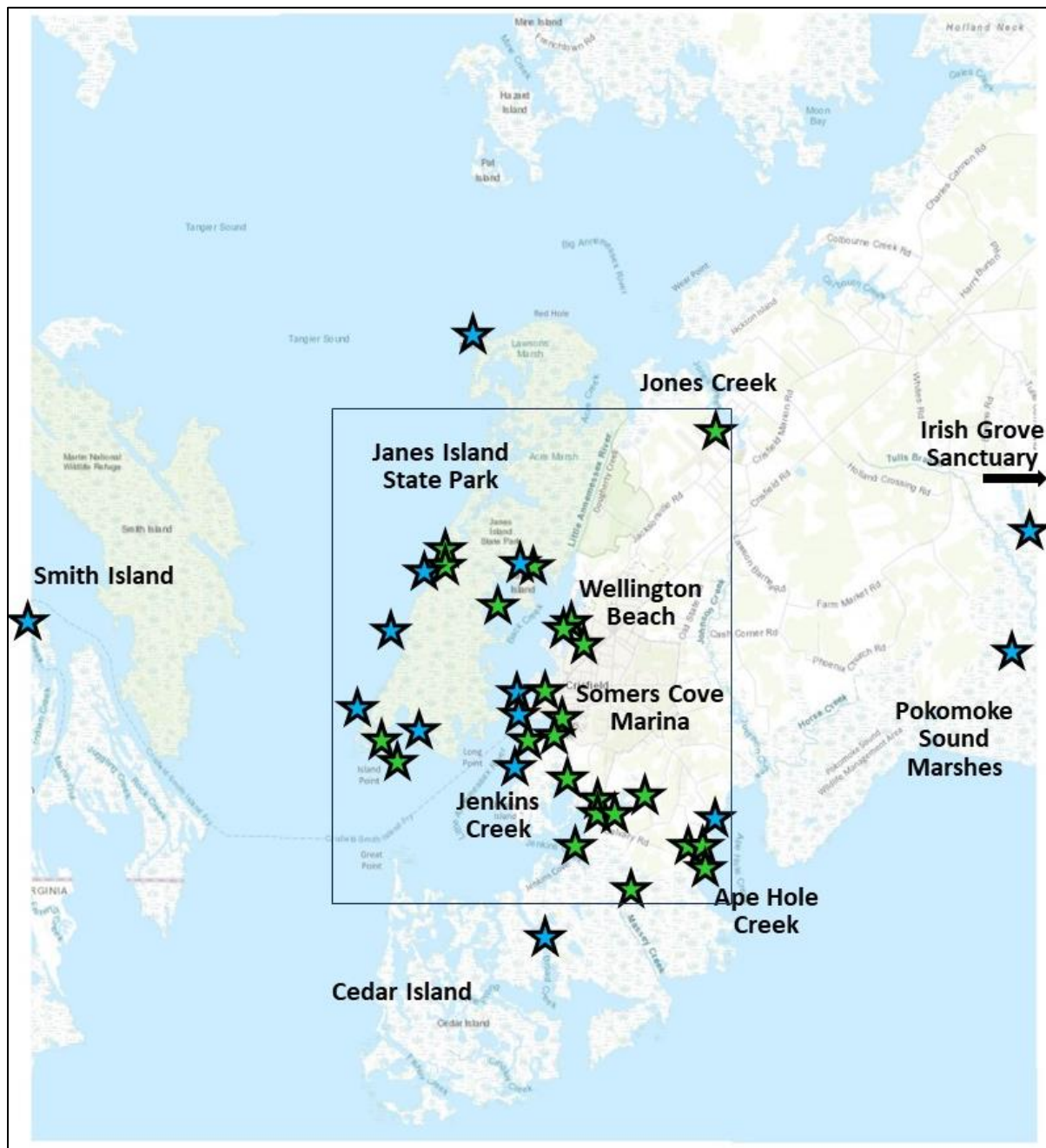


Figure 20. Locations where meeting participants placed stickers of important natural places in the greater Crisfield area (blue stars). The rectangular area was a second poster zoomed in on Crisfield where participants could also place stickers (green stars), with both sets of stickers combined here to one map. The rectangular area can be seen in greater detail in Figure 21.

Participants placed stickers on multiple locations around Janes Island State Park, Wellington Beach, Somers Cove Marina, Jenkins Creek, and Ape Hole Creek. Smith Island, Cedar Island, Jones Creek, and the Pocomoke Sound Marshes were also identified. After starting the meeting with a brief introduction of the objectives and agenda for the meeting, participants were asked to volunteer why they selected certain locations. Janes Island was identified for its free access as a resource with white, sandy beaches, a dock, a nature center, walking trails, and fishing. Also identified was Irish Grove Sanctuary, 2,300 acres of protected land owned by the Maryland Ornithological Society, and Crisfield Marina with its boat ramps is a nice resource for anyone with a boat. Beaches were mentioned as a place where dog lovers have a place to bring their dogs. Some family grave sites were mentioned in an area that is becoming marsh. Also identified was the Crisfield Library and City Dock area as community resources, and Cedar Island for duck hunting.

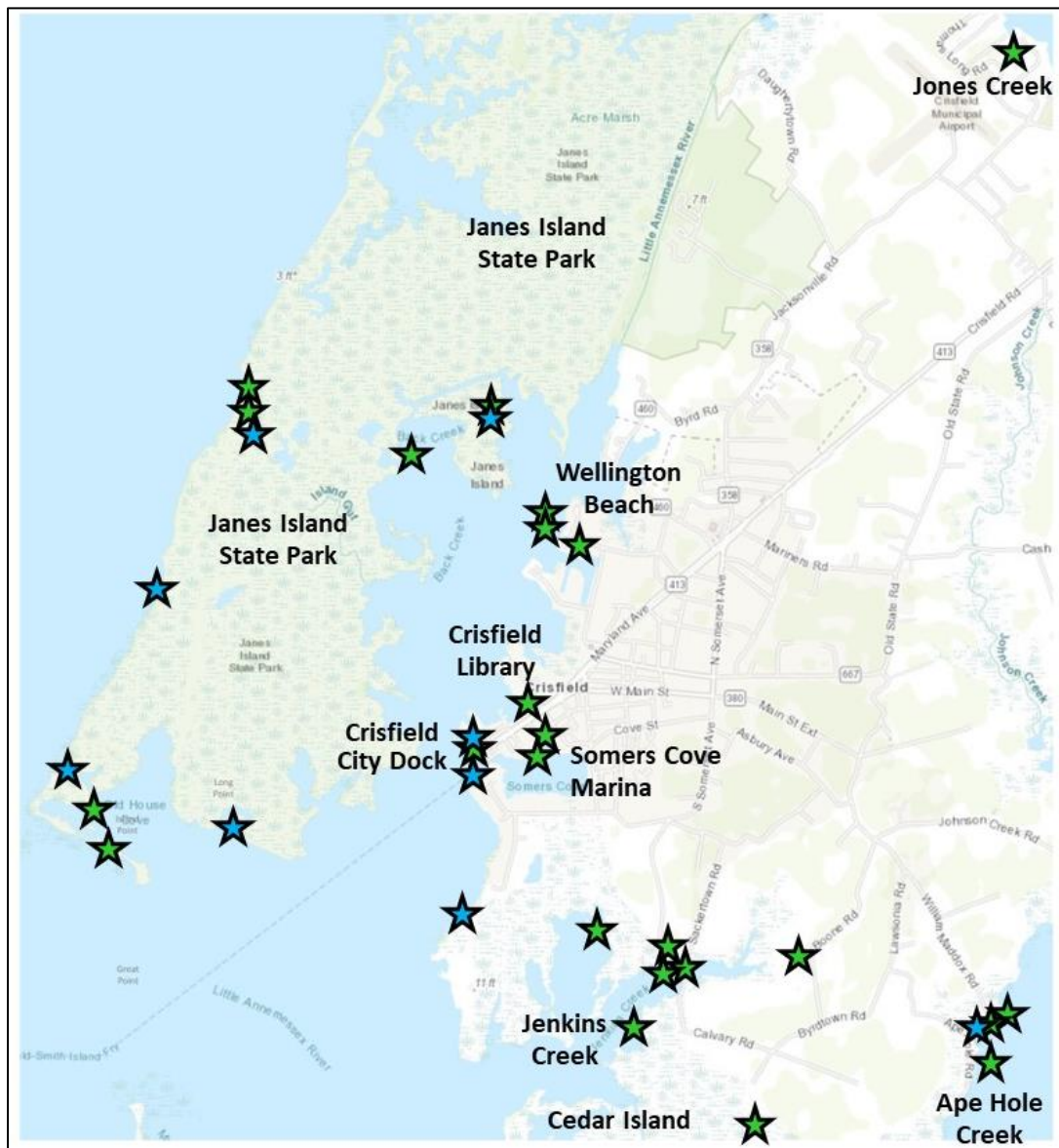


Figure 21. Zoom in on the rectangular area from Figure 20 detailing locations around the city of Crisfield where meeting participants placed stickers of important natural places. Stickers from the two posters – the greater Crisfield area (blue stars) or the zoomed in area around the city (green stars) were combined here to one map.

## WHO USES OR CARES ABOUT CRISFIELD'S COASTAL NATURAL SPACES?

Next, meeting participants broke into four small groups to discuss “Who Uses or Cares About Coastal Natural Spaces?” including i) Who uses, cares about, depends on, benefits from, or is affected by Crisfield’s coastal spaces, and why?, ii) What economic, cultural, social, or health impacts do coastal spaces have on people of Crisfield?, and iii) What are some challenges people face to using coastal natural spaces? Participants were provided visual examples of coastal habitats, including seagrass, beaches and dunes, oyster reefs or artificial reefs, shorelines, salt marsh, and breakwaters.



Figure 22. Top row Left to Right: Marsh (Credit: EPA ORD). Seagrass (Credit: E. French-E. Shields/VIMS). Breakwaters (Credit: EPA ORD). Bottom row Left to Right: Beaches and dunes (Credit: EPA ORD). Oyster reef (Credit: L. Kellogg/VIMS). Living shoreline (Credit: C. Stiehl/Chesapeake Bay Program).

## WHO USES, CARES ABOUT, DEPENDS UPON, OR BENEFITS FROM COASTAL SPACES?

Types of people identified during small group discussions as using or caring about Crisfield’s natural coastal spaces included:

- Watermen
- Tourists, the tourism industry, vacationers and visitors
- Locals, residents at large
- Store owners
- People who work in businesses owned by waterman food industry
- People who eat the crabs (consumers)
- Friends and family
- Bike riders and walkers on “rail to trail”
- Duck hunters
- Recreational fishermen
- Kids gathered on the beach
- Local beachgoers
- Artists, including painters and carvers
- Everyone



## WHAT ECONOMIC, CULTURAL, SOCIAL, AND HEALTH IMPACTS DO COASTAL SPACES HAVE ON PEOPLE?

Participants in small group discussions identified local residents and local businesses as being impacted by coastal flooding, contributing to economic (businesses closed; impacts on tourism), health and safety (access to hospital, mold issues), as well as nuisance (fish in yards; lawn mowing) concerns. The importance of the waterfront as part of Crisfield's cultural identity was also mentioned. Coastal spaces, like Janes Island and Smith Island, are also important for attracting visitors and vacationers to the area, and local businesses like hotels and restaurants are needed to support and sustain tourism. Both visitors and residents depend on coastal habitats for recreational opportunities, like fishing, hunting, and kayaking. Meeting participants also raised concerns about the ecological health of coastal habitats, including invasive species, erosion, and marsh degradation. Concerns were also raised about the role government agencies play in managing coastal habitats, and the impacts these decisions have on Crisfield.

*Table 5. General themes identified from small group discussions on who is impacted by coastal habitats and how. Notetakers captured quotes and thoughts from participants live during small group discussions in response to the question "What economic, cultural, social, and health impacts do coastal spaces have on people?". Post-meeting clarifications of notes by the EPA ORD authors are in italics. Notes were grouped into themes by EPA ORD after the meeting.*

Who is Impacted?	How are they Impacted?	Responses from Small Group Discussion Participants
Residents	Coastal Flooding	Flooding impacts people's ability to get to hospital for workers and patients. ◦ There is a real flooding issue on Ape Hole Creek; when the road floods it is hard to tell where the ditches and roads are. ◦ Flooding washes away property every day. During every high tide, yards and driveways flood. ◦ Crabs, fish, crawfish are in people's yards. ◦ Can't cut the grass because it's flooded with saltwater. ◦ People are struggling to keep mold out, and it causes negative health effects.
	Cultural Identity as a Waterfront Community	People locally depend on the fishing community. ◦ Noted waterman culture. ◦ Beauty ( <i>scenery</i> ), enrichment, language/culture are benefits. ◦ Gordon's Confectionary ( <i>near the waterfront</i> ) with its 100-year history.
	Community Cohesiveness	Culturally, it's a small town that comes together in a time of crisis. ◦ Opportunity for tourists and locals to do a coastal cleanup and be a part of the community ( <i>applies to both resident and visitors</i> ).
	Coastal Location	Can be anywhere in a short amount of time. ◦ It's a challenge being a rural area because of distance to other amenities.
	Health Benefits & Quality of Life	Mosquitos are a negative. ◦ There are health benefits living here. ◦ Quality of life has been impaired compared to when growing up
	Youth Opportunities	There is a nature camp for children on Janes Island.
Local Businesses	Coastal Flooding	People cannot get into town to get to stores/businesses. ◦ Closed businesses, from flooding and other reasons is negative.
	Scenic Beauty & Natural Materials	Artists use Crisfield's natural beauty as inspiration for their work as painters and carvers. ◦ Crisfield provides materials such as shells or driftwood for work.

Who is Impacted?	How are they Impacted?	Responses from Small Group Discussion Participants
Visitors & Vacationers	Local Businesses	Need a good hotel, more shops, and more restaurants to keep visitors coming.
	Scenic Attractions	Natural beauty and things to do bring people to Crisfield. ◦ The ferry that currently operates is positive, and the expected passenger ferry would be good. ◦ Smith Island is an attraction. ◦ Island tours are beneficial. ◦ Free is a big positive quality for some nature-based activities. It's noted that there was once a donation/payment for Janes Island.
	Youth Opportunities	There is a nature camp for children on Janes Island.
	Health Benefits	The salt air attracts visitors.
	Impacts to Residents	Some visitors leave behind litter, and there's no trash collection at the beach. ◦ Opportunity for tourists and locals to do a coastal cleanup and be a part of the community ( <i>applies to both residents and visitors</i> ).
Watermen & Seafood Industry	Fish & Crab	Restaurants depend on the crab industry; consumers do, too. ◦ Picking crabs is a skill. It is hard to find crab pickers now. ◦ There are economic benefits of crabs. ◦ Fishing is in cycles: one year a whole bunch of a species of fish can be caught and the next year hardly catch any of that same species ( <i>applies to both commercial and recreational fishing</i> ). ◦ Watermen make a living on the bay.
	Ecosystem Health: Invasives	The bluehead catfish is going to kill the fishing industry. ◦ Snakehead can be eaten as well.
Recreational Fishermen	Fish & Crab	Fishing is in cycles: one year a whole bunch of a species of fish can be caught and the next year hardly catch any of that same species ( <i>applies to both commercial and recreational fishing</i> ). ◦ People can fish and crab.
	Water Access	Water access is key for fishing.
Recreational Boaters	Water Access	There are numerous access points or put-ins for kayaks. ◦ There are kayak trails and area to explore.
Recreational Hunters	Wildlife	Benefits of hunting: hunters coming into town to hunt and they spend money in the town and the county. ◦ Animals that are hunted and eaten include deer, rabbit, duck, and turkey.
	Ecosystem Health	Ditches ( <i>mosquito ditches in marsh</i> ) continue to erode; ponding in the marsh is getting bigger and bigger and destroying the marsh, ruining opportunities for hunters.
People Who are Generally Concerned about the Environment	Ecosystem Health: Fish & Wildlife	Eating crabs and reducing the crab population. ◦ Marsh degradation is somewhat responsible for the loss of the original fish (changing vegetation of the plants that were originally there, marshes act as the filter). ◦ There is a loss of historic freshwater ponds like the black duck habitat. It's becoming saltwater. ◦ We're not seeing as many waterfowl.
	Ecosystem Health: Marsh	Mosquito trenches ruined the marsh. ◦ Areas used to be protected. ◦ Great Point used to be continuous; now it's degraded. Janes island is the same way. ◦ The ditching really messed up the hydrology.
	Ecosystem Health: Invasives	Blue headed catfish is an invasive species that is here. ◦ Only thing that grows is phragmites.
	Flooding	Some of the challenges are flooding and pine trees being killed. ◦ Floodwater causes erosion. ◦ Damage could be done to the wildlife.



Who is Impacted?	How are they Impacted?	Responses from Small Group Discussion Participants
Environmental Managers and other Government Agencies Who Manage these Habitats	Need to Address Resident Concerns	Legislators don't understand the actual experiences of residents and people that utilize the marshlands. ◦ Water quality problems from upper bay come down to us, and those laws ( <i>enacted to address pollution</i> ) aren't as applicable to us as it is to them. It restricts us ( <i>burdensome regulations</i> ). ◦ Historical decisions have unintended impacts 50+ years later.
	Need to Address Ecosystem Health	The plants were supposed to be regulated by the State of Maryland. ◦ State of Maryland focuses more on northern bay and put in laws to over control the rockfish (and other laws and regulations), without considering how it will affect the lower bay.
	Need to Address Flooding	Need to have experts come in to solve these problems.

## WHAT ARE SOME OF THE CHALLENGES PEOPLE FACE WHEN USING COASTAL SPACES?

Participants in small group discussions expressed a desire for more community gathering spaces and recreational opportunities that take advantage of Crisfield's coastal location. It was mentioned that access to many scenic places was limited to boats, and access could be improved to accommodate more people, including those with disabilities. Participants noted that wildlife has changed over time, and that nuisance wildlife, like jellyfish, can create hazards for recreation. Small groups also discussed that Crisfield is increasingly exposed to more wind and waves, and flooding has impacts on accessibility, safety, and economic development as a coastal community. Concerns were raised that inland flooding, and more generally lack of services like physicians or hotels, makes Crisfield less attractive to new residents, visitors, or businesses that might use or benefit from coastal spaces.

*Table 6. Themes identified from small group discussions on challenges people face to using coastal spaces. Notetakers captured participant quotes and thoughts live during small group discussions in response to the question "What are some of the challenges people face when using coastal spaces?". Post-meeting clarifications of notes by the EPA ORD authors are in italics. Notes were grouped into themes by EPA ORD after the meeting.*

Challenge	Responses from Small Group Discussion Participants
Access to scenic natural places restricted to boats	Access, for example, depends on whether you own a boat. ◦ The ferry is a big industry. ◦ Only ferry goes to Tangier and Smith Islands; otherwise, you can't get there unless you own a boat. A ferry system, like a water taxi, that goes from island to island would be great. ◦ You can't access some beaches without a boat. ◦ Flat Cap Beach is great if you have a boat. ◦ Janes Island used to carry visitors there by boat.
Crisfield is exposed to wind and waves	Crisfield used to be more protected when they were younger, but now more exposed to the wind and waves. ◦ Put up jetties like the ones in Ocean City to help stop the wind from pushing the water even more. Leave an open spot in the middle ( <i>for the ferry and other boats</i> ). Put them at Long Point and Great Point. Water would still come in, but jetties can help prevent wind from making it worse.

Challenge	Responses from Small Group Discussion Participants
Coastal flooding affects access to amenities and impacts safety	Flooded roads keep people from getting to Food Lion ( <i>grocery store</i> ). Some stores and businesses won't set up in Crisfield because of the flooding. Sometimes people can't get to them. ◦ People need to be very aware of the tides. ◦ Safety is a challenge: When it floods, water is over the river. Tidal ditches are 2-3 feet deep, roads are narrow, and you can't see where the ditches are. You can flip your car if you drive into them. Markings on the side of the road are needed for when it's flooded. ◦ Whatever floats, floats around. Buoys and trash cans and trash float everywhere including roads, marina, and marshes. ◦ Festivals can be cancelled due to the flooding. ◦ Some roads need to be raised up. ◦ Flood insurance only covers so much; it covers the lowest floor.
Habitat changes impact wildlife	Eagles are everywhere here now. ◦ Saltwater drives away hummingbirds.
Access to dock limited by how it is currently constructed	Janes Island needs a boardwalk at the dock that accommodates all people, including those with disabilities, so people could get close to water. It'd be a big attraction, like the one in Havre de Grace, MD. ◦ Raising dock up to five-foot level with the boardwalk would help. ◦ Protect access to dock.
Loss of businesses and need for more economic development	The loss of business traffic, particularly the seafood industry and the food industry, all the picking and shucking activities. The traffic downtown has gone. The three hardware stores are gone. Store dedicated to boating, anything available, all gone. ◦ Crisfield needs a nice hotel and conference center. That would help with tourism. More restaurants too. ◦ There was an establishment downtown that had a bowling alley on the second floor. ◦ The flooding really needs to be addressed first because businesses are not going to come without it being solved. Decades ago, it was a busy, bustling space with lots of stores and restaurants, and there were no spaces in the marinas for boats, it was that busy. Now it is not the case. ◦ Limited number of physicians ( <i>general lack of services makes the community less attractive to new residents, businesses, visitors</i> ), although a positive is the hospital with rehab center ◦ Limited funding to help with these issues is a problem.
Nuisance wildlife create hazards	Some challenges include bugs. ◦ Wellington Beach is great, but swimming is a challenge with sea nettles and jellyfish. There is netting allowing children to swim. ◦ A lot of underwater grasses are at the city beach. ◦ Oysters are at the city beach. ◦ Seagulls crack the oysters on the parking lot and sometimes drop them on cars.
Outreach and amenities for visitors is lacking	Lack of public transportation. ◦ There are no real amenities for beachgoers (trash cans, dumpsters, etc.). They have to "pack" their trash at many of these beaches, which saves money but runs the risk of pollution. The trash and pollution ruin the space, which negatively impacts the local community. Additionally, tourists could see the garbage and then not want to come here anymore. ◦ Getting people to know that Crisfield offers fishing, crabbing, etc.
Need more places for community gatherings & recreation	Crisfield needs more outdoor recreational opportunities, such as festivals. ◦ Hard to find a place for meetings, other than limited use of the library ( <i>general lack of amenities limits new residents, businesses, visitors; could there be new gathering spaces on the waterfront or other coastal places</i> ). ◦ Armory used to be a good place for meetings and entertainment.

## WHAT IS IT ABOUT NATURAL SPACES THAT MATTERS TO PEOPLE?

Next, participants were asked to brainstorm attributes of natural coastal spaces that are important to the different kinds of resource user they identified during the prior small group discussions (see [Who Uses or Cares About Crisfield's Coastal Natural Spaces?](#)). For example, when birdwatchers go to Janes Island, what do they want to see? What makes a particular location attractive to kayakers?

Because many different types of resource users were mentioned during small group discussions, participants were asked to simplify down to the top five categories of people who use or care about Crisfield's coastal habitats. The participants identified: i) Local Businesses, ii) Residents and Locals, both new and existing, iii) Watermen, iv) General recreation including recreational fishing, hunting and boating, and v) Tourism.

Participants were asked to write on sticky notes for each category "What the characteristics of coastal spaces that matter to each group of people?" This could include what is it that they need or want to see there, what shouldn't be there, or what are the ideal conditions of coastal spaces for these different categories of people. It was noted that there may be overlap in these groups, as for example local businesses may depend on tourism, and residents enjoy recreational opportunities.

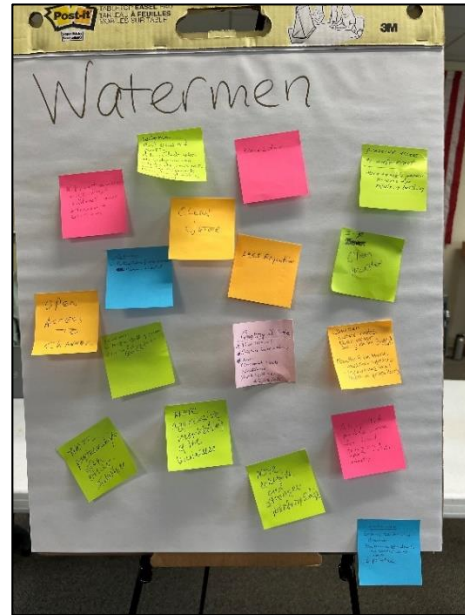


Figure 23. Example of post-it note exercise where participants brainstormed attributes of coastal spaces important to watermen.

Attributes written down for each group are listed below, with mentions by more than one participant in parentheses. Participants also mentioned attributes that weren't necessarily derived from coastal habitats, but may directly or indirectly impact the ability of each kind of user to benefit from coastal habitats. For example, additional hotels or tourist attractions might increase tourism that brings more visitors to Crisfield's coastal spaces or provide an incentive for people who come to visit the coastal spaces to stay in town longer.

## WHAT MATTERS TO LOCAL BUSINESSES?

- Flood prevention & mitigation (3)
- Clean water
- Invasive species
- Good infrastructure
- Diversity of businesses
- Small, medium, & large sized businesses (2)
- Welcoming/attractive for new businesses (2)
- Population growth (retention for customers & employees)
- Create year-round tourism (3)
- Attracting new residents to support more businesses (2)
- Collaboration with local businesses and our coastal spaces (2)

- Represent history
- Sell local products
- Open later hours

#### **WHAT MATTERS TO RESIDENTS AND LOCALS (EXISTING OR NEW)?**

- Flood protection and mitigation (5)
- Clean water and marshes (4)
- Loss of recreation parks
- Property owners near water need sewer lines because septic fields are failing
- Mosquito control
- Black mold after flooding
- Diverse cultures & ethnicities (2)
- More community development organizations (2)
- Neighbor associations
- Beautiful views
- Waterpark
- Better access to local seafood
- More people in town/attracting new residents (2)
- Owning property & paying taxes on land now considered wetland (2)
- Housing – ecofriendly and for all market segments

#### **WHAT MATTERS TO WATERMEN?**

- Vibrant industry large enough to attract more watermen and workers
- Boat access and parking. A large deck where the watermen can sell to the consumer and the restaurants. Recreational fishing for all guests
- Clean water and marshes (4)
- Preserve access to waterfront. More sensible permit process for repairs and building
- Pollution free areas (2)
- Less regulation
- Open access to channel
- A longer crabbing and fishing season
- Tide control
- Neighbor associations
- Urban and commercial assets (entertainment, youth facilities, etc.)
- More partnerships with other industries
- More aggressive marketing of the businesses
- More cohesive and stronger relationships
- Policy that makes sense for local conditions and impacts on the whole industry
- Ensure continued species safety
- Be aware of rules to continue to work

## **WHAT MATTERS TO RECREATIONAL FISHERMEN, HUNTERS, & BOATERS (RECREATION IN GENERAL)?**

- Accessibility to natural resources (2)
- Provide easy access (2)
- Transportation
- Boat rentals (2)
- Bike rentals
- More charters
- Kayaking tours to enjoy beautiful setting and wildlife
- Sunsets
- Healthy bird habitat
- Uninterrupted views
- Healthy fish habitat
- No events or vacations canceled due to flooding
- Explore local conditions (2)
- Encourage activity (2)
- Increase availability (2)
- Control invasive species

## **WHAT MATTERS TO TOURISTS?**

- More understanding of the overall area and the people
- Build year-round appeal
- Activities for families (2)
  - Mini golf
  - Playgrounds
- Clean marshes
- Offer value
- Demand respect for environment
- Allow for input
- Promote interaction
- Expansion of hiking areas
- Boardwalk around the city
- Better or more accommodations, lodging, and hotels (6)
- More ecofriendly spaces to explore
- Access to rent boats
- Transportation options
  - Water transport to secluded areas
  - Boat launches to Smith & Tangier
- Historical tours by locals
- Indoor and outdoor enjoyment of environment
- More places to spend money
- Safety from flooding
- Beautiful views



- Seafood restaurants open on regular hours
- Greater choice of urban-type activities

## HOW DO CHANGES IN NATURAL COASTAL SPACES AFFECT PEOPLE?

Finally, participants were divided back into four small groups and asked to discuss i) How have past changes in coastal habitats benefitted or adversely affected different people, and ii) How might different people like to see coastal spaces change in the future and why?

### PAST CHANGES IN COASTAL HABITATS

Participants mentioned during small group discussions the following changes they have seen over time:

- **Flooding has gotten worse over the last few years.** Water stays several days after a flooding event. People struggle to access local businesses or medical care during flooding, and struggle to get back home. Cars and property suffer damage, and school gets cancelled. Property is sinking. Houses may need to be raised. Tides are getting stronger. Failing septic tanks is a major environmental issue impacted by tides and flooding.
- **Methods implemented to help with flooding in the past are outdated.** Only a few of the tidal gates are currently working. An implemented living shoreline was failing because the conditions where it was implemented were not right.
- **Erosion has gotten worse.** More flooding brings more erosion. Holland's Island washed away and homes had to be moved. Smith Island is getting smaller.
- **Natural spaces have changed.** Saltwater intrusion is a problem. Pine trees are dying, and ghost forests are increasing. Eagles are moving closer in. Marsh is encroaching onto land. Wetlands are being lost. There are fewer fish.
- **Invasive and nuisance species have increased.** Warmer temperatures have impacted the proliferation of wisteria. Blue catfish affect crabbing and oystering, hurting small towns.
- **The area has experienced economic decline.** Property values have decreased. There are fewer businesses in town. There is limited ability for visitors to get from Janes Island into town. One participant noted 55 years of failed policies everywhere along the Chesapeake Bay.

### FUTURE CHANGES IN COASTAL HABITATS PEOPLE WOULD LIKE TO SEE

Participants suggested actions such as artificial reefs, living breakwaters, living shorelines, dredging of channels, boardwalks, and marsh restoration to preserve habitats, slow erosion, and stop waves. Small groups also noted the importance of not just restoring, but protecting coastal spaces into the future. Factors like flooding, economic development, or government regulations were identified as barriers that needed to be overcome before any desired goals related to coastal habitats could be fully addressed. Small groups noted a desire for government agencies to be more involved in assisting homeowners and listening to local concerns. Participants noted the community needs to come together, and expressed willingness to do any solution if it's going to work.

*Table 7. Notes from small group discussions in response to the question “What are desired future changes to coastal spaces that they would like to see?”. Notetakers captured participant quotes and thoughts live during small group discussions. Post-meeting clarifications of notes by the EPA ORD authors are in italics. Notes were grouped into themes by EPA ORD after the meeting.*

Desired Future Change	Responses from Small Group Discussion Participants
Flooding and wetland encroachment need to be addressed	Weather is getting more extreme and problem will only get worse. Needs to be addressed now. ◦ What can be preserved and stabilized should be, but if it can't be then those homeowners need to be compensated. ◦ If nothing is done it's going to keep encroaching, people will move out, and businesses will move out. This is already starting to happen. People can't move out. ◦ Making sure that we don't lose any more land is important for houses on the water. ◦ The government needs to offer to buy people's land if it becomes wetland.
Economic development	We need more job creation, but that's a challenge because business owners are concerned about flooding. ◦ For businesses, you want to make sure you're investing in a place that's going to be okay in the long run.
Attract more people	It's about improving the quality of life of the people that live here, yes, but also about attracting new people to help continue. ◦ We have everything people want for retirement, so how can we fix ourselves, so people want to stay here? ◦ Build more year-round appeal for the local area. Perhaps have locals conduct historical tours. There is a lot to offer in Crisfield, including beautiful views, great seafood, and free activities.
Improve access for visitors and recreational users	Improve access to areas for visitors; it's often too wet for them to hike. ◦ Increase access to playground activities for children over 5 years old. ◦ Enlarge Wellington Beach or develop other public beach areas.
Invest in infrastructure	Invest in infrastructure, especially the sewage system—system is porous and affected by high tide. ◦ It's not a coincidence that Somerset is the poorest county in Maryland and also has the worst flooding in Maryland.
Create and restore coastal habitats	Artificial oyster reefs could help. Can't have enough oysters, they clean the water. ◦ We would like to see the marsh restored if possible. ◦ May not be possible on the entirety of Janes Island, but where are the priority places? ◦ Living breakwaters would be ideal to stop wave actions and land erosion; people are losing their yards. ◦ You can't put a living shoreline on an area that is subject to high winds. ◦ Maybe create canals to help deal with flooding. People will need to live with water, like in Amsterdam.
Manage invasive species	Have an open season on blue catfish or problem will get worse.
Preserve channels and coastlines	Keep channels open with dredging. ◦ Maybe dredging will help. ◦ Tides Inn in Virginia on the Rappahannock River put in boardwalks to preserve their coastlines. We can do the same thing here.
Protect natural spaces	Protection for Smith Island and other islands because of erosion. Build up the island and increase protections. These islands are historic and need to be protected. ◦ Protect Flat Cap Beach at north of Janes Island. The gut ( <i>the water area between a beach and a sandbar</i> ) has gotten deep. ◦ Protect Big Marsh on Pocomoke Sound. ◦ It's important to fix and restore, yes, but it's also about preserving so this doesn't happen again.
Government agencies need to be more sensibly involved	Want sensible permitting for septic tanks and sewage system—very difficult to replace septic tank and connect to sewage system. When flooding affects the system, the reaction is often to overregulate, which hurts residents. ◦ Need multiple agencies working here, not just FEMA. ◦ Crisfield is so far removed from the state government and the federal government that we don't have a voice here, and the state and federal government don't consider our individual needs here in Crisfield when creating legislation.
Community needs to come together	Everyone needs to come together if they want to save Crisfield. ◦ They're willing to do any solution if it's going to work. ◦ Look at the quarterly report for environmental concerns (Crisfield newsletter, and once a quarter a listing of the projects). The same problems exist for Deal Island and other islands as well.

## SUMMARY AND NEXT STEPS

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Information learned from the meeting will be used to help EPA ORD focus research on nature-based strategies around what matters most to Crisfield, including i) the potential benefits of strategies like marsh restoration, dune restoration, living shorelines, artificial reefs, and living breakwaters to protect Crisfield from storm events, and ii) the potential additional environmental, social and economic co-benefits these strategies might provide to Crisfield.

EPA ORD is using feedback from both the [April 19 Institutional Partner Meeting](#) and the [April 20 Public Discussions](#) to narrow down a list of the top social and economic co-benefits most relevant to Crisfield, which are most important to consider as potential co-benefits of nature-based strategies. Next steps through summer 2025 are to use hydrodynamic modeling to better understand how much wave and storm surge water level reduction might be possible from different types of strategies, tentatively identified as i) marsh restoration at Janes Island, Cedar Island, and/or Jersey Island, ii) marsh restoration at these location in combination with dune restoration or living shorelines, and iii) living breakwaters or artificial reefs in the Little Annemessex River or other locations (Tangier Sound). In addition to the planned hydrodynamic modeling, EPA ORD is continuing to work with community partners through a technical working group to identify metrics and models to quantify potential co-benefits of these strategies, such as to the seafood industry (habitat for key commercial fish and shellfish, water access, water quality) and to tourism and recreation (scenic natural spaces, habitat for recreational fish and shellfish, habitat for hunting, habitat for birdwatching, water quality for swimmers, water navigability for boaters).

Ultimately the goal of the EPA ORD project, through a process of co-production with community partners, is that research is formulated and conducted to directly inform on-the-ground decisions by community partners about what type of NBS could be implemented and where, and how NBS could help support Crisfield's broader resilience goals.



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