United States Environmental Protection Agency

Disclaimer: The views expressed in this presentation are those of the author(s) and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

Supporting Coastal Community Resilience through Natural Infrastructure

EPA Crisfield Technical Working Group Meeting

Roxolana Kashuba, Susan Yee, Rich Fulford

EPA Office of Research & Development

07/31/2024

Technical Working Group Goals and Process

- Provide expert review and input for the research on nature-based solutions to improve Crisfield's coastal resilience
- Discuss new developments and results
- Tentative meeting dates:
  - Meeting 1: July 2024
  - Meeting 2: September 2024
  - Meeting 3: November 2024
  - Meeting 4: February 2025
  - Second all-partners meeting: April 2025
  - Meeting 5: July 2025
- Materials posted publicly afterwards

Current Project Status

Research Questions:

1. How much can Nature-Based Solutions (NBS) help protect Crisfield community from waves and storm surge, in the context of the FEMA plan for hard infrastructure?
2. Which metrics measuring co-benefits best represent the community's articulated values and preferences to contribute to Crisfield's coastal resilience goals?

Research Progress:

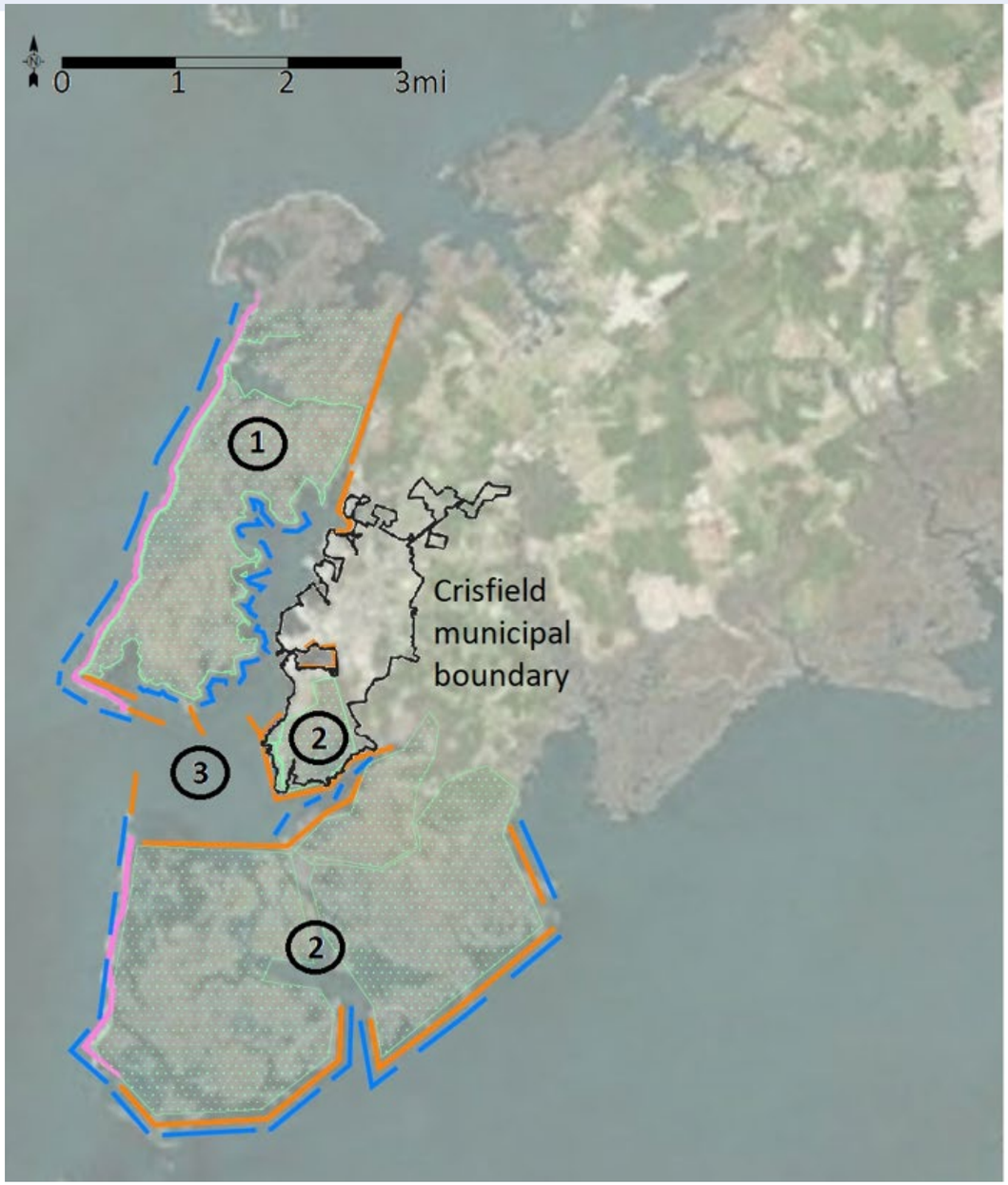
1. Selection of top NBS strategies based on literature combined with environmental data about Crisfield
2. Review of Crisfield-relevant planning documents and community and partner elicitation of desired co-benefits from NBS strategies

Results to discuss today:

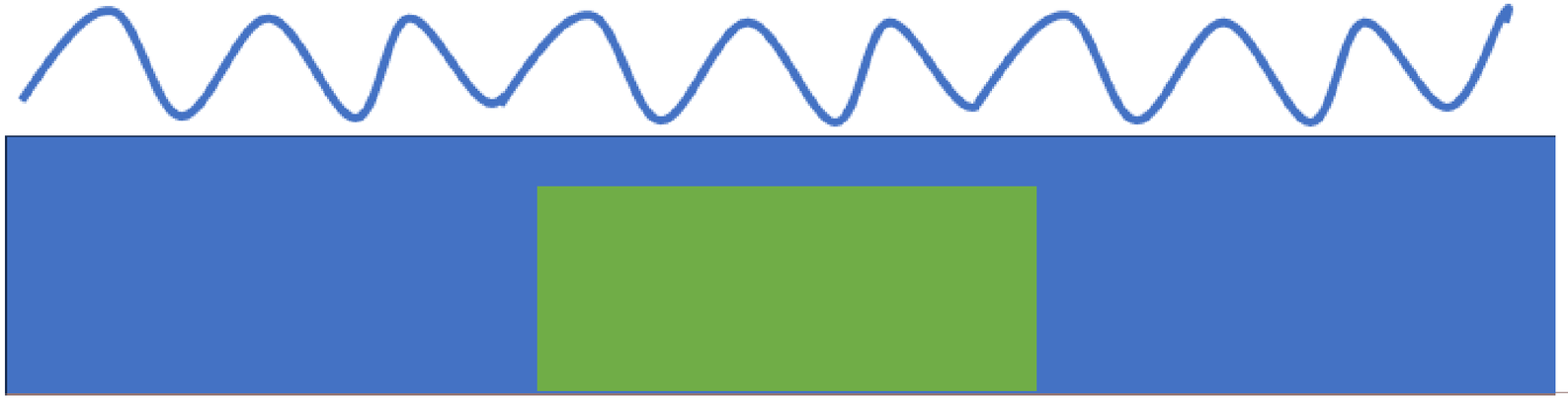
1. Baseline storm surge estimation; storm magnitude selection; vetting of approach, type and format of model results
2. Summary of community values and preferences around environmental co-benefits; selection of measures to assess

Proposed nature-based projects

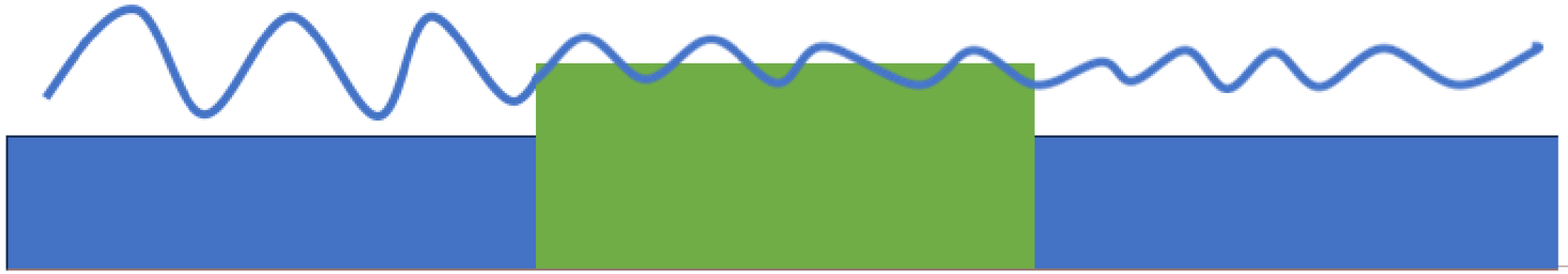
1. Janes Island marsh + sand dune restoration
2. Cedar Island marsh + sand dune restoration
3. Lower Annemessex living coastal breakwaters



Wave height vs. marsh height – which storm to model?



Wave height not decreased much because waves are not directly attenuated by marsh



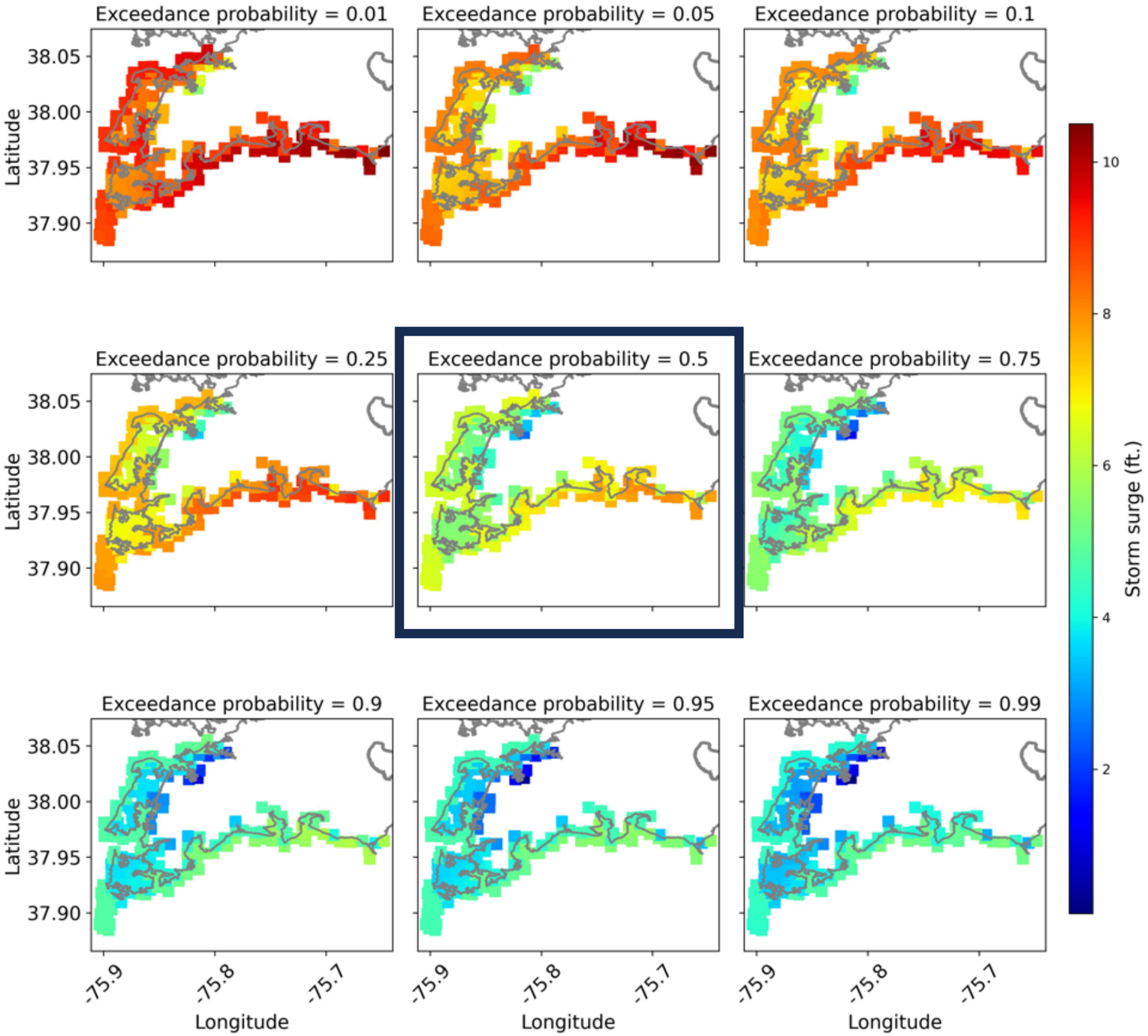
Wave attenuated some because obstructed by marsh a bit

Wave attenuated a lot because whole wave height passed through marsh

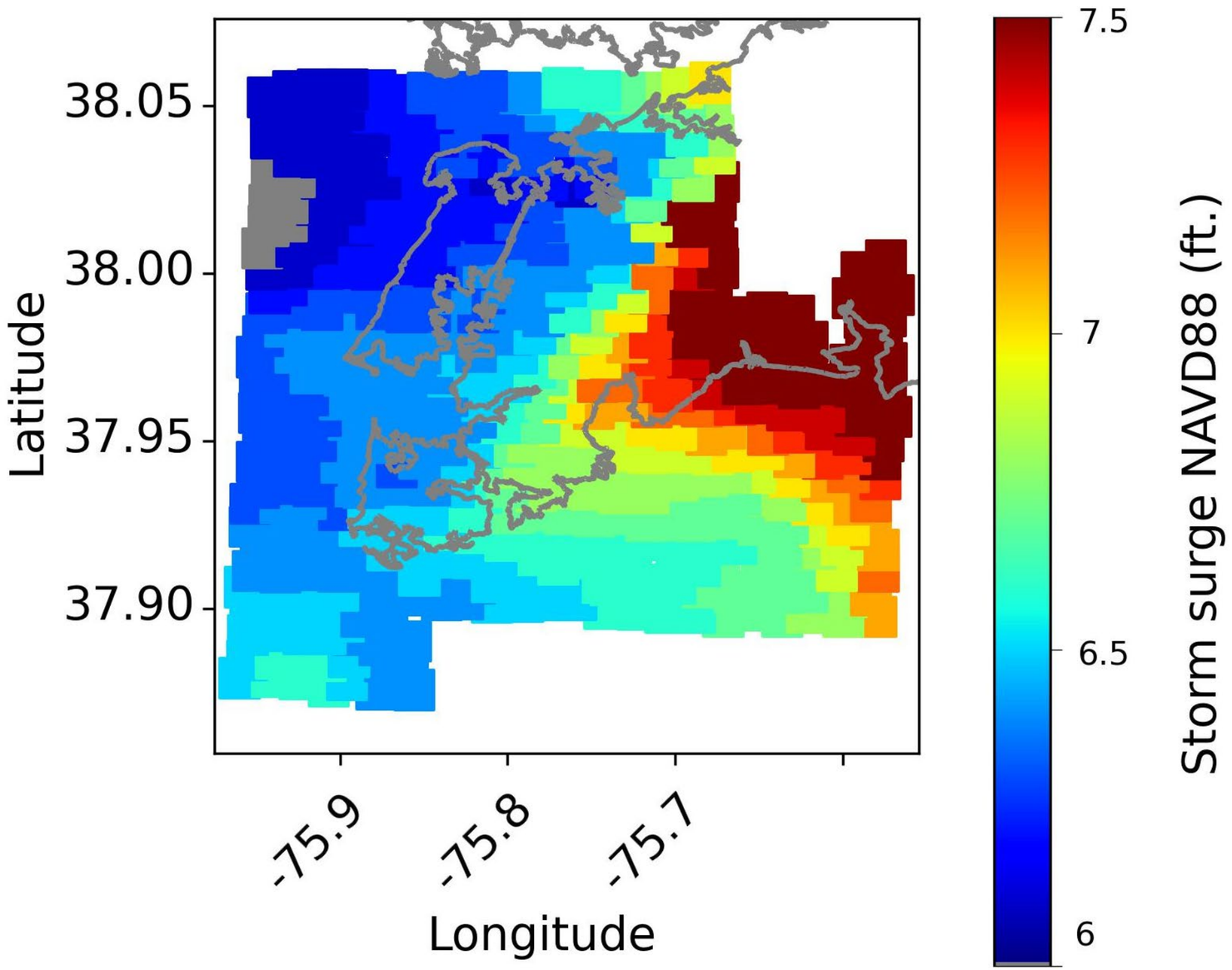
Baseline storm surge

Exceedance probability	Probability that water depth is exceeded in any year	Return period – "one in X year storm"
0.01	0.0003	3383
0.05	0.0017	663
0.10	0.0035	323
0.25	0.0095	119
0.50	0.0228	50
0.75	0.0452	25
0.90	0.0739	15
0.95	0.0950	12
0.99	0.1423	8

- SLOSH (NOAA) model: ~700 m x 700 m grid cells
- 42 historic storms in Crisfield (1990-2024)
- Storm surge + high tide



One-in-50-year storm

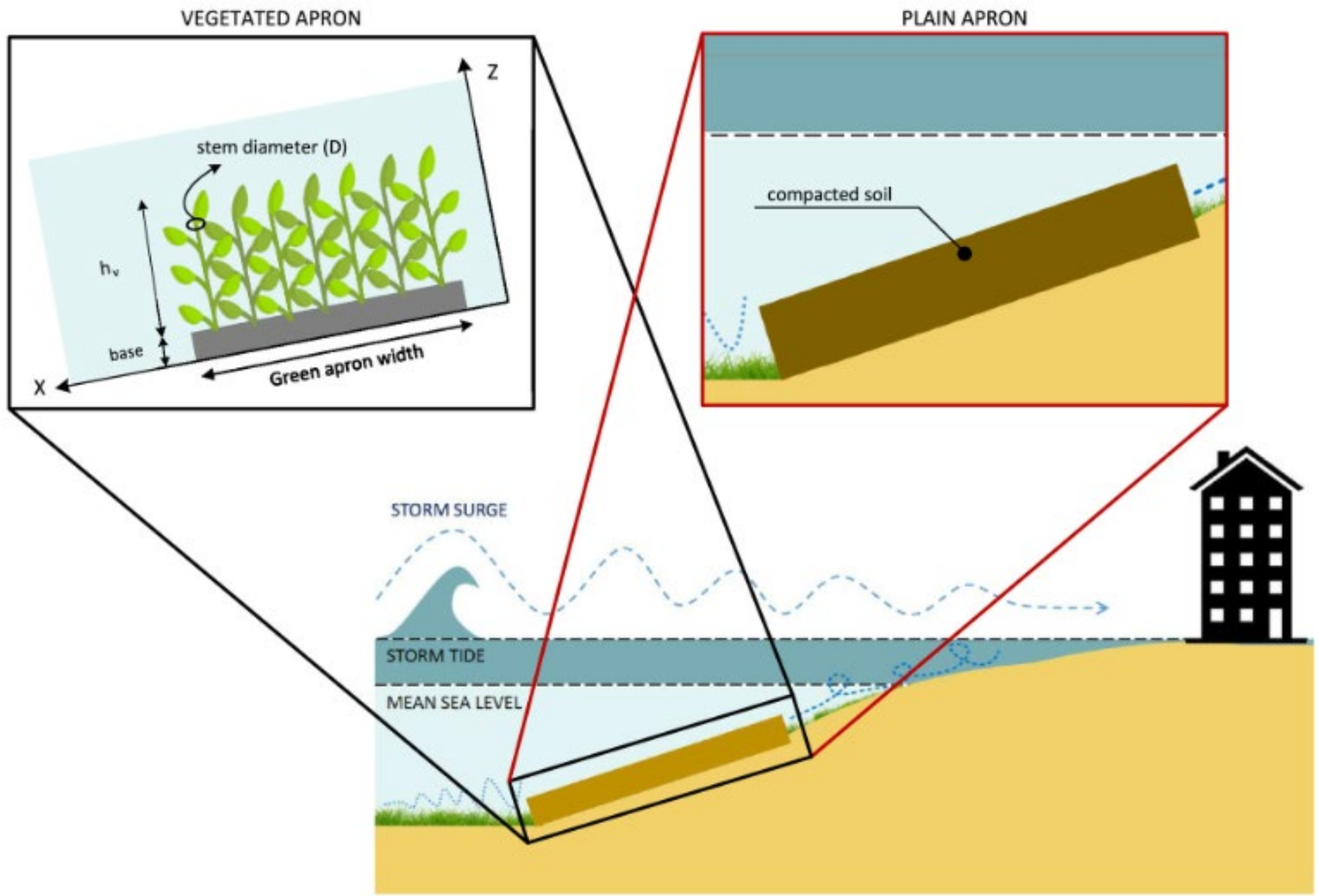


Challenges with using SLOSH:

- Low spatial resolution
- Inability to alter current elevation and roughness
- Does not simulate waves
  - ~40% wave attenuation in Crisfield area (Cassalho 2023)
  - ~50-70% wave attenuation reported elsewhere in literature (Moller 2014, Zhang 2020, Garzon 2019, Stark 2015, Marsooli 2017, Miesse 2023)

Delft 3D (surge) + EurOtop (waves)

- Finer resolution (more spatially resolved results)
- Able to simulate part of water column known to be affected by salt marsh (waves)
- Able to change offshore interventions (compare current conditions to NBS options or no marsh)
- Plan is to run:
  - 3 NBS options
  - 1-in-50-year storm from two incoming directions (NE & NNE)



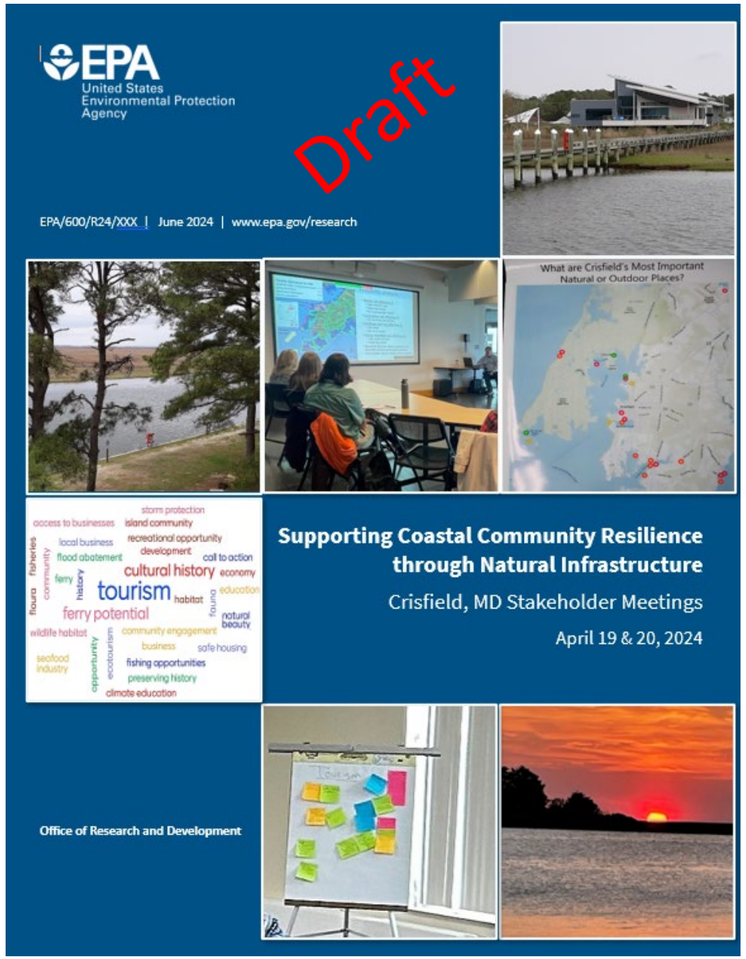
https://oss.deltares.nl/web/delft3d

Questions for Technical Working Group

- Will modeling a 1-in-50-year storm provide the most useful information about NBS storm surge and wave attenuation capabilities? (or should we consider other storms and why?)
- Are there other data, studies, information, or resources specific to Crisfield that would be relevant to informing our Delft3D+EurOtop model approach?
- Do you have any other questions about the approach? Is there anything we have not thought of?
- Do you think this will inform decision-making in a way that gives the community the data they need? How will model results need to be framed to be sure they inform NBS decision-making?

Assessing Potential Social & Economic Benefits of NBS to Crisfield

- What we learned from the April 19, 20 Stakeholder Meetings
- List of potential metrics & models
- TWG Feedback:
  - What are the top co-benefits that should be evaluated and how?
  - Are there additional models, data, or experts we should consult?



Report on April Stakeholder Meetings planned for early Fall

Institutional Partners Meeting
April 19, 2024

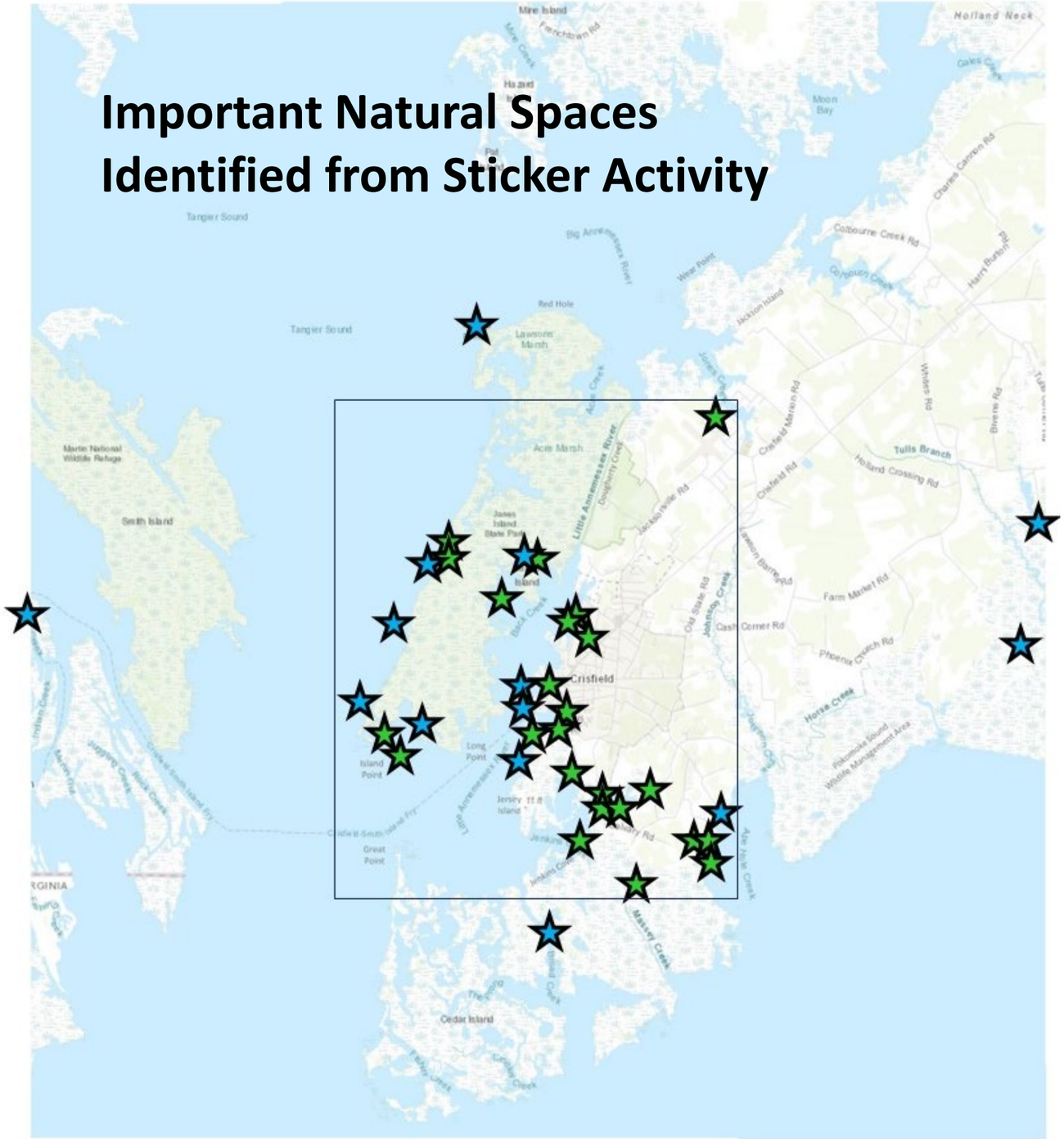
Institutional Partners Meeting				
Criteria that EPA Suggested	**Option 1** Status Quo	**Option 2** Janes Island Marsh+Dune Restoration	**Option 3** Cedar Island Marsh+Dune Restoration	**Option 4** Little Annemessex Living Coastal Breakwaters
Effectiveness for Storm Surge & Wave Attenuation				
Wave height reduction				
Rates of coastal erosion				
Resilience (Risk of Failure, Lifespan)				
Social/Economic Co-Benefits				
Fish/Oyster/Crab Abundance				
Charismatic or Other Important Birds/Mammals/Reptiles				
Native/Rare Plants				
Seagrass/Marsh (Area & Quality)				
Aesthetics/Viewscapes				
Navigable Water (Boating Conditions)				
Water Clarity				
Access for Recreation/Fishing/Education				
Fairness/Equitability of Benefits				

Additional Things identified by Meeting Participants

Storm flooding as a deterrent to economic development
Tax Revenue spent on flooding vs. other stuff
Restoring Crisfield to 'what it used to be'
Community cohesiveness (working together to solve flooding problem)
Whether NBS could help with drainage
Availability of dredge material
Impacts to navigability of the ferry path

Public Meeting
April 20, 2024

- Where and what are some of Crisfield's most important natural spaces?
- Who uses or cares about by Crisfield's coastal habitats and why?
- What are some attributes of coastal habitats that matter most to people?
- How have past coastal habitat changes affected people, and how might you like to see them change in the future?



Who might be impacted by NBS decisions?

Residents & Locals

Youth & Educators

Recreational Hunters

Public Property Owners & Users (Boardwalk, Library)

Artists & Festival Participants

Septic System Users

Recreational Fishermen

Ferry Service & Other Public Transportation

Recreational Boaters

Local Businesses

Local Sources for Food

People Who Care (Conservation)

Watermen/Seafood Industry

Beachgoers & Swimmers

Bikers, Hikers, Scenic Viewers, Wildlife Viewers

What matters to them?

Residents & Locals
Natural beauty
Flood protection
Food availability
Protection from mold
Recreational opportunities
Air quality (salty, fresh air)

Youth & Educators
Natural beauty
Access to natural open spaces
Water access
Ecological condition
Fauna & Flora community
Flood protection

Recreational Hunters
Natural beauty
Access to natural open spaces
Water access
Huntable wildlife

Public Property Owners & Users (Boardwalk, Library)
Natural beauty
Access to natural open spaces

Artists & Festival Participants
Natural beauty
Natural materials
Fish & Shellfish (Seafood)
Charismatic fauna

Septic System Users
Flood protection

Recreational Fishermen
Target species for fishing
Ecological condition
Invasive or nuisance species
Access to water

Recreational Boaters
Access to water
Navigable water
Natural beauty

Local Businesses
Flood protection
Natural beauty
Natural materials
Fish & Shellfish (Seafood)

Local Sources for Food
Fish & Shellfish (Seafood)

Ferry Service & Other Public Transportation
Flood protection
Navigable water
Natural beauty
Access to natural open spaces

People Who Care (Conservation)
Ecological condition
Natural beauty
Water quality
Fauna & Flora community

Watermen/Seafood Industry
Fish & Shellfish (Seafood)
Access to water
Invasive or nuisance species

Beachgoers & Swimmers
Water access
Water quality
Invasive or nuisance species

Bikers, Hikers, Scenic Viewers, Wildlife Viewers
Natural beauty
Access to natural open spaces
Water access
Charismatic wildlife

Categories of Co-benefits	
Goal	**Co-benefit**
Storm Protection	Flood Protection
	Weather
	Mold Reduction
Seafood Industry	Species for Fishing/Seafood
	Water Access
	Water Navigability
	Nuisance & Invasive Species
	Water Quality
Recreation and Tourism	Natural Beauty
	Historical or Cultural Resources
	Ecological Condition of Marsh
	Animal Community
	Plant Community
	Species for Hunting
	Natural Open Spaces
N/A	Natural Materials
	Air Quality

17 Categories of Co-benefits

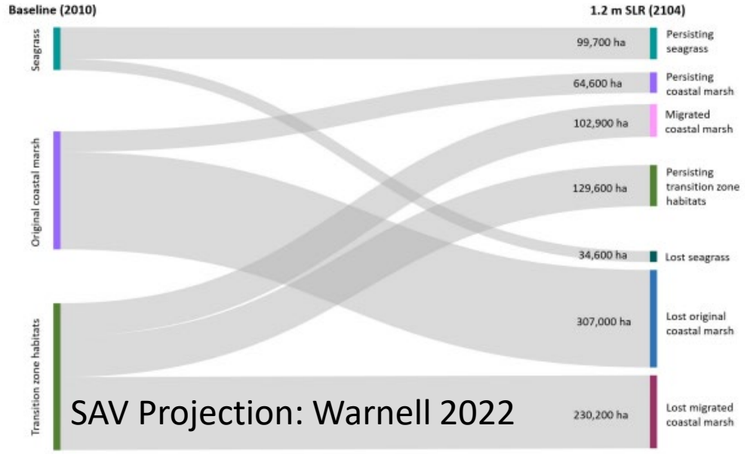
- That have the potential to resonate with a wide range of user groups
- That have the potential to be affected by NBS options

- That can be connected to broader Crisfield resilience goals:
  - Resilient infrastructure
  - Flood safe & affordable housing
  - Business and job creation
  - Enhanced recreation
  - Youth development
  - Enhanced community spaces

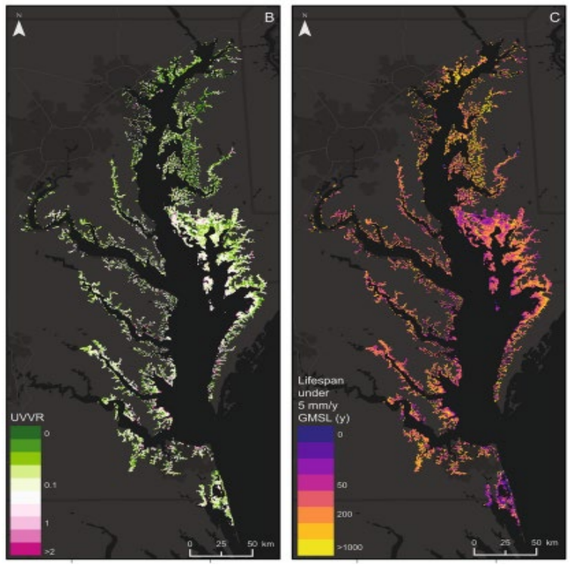
Goal	Co-benefit	Initial Plan for Analysis
Storm Protection	Flood Protection	Water height attenuation during storms
	Weather	
	Mold Reduction	*Inferred benefit if waves attenuated*
Seafood Industry	Species for Fishing/Seafood	Fish/Seafood Habitat Suitability
	Water Access	**Access and transportation by boats**
	Water Navigability	Wave heights in non-storm conditions
	Nuisance & Invasive Species	
	Water Quality	**Denitrification; Water quality related to SAV**
Recreation and Tourism	Natural Beauty	Unimpeded view from coast/residence
	Historical or Cultural Resources	
	Ecological Condition of Marsh	**Marsh Unvegetated/Vegetated Ratio; Marsh lifespan until submerged; Carbon storage/sequestration**
	Animal Community	Wildlife habitat suitability
	Plant Community	**SAV Distribution & Condition**
	Species for Hunting	Wildlife habitat suitability
	Natural Open Spaces	Access for recreation or education; Acres of coastal habitats
N/A	Natural Materials	*Not something likely to be affected by NBS*
	Air Quality	*Not something likely to be affected by NBS*

InVEST integrated valuation of ecosystem services and tradeoffs

USEPA H2O HYDRO-ECOLOGY GIS



SAV Projection: Warnell 2022



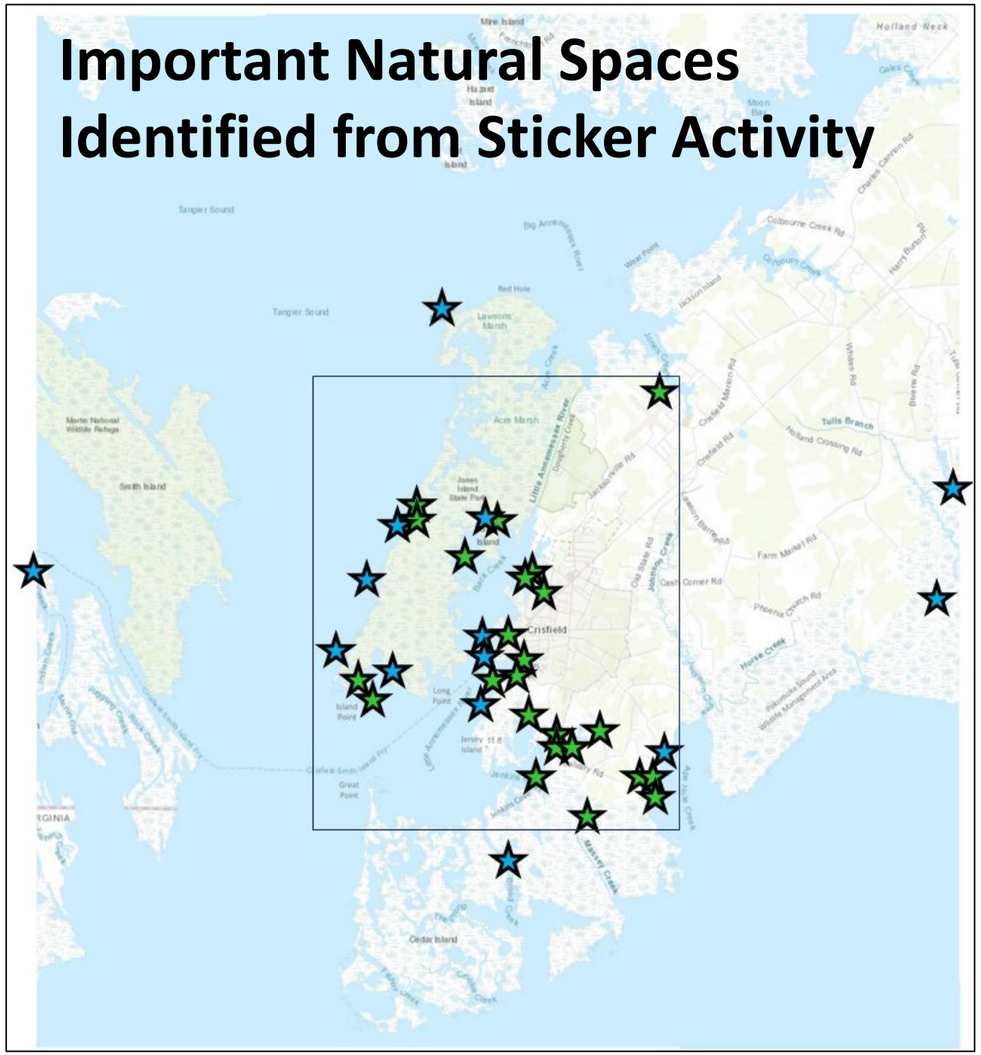
Marsh UVVR: Ganju 2023

Goal	Co-benefit	Initial Plan for Analysis	Other potential measures (if we can find models/data)
Storm Protection	Flood Protection	Water height attenuation during storms	Indicators of flood reduction on land (elevation relative to water height; relative spatial location/disparity of attenuation); Erosion protection
	Weather		Ability to serve as a wind buffer
	Mold Reduction	*Inferred benefit if waves attenuated*	Risk of mold x Risk of flooding
Seafood Industry	Species for Fishing/Seafood	Fish/Seafood Habitat Suitability	Fish; Crabs; Oysters, Shrimp (Biomass)
	Water Access	**Access and transportation by boats**	Water depth; Blocking the Ferry pathway; Access to fishing sites
	Water Navigability	Wave heights in non-storm conditions	Currents; Water depth
	Nuisance & Invasive Species		Snakehead, Jellyfish, Catfish
	Water Quality	**Denitrification; Water quality related to SAV**	Water clarity or quality (sediment/nutrient/contaminant)
Recreation and Tourism	Natural Beauty	Unimpeded view from coast/residence	Index of 'beauty'
	Historical or Cultural Resources		Important sites based on local knowledge; Cultural resources (the stack) protected from erosion or storm damage
	Ecological Condition of Marsh	**Marsh Unvegetated/Vegetated Ratio; Marsh lifespan until submerged; Carbon storage/sequestration**	Ecological condition index
	Animal Community	Wildlife habitat suitability	Biodiversity (Birds, Mammal richness)
	Plant Community	**SAV Distribution & Condition**	Plant diversity; Native, rare plants
	Species for Hunting	Wildlife habitat suitability	Abundance of Duck or other Target Species
	Natural Open Spaces	Access for recreation or education; Acres of coastal habitats	Disparity in access
N/A	Natural Materials	*Not something likely to be affected by NBS*	Shells; Driftwood
	Air Quality	*Not something likely to be affected by NBS*	Fresh air; Salty air

Questions for TWG Discussion

- Does the initial plan for analysis resonate with Crisfield's information needs?
- What alternative measures may be as or more important to evaluate across NBS options?
- Are you aware of models, data, studies that we could leverage to evaluate important co-benefits of NBS?

- What might be the ~Top 5 most important co-benefit metrics to compare across NBS options?



Wrap-up

- General feedback?
  - Does this format work for you?
  - Thoughts for us on how to make this information more accessible?
  - Other expertise we need to include?
- Thank you so much for your time and help!

Questions?

Kashuba.Roxolana@epa.gov
Yee.Susan@epa.gov
Eisenhauer.Emily@epa.gov
Fulford.Richard@epa.gov