Ecosystem Services 101

Advancing Chesapeake Bay Watershed Agreement Outcomes

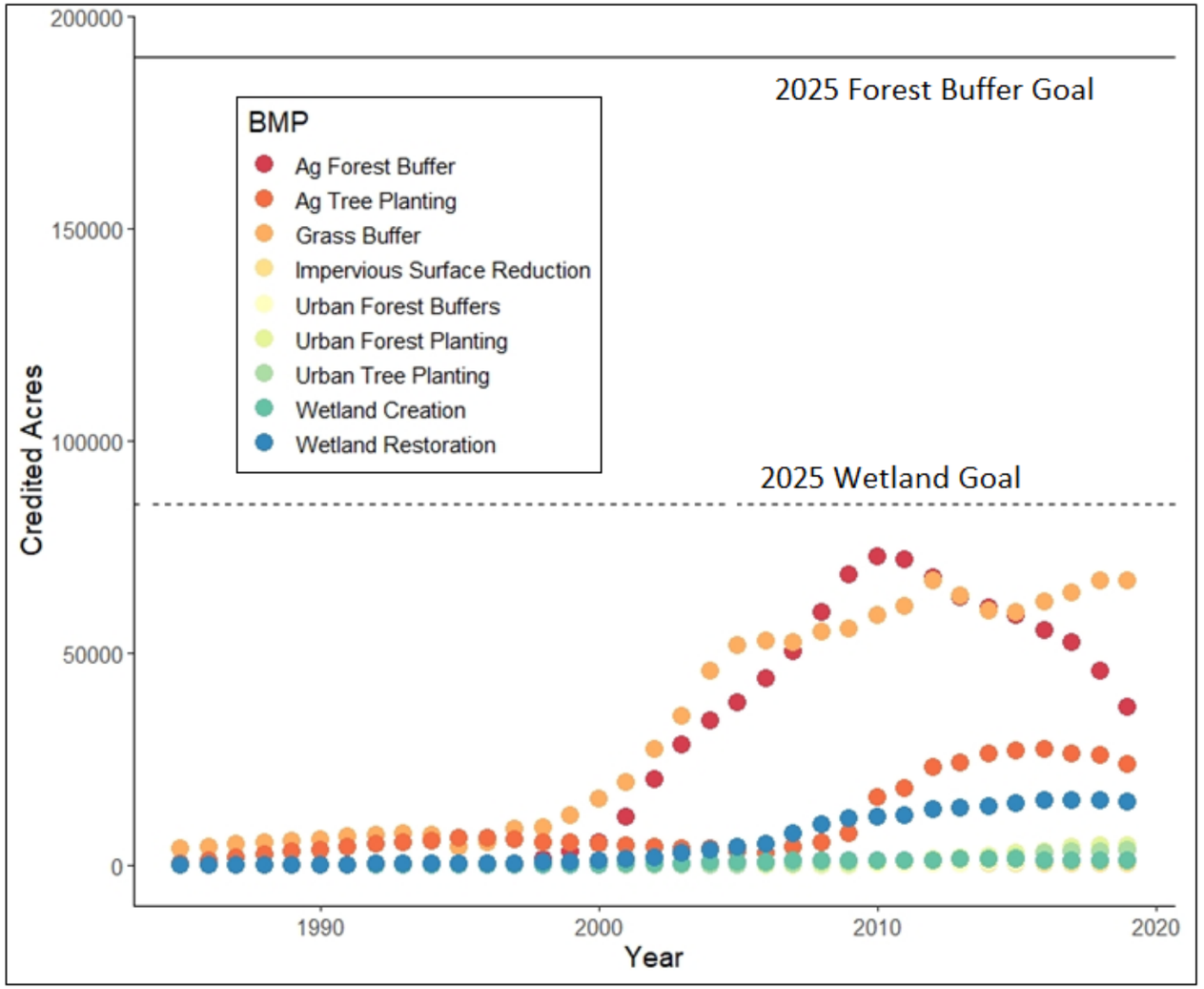
Susan Yee

EPA Office of Research & Development

05/23/2024

Motivating Lagging Conservation BMPs

- Some BMPs in the Watershed Agreement are behind on implementation – e.g. wetlands and forest buffers
- Need to enhance stakeholder buy-in of implementation of these practices, especially in headwater communities
- Want to be able to better communicate and quantify benefits associated with these practices, specifically beyond water quality



Challenges for Resource Managers

When considering & implementing restoration projects,

Resource managers and communities need methods to:

"…Inspire the public to act"

"…Determine local priorities for action"

"…Evaluate alternative restoration options"

"…Gain public support for planned projects"

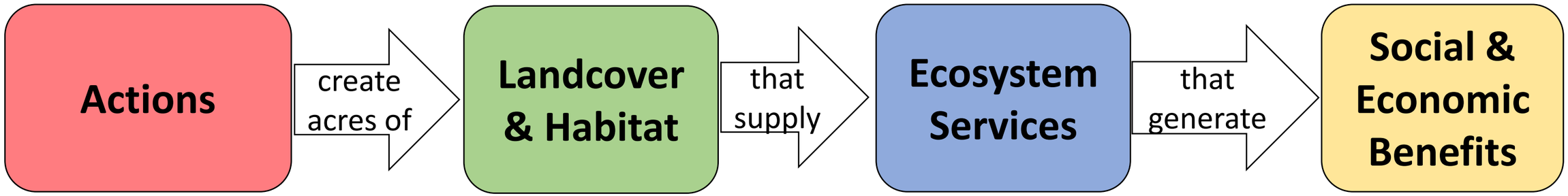
"…Identify metrics to monitor progress"

"…Communicate benefits post-restoration"

Pre-restoration Planning **Restoration Implementation** **Post-restoration Monitoring**

Ecosystem Services as a Bridge

- Actions to restore, conserve, or protect landcover & habitat can be linked to social and economic benefits to people and communities through ecosystem services



What are Ecosystem Services?

"[biophysical] components of nature, directly enjoyed, consumed, or used to yield human well-being" ***(Boyd & Banzhaf 2007)***

Environmental Context

Salt Marsh

Where?

+

Beneficiary

Birdwatchers

Who?

+

Ecological Attribute

Charismatic bird species

What?

Dewitt et al. 2020

Why a Beneficiary-focused Perspective?

- Clarify what is meant and reduce ambiguity
- Directly relevant to stakeholders
- Helps to ensure key stakeholders or benefits aren't overlooked

Water quality

Where?

For who?

What?

Water salinity in **groundwater** that local **farmers** depend on for irrigating crops

Water temperature in **local streams** used by **industrial processors** for cooling

Water turbidity in **coastal waters** that are visited by **snorkelers**

Review of Planning Documents

"gazing at stunning coastal sunsets"

"protect rare and endangered species in the estuary"

"collect mushrooms along the streambank"

"rich agricultural soils preserved for farming"

"fibers from the area used to temper pottery"

"enjoy migratory songbirds near the water"

"open spaces for public use"

"the community depends on natural systems for water resources"

"sailing and windsurfing"

"pollination of agricultural plants"

"a panoramic view of the bay from the observation tower"

"protecting the air our residents breathe"

"the waters provide shellfish for commercial fisheries"

"a natural lab for students to learn about the estuary"

Yee et al. 2019

Review of Planning Documents

- Illustrates management programs and communities are implicitly considering ecosystem services in planning

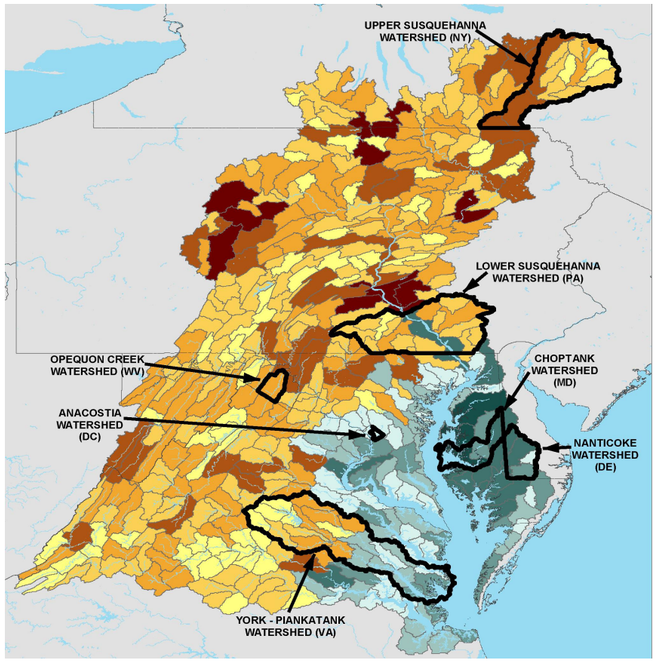
- Yet… widespread implementation of ecosystem services assessments is still limited
  - Perceived as too technical or nuanced to convey to stakeholders
  - Perceived as requiring economic or monetary valuation (special expertise)
  - Management & restoration fall back on ecological proxies (habitat cover, water quality) - “easy wins”

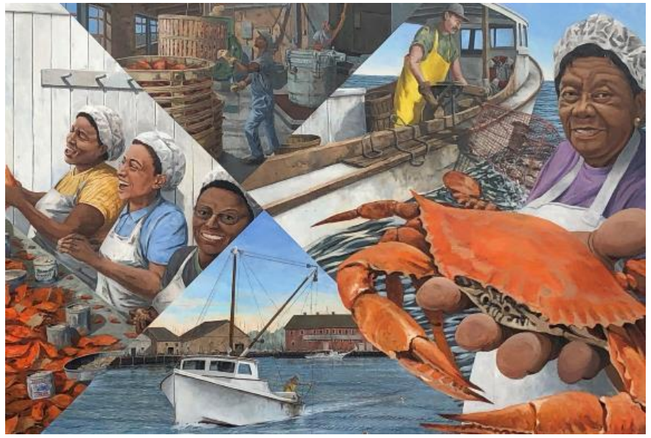
- Reinforces that approaches and tools are still needed to simplify ecosystem services assessment

Research Program

- Provide frameworks, tools, and approaches to link restored biological condition to social and economic benefits via ecosystem services

- Chesapeake Bay RESES - motivate implementation of conservation BMPs in upper watershed
- Crisfield, MD – evaluate nature-based solutions for storm-related flooding





Research Approach

Step 1. Clarify scope for the project, and how/where ecosystem services play a role

Step 2. Identify stakeholder objectives and which are ecosystem services

Step 3. Identify potential metrics to measure ecosystem services

Step 4. Identify management actions

Step 5. Apply data/models to compare ecosystem services change under different actions

Step 6. Communicate links between actions and ecosystem services to support decisions

EnviroAtlas

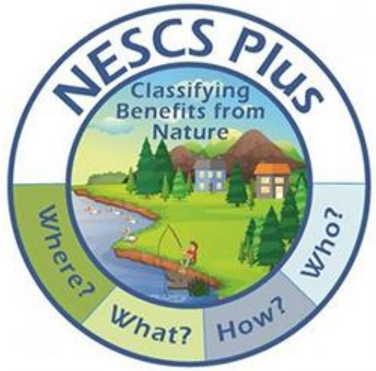
USEPA H2O HYDRO-ECOLOGY GIS

i-Tree

InVEST

FEGS Scoping Tool

NESCS Plus

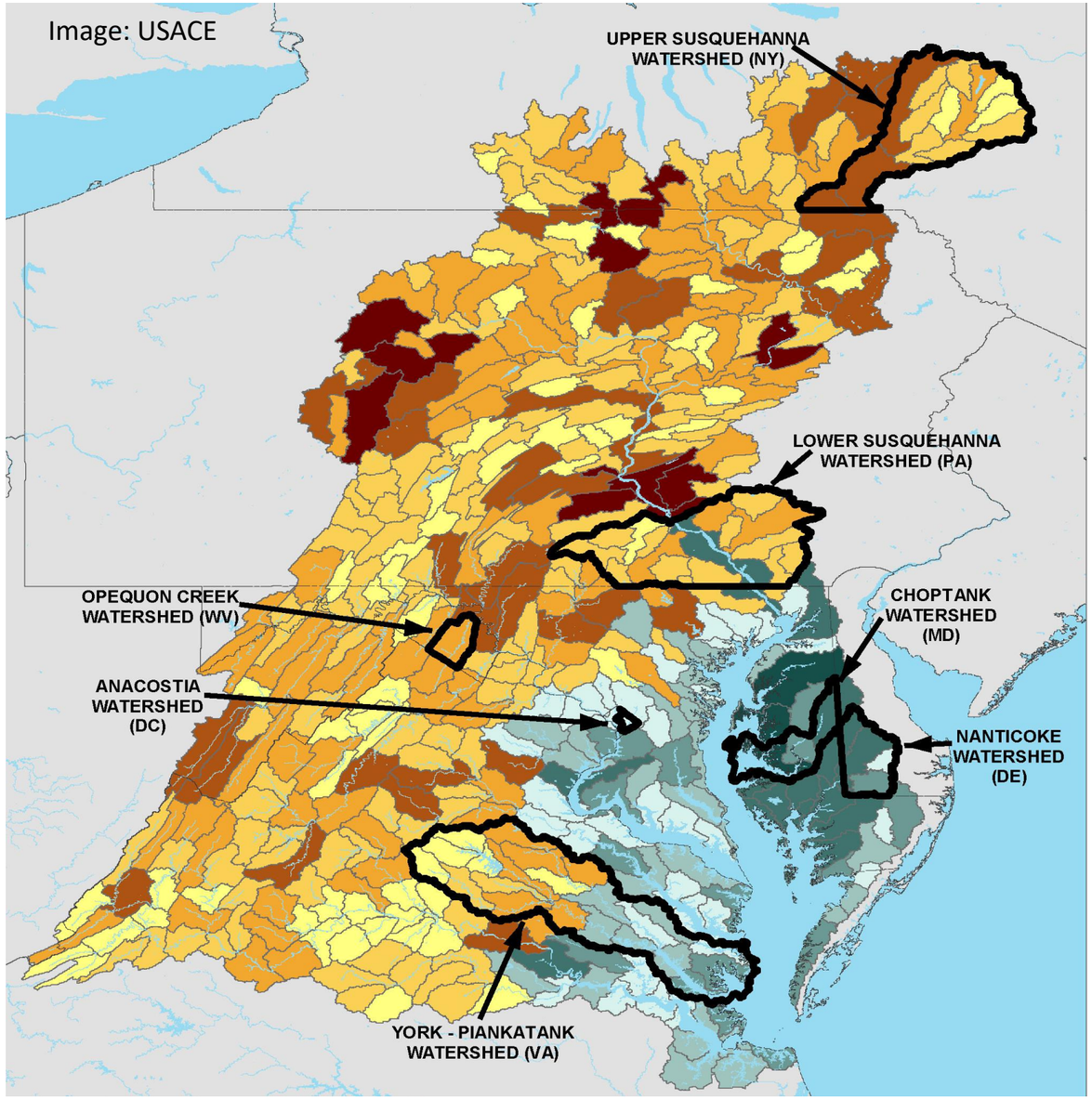


EcoService Models Library (ESML)

Ecosystem Services Tool Selection Portal

Case Study 1: Chesapeake Bay RESES

- Goal: Motivate implementation of Conservation & Restoration Related BMPs that are lagging, especially in upstream communities
- Quantify how BMPs may affect ecosystem services, particularly beyond sediment and nutrient reduction



Project Approach

- Identify priority ecosystem services and quantify how BMPs may affect them
- Communicate potential contributions of ecosystem services to Watershed Agreement Outcomes
- Build off existing tools like Co-Benefits Report and CAST

Determine which BMPs to Focus on

Focus on BMPs that are:

1. Lagging in implementation
2. Relevant to upstream communities
3. Have associated Watershed Agreement goals that have not been met
4. Related to habitat conservation or restoration

Used these 4 "criteria" to scope

Scoped list of BMPs:

- Agricultural forest buffers
- Agricultural grass buffers
- Agricultural tree planting
- Agricultural cover crops
- Urban forest buffers
- Urban forest planting
- Urban tree planting
- Forest conservation
- Impervious surface reduction
- Wetland creation
- Wetland restoration

Rossi et al. 2022

Identify Relevant Ecosystem Services

Who is might benefit?

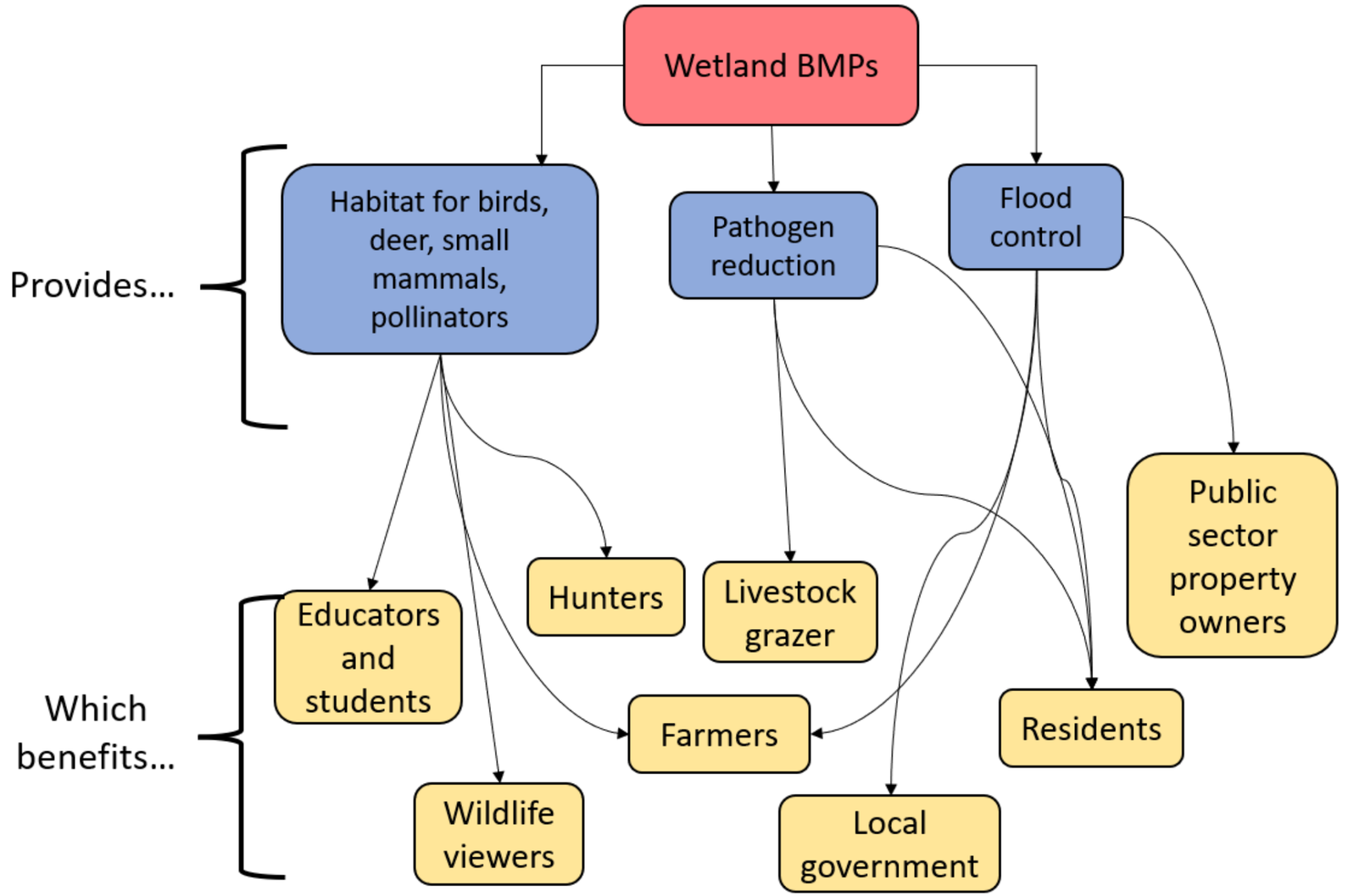
Agricultural	Agricultural Processors	Farmers
	Livestock Grazers	Foresters
	Aquaculturists	
Commercial / Industrial	Private Drinking Water Plant Operators	
	Industrial Processors	Private Energy Generators
	Pharmaceutical and Food Supplement Suppliers	
	Timber, Fiber, and Ornamental Extractors	
	Food Extractors	Fur / Hide Trappers and Hunters
	Property Owner	
Government, Municipal, Residential	Municipal Drinking Water Plant Operators	
	Public Energy Generators	Military / Coast Guard
	Residential & Nonresidential Property Owners	
Humanity	All Humans	
Inspirational	Artists	
	Spiritual/Ceremonial Participants, Participants of Celebration	
Learning	Researchers	
	Educators and Students	
Non-Use	People Who Care - Option / Bequest	
	People Who Care - Existence	
Recreational	Anglers	Boaters
	Waders/Swimmers/Divers	Hunters
	Food Pickers/Gatherers	Experiencers/Viewers
Subsistence	Water Subsisters	Food/Medicinal Subsisters
	Timber/Fiber/Fur/Hide Subsisters	
	Building Material Subsisters	
Transportation	Transporters of Goods	
	Transporters of People	

What do they care about?

Atmosphere	Air quality, Wind strength/speed, Precipitation, Sunlight, Temperature	
Soil	Soil quantity, Soil quality, Substrate quantity, Substrate quality	
Water	Water quality, Water quantity, Water movement	
Fauna	Fauna community, Edible fauna, Medicinal fauna, Keystone fauna, Charismatic fauna, Rare fauna, Pollinating fauna, Pest predator/depredator fauna, Commercially important fauna, Spiritually/culturally important fauna	
Flora	Flora community, Edible flora, Medicinal flora, Keystone flora, Charismatic flora, Rare flora, Commercially important flora, Spiritually/culturally important flora	
Fungi	Fungal community, Edible fungi, Medicinal fungi, Rare fungi, Commercially important fungi, Spiritually/culturally important fungi	
Other Natural Components	Fuel quality, Fuel quantity, Fiber material quantity, Fiber material quality, Mineral/chemical quantity, Mineral/chemical quality, Other natural materials for artistic use, consumption (e.g. shells, acorns, honey)	
Composite (and Extreme Events)	Site Appeal	Sounds, Scents, Viewscapes, Phenomena (e.g. sunsets, northern lights, etc)
	Ecological condition	
	Open space	
	Regulating Services	
	Extreme Events	Flooding, Wildfire, Extreme weather events, Earthquakes

Identify Relevant Ecosystem Services

- Use NESCS Plus to identify potential ecosystem services (ES)
- Mine Chesapeake Bay Program (CBP) documents and reports for ecosystem services to add to list
- Feedback from partners on priorities in their regions on anything missing



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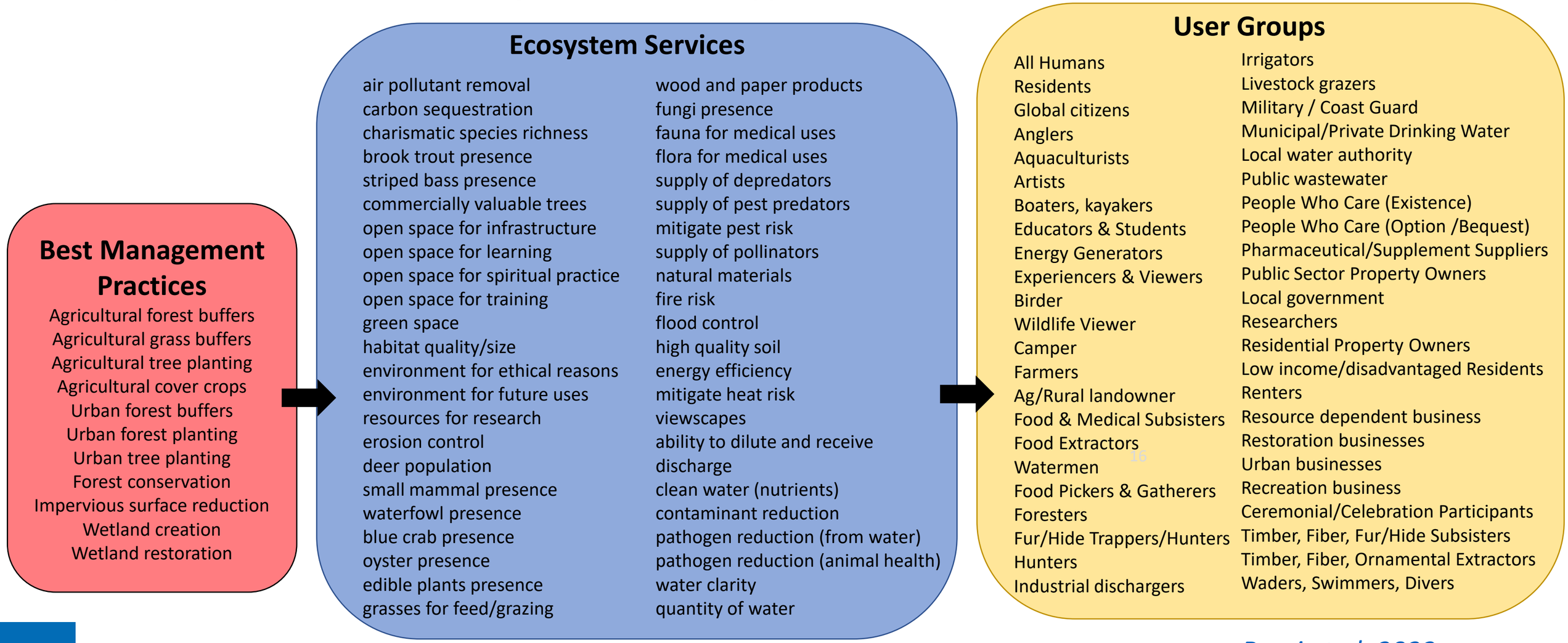
Identify Relevant Ecosystem Services

In total, review identified focal BMPs could provide 45 potential types of ecosystem services benefitting 46 different types of users



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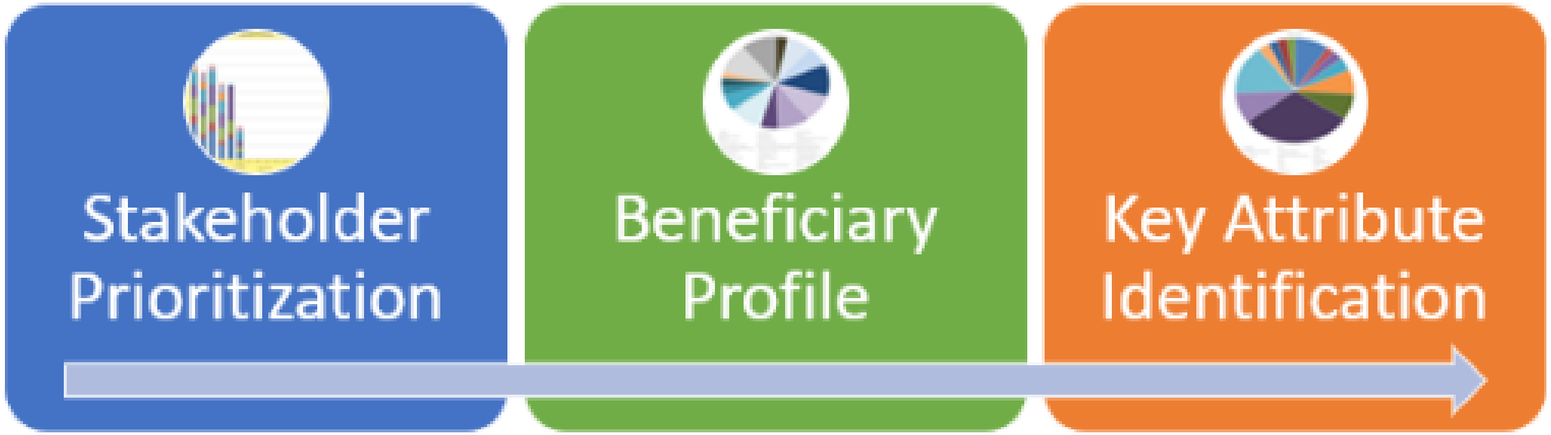
Prioritize Most Relevant Ecosystem Services

- Chesapeake Bay Scientific Technical and Reporting Team (STAR) and Local Government Advisory Committee (LGAC) partners asked to identify **top 5** ecosystem services and users most relevant to their region or expertise
- Final Ecosystem Goods & Services (FEGS) Scoping Tool to assign importance weights

FEGS Scoping Tool



Step 1. Stakeholder groups most likely to be impacted or of high priority

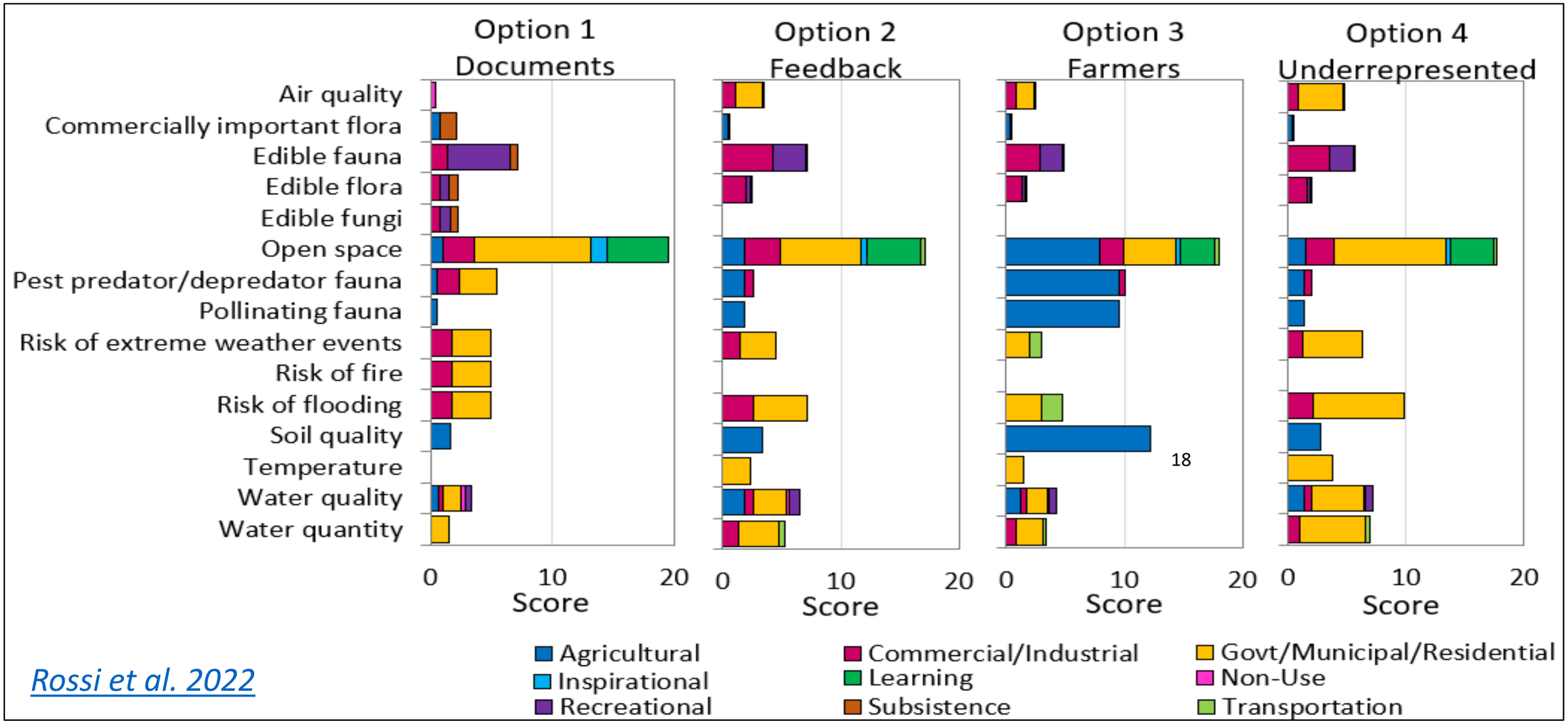
Step 2. The different roles those stakeholders play as users of natural resources

Step 3. The ecosystem services those users care about

Rossi et al. 2022

Prioritize Most Relevant Ecosystem Services

Explored different weighting options based on 1) documents, 2) partner rankings, 3) farmers as most likely to be impacted by BMPs, and 4) underrepresented/low-income communities to address inclusivity and EJ goals



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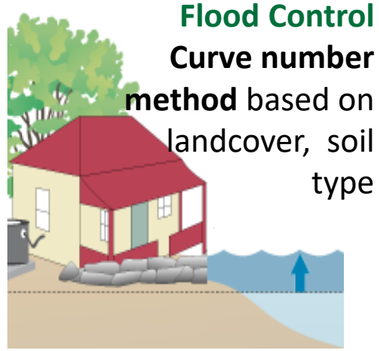
Quantify Ecosystem Services per acre of BMP

- Each BMP associated with a CAST land cover class
- Identified or generated models to describe ES supply per acre of landcover

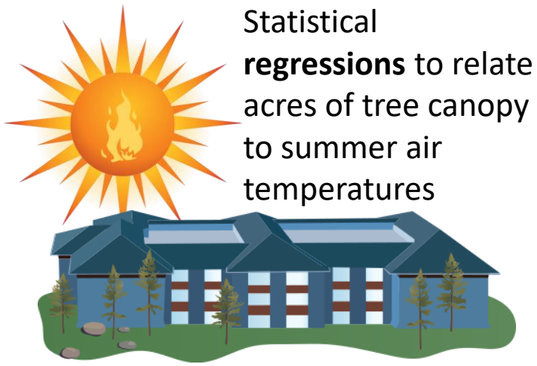
Air Quality
Air pollutant removal rates in urban and rural areas obtained from **i-Tree** and multiplied by acres of tree cover

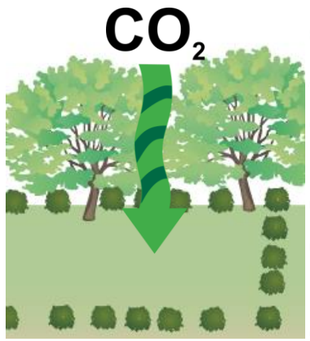
Bird Diversity
Species area curves relate increasing acres of land cover type to potential bird species richness, obtained from USGS GAP



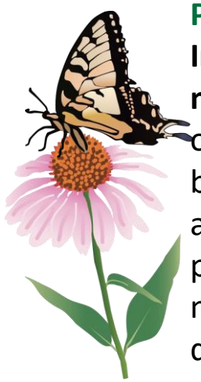
Flood Control
Curve number method based on landcover, soil type

Heat Risk Reduction
Statistical **regressions** to relate acres of tree canopy to summer air temperatures



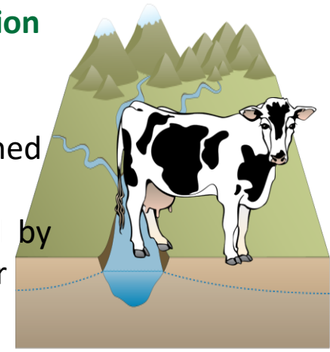


Carbon Sequestration
Average rates of burial of atmospheric carbon into soil (i.e., in support of mitigating climate change) by landcover type, obtained from **COMET-Planner** and literature review, multiplied by acres of landcover



Pollination
InVEST pollinator model to assign index of habitat suitability based on land cover, and characteristics of pollinators such as nesting and foraging distance

Pathogen Reduction
Fecal indicator bacteria removal efficiencies obtained from literature review, multiplied by acres of landcover type



Water Quantity (Stream Flow)
CAST Hydrological Model

Open Space
Acres of **landcover per capita** identified as wetland, tree canopy, shrubland, and low vegetation

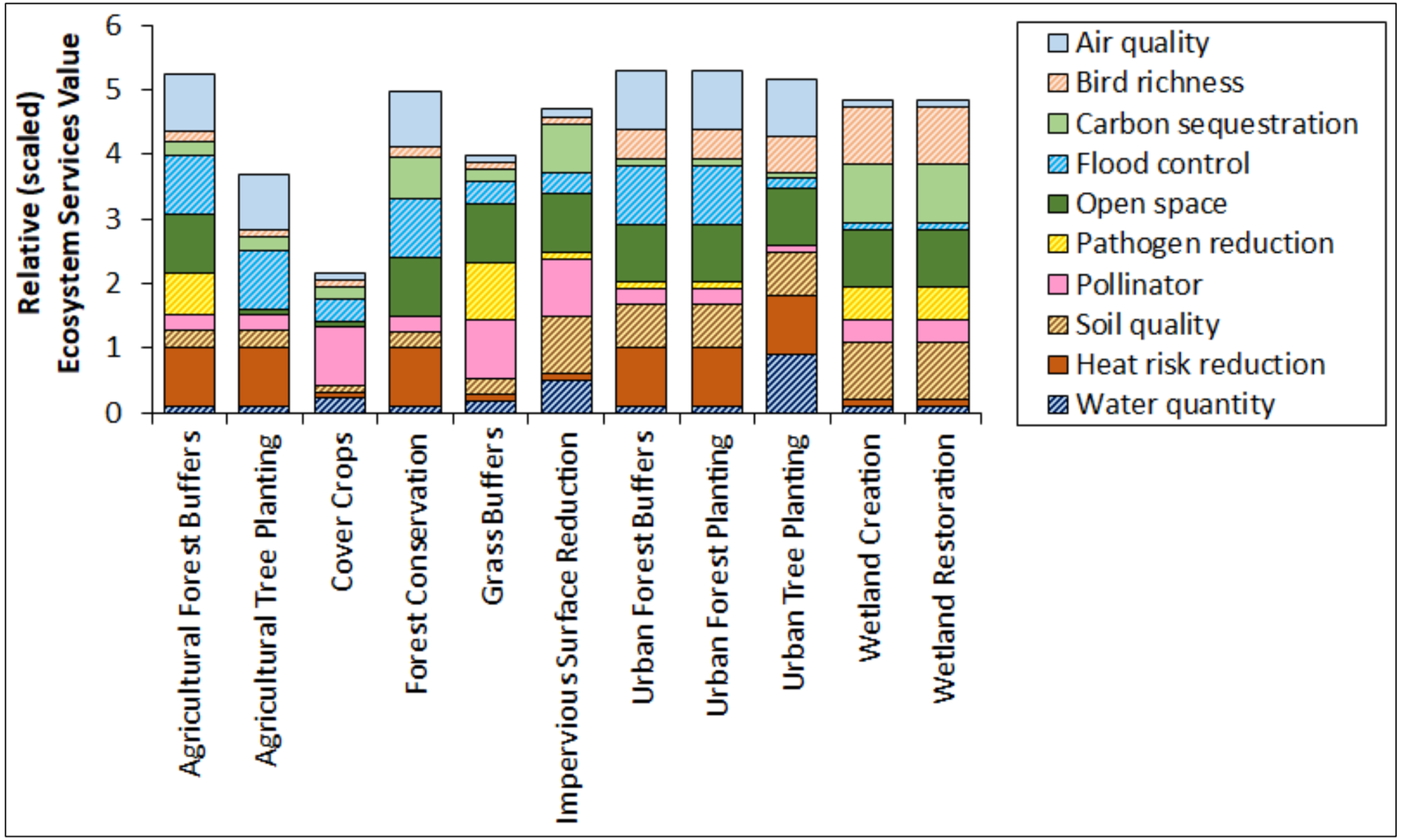
Soil Quality
Average **carbon content of soil** by landcover type, obtained from and literature review, multiplied by acres of landcover

https://ian.umces.edu/media-library

Rossi et al. 2023

Decision Support for BMP Implementation

- A demonstration of lookup tables and models to layer ES predictions onto sediment/nutrient reductions in Chesapeake Bay Assessment Scenario Tool



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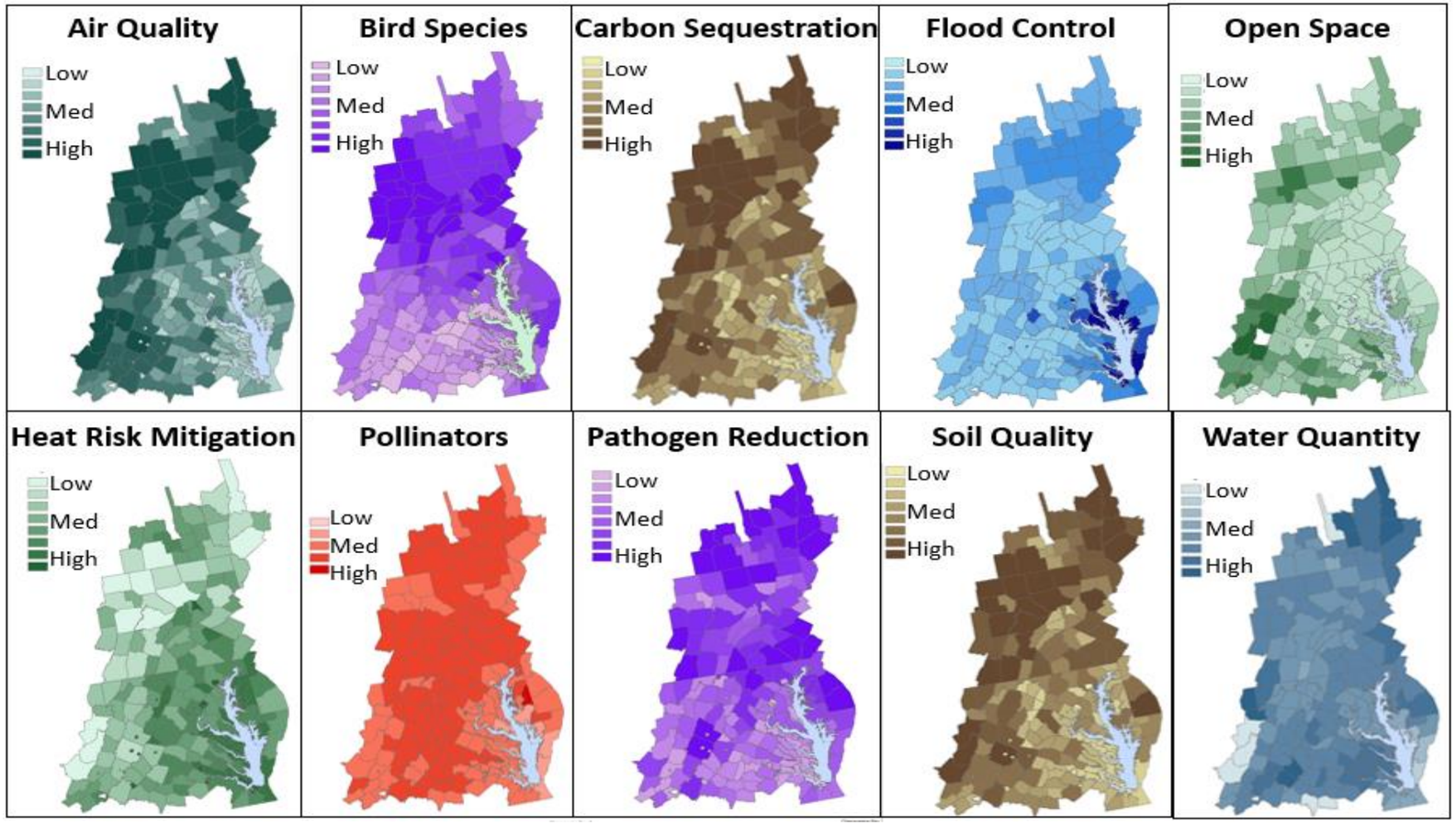
Decision Support for BMP Implementation

- A demonstration of lookup tables and models to layer ES predictions onto sediment/nutrient reductions in Chesapeake Bay Assessment Scenario Tool
- Maps of current levels of ecosystem services



https://gis.chesapeakebay.net/targeting/

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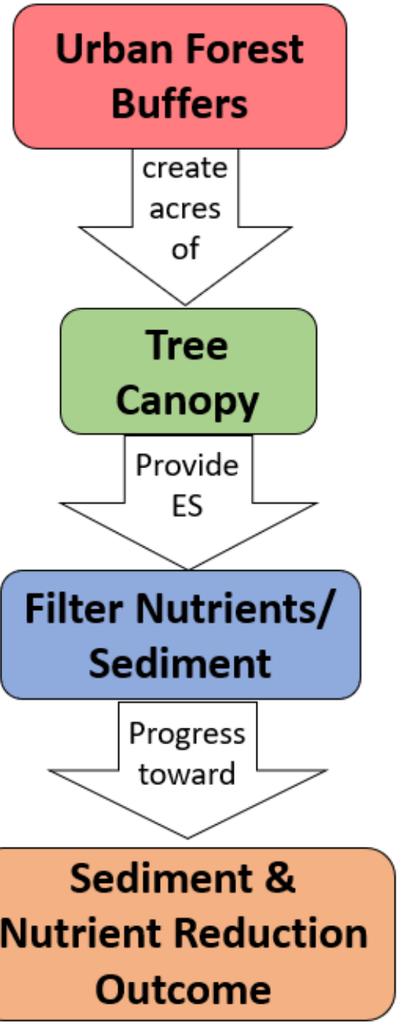
Decision Support for BMP Implementation

- Project also recognized where ecosystem services gained from BMPs could contribute (indirectly or directly) to Watershed Agreement Outcomes



https://cast.chesapeakebay.net/ecohealth/index

Rossi et al. 2023

Decision Support for BMP Implementation

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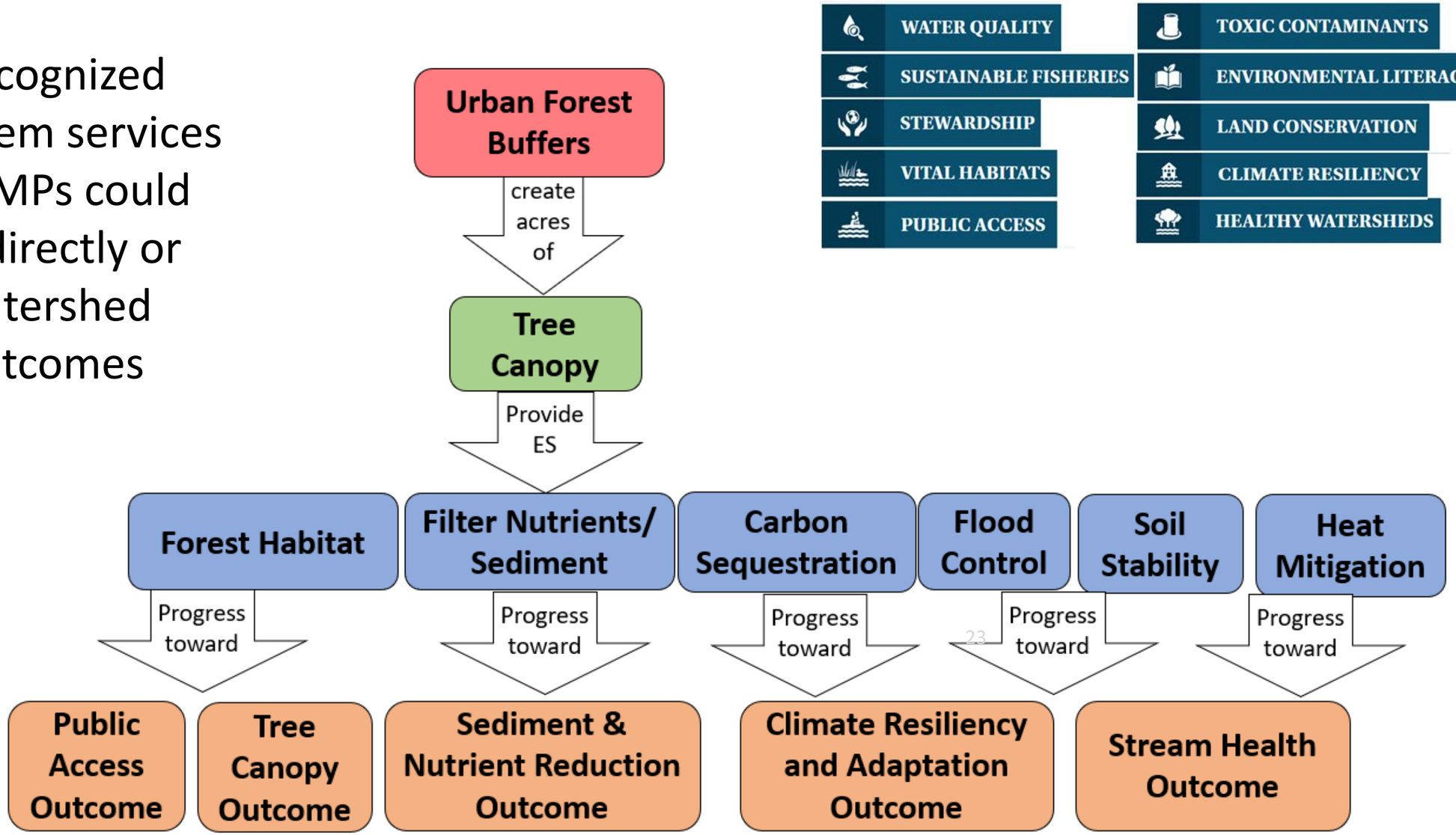

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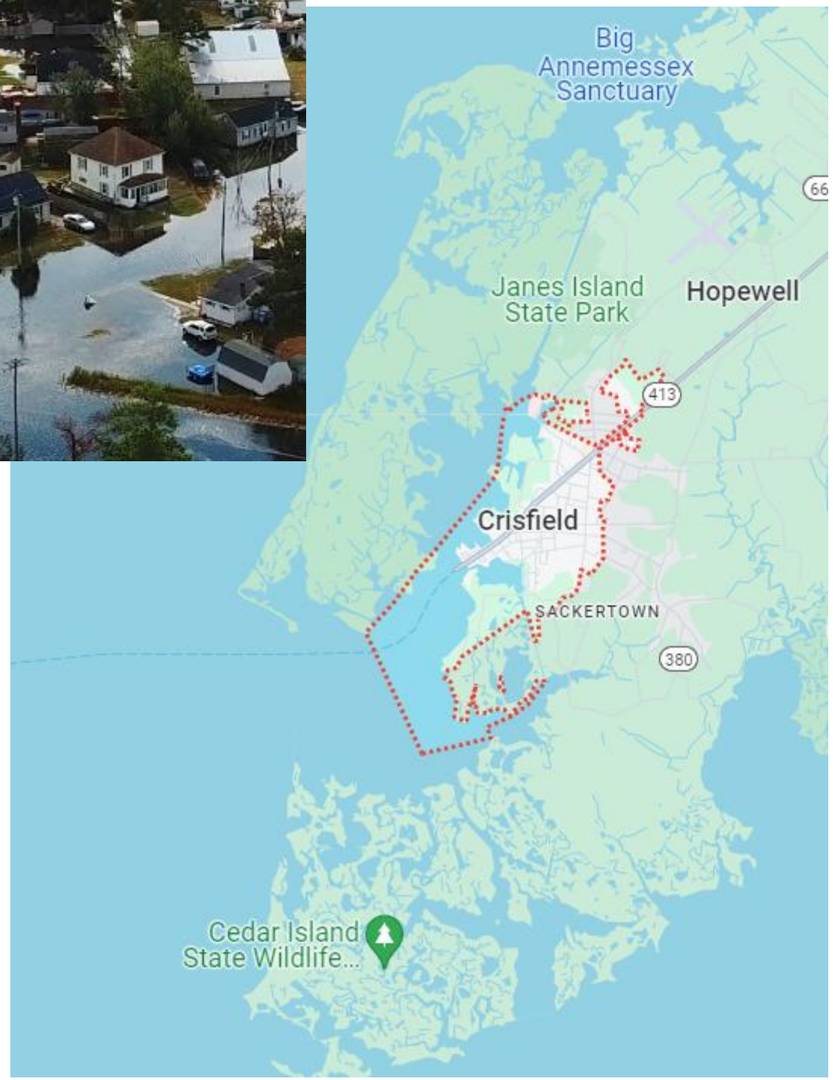
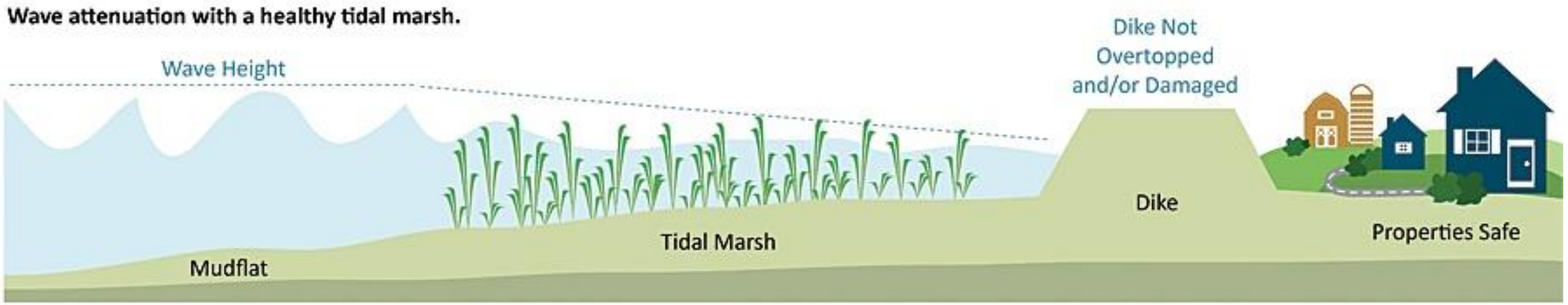
Case Study 2: Storm Flooding in Crisfield, MD



- Climate challenges:
  - Tidal flooding
  - Storm flooding
  - Coastal erosion
- Opportunities for natural infrastructure:
  - Surrounded by salt marshes and seagrasses
  - Extensive existing and historical oyster reefs
- Nature interwoven with community resilience goals:
  - Flood-safe housing and resilient infrastructure
  - Tourism and recreation tied to waterfront
  - Commercial fisheries

Research Questions

- Can Nature Based Strategies (NBS) help protect Crisfield from storm surge and flooding?
- What are the social and economic co-benefits of potential NBS?



What kinds of NBS can help with Storm Surge?

Literature Review

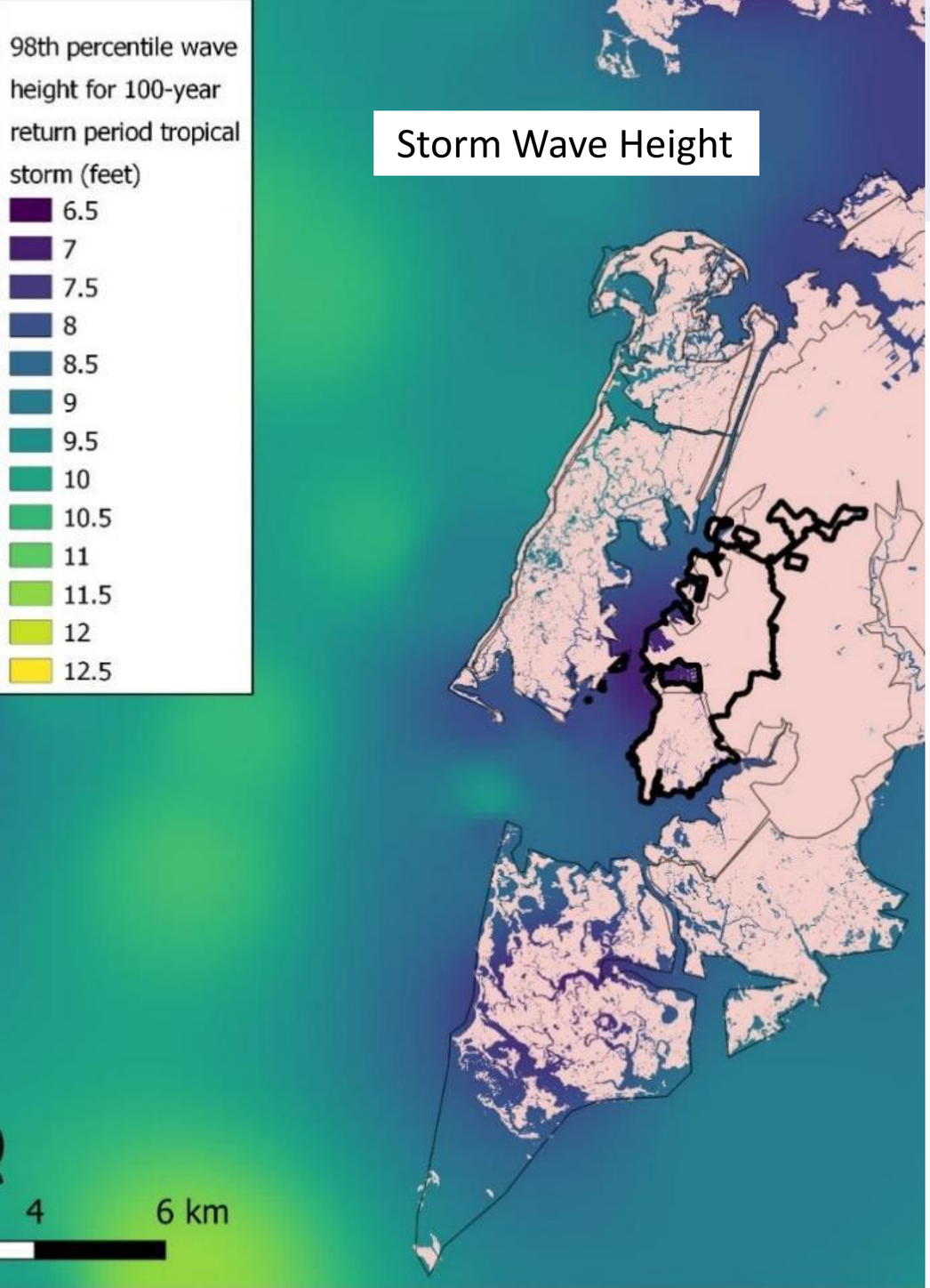
- Success stories from locations similar to Crisfield
- Identify criteria associated with their success and conditions required for them to be successful
  - Shallow water
  - Land slope
  - Historic erosion
  - Wave energy
  - Submerged vegetation
  - Substrate

Dune Restoration

Salt Marsh Restoration

Living Shorelines

Artificial Reefs/ Living Breakwaters



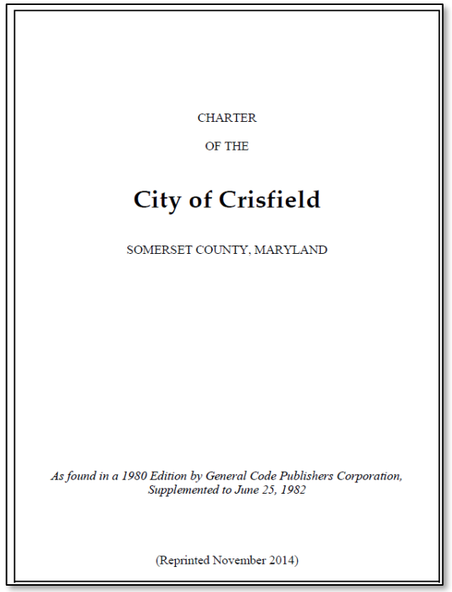
Next steps

- Baseline storm surge attenuation modeling
  - Current existing natural conditions (2024)
  - “Do nothing” scenario by 2050 and 2100
- Calculate maximum wave and storm surge height reduction possible from selected NBS
  - Estimated attenuation when installed (2024)
  - Attenuation by 2050 and 2100 (including sea level rise)
- Assess additional ecosystem services co-benefits possible from NBS

What Ecosystem Services Matter to Crisfield?

Review of Crisfield Planning and Management Documents

- Identified sentences mentioning i) coastal habitat, ii) type of user group, and iii) attributes they care about
- "Relative importance" based on frequency of mentions in documents



CHARTER

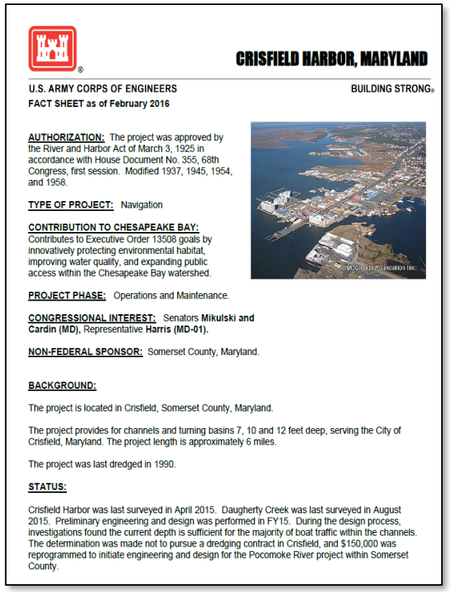
OF THE

City of Crisfield

SOMERSET COUNTY, MARYLAND

As found in a 1980 Edition by General Code Publishers Corporation, Supplemented to June 25, 1982

(Reprinted November 2014)



CRISFIELD HARBOR, MARYLAND

U.S. ARMY CORPS OF ENGINEERS BUILDING STRONG®

FACT SHEET as of February 2016

AUTHORIZATION: The project was approved by the River and Harbor Act of March 3, 1925 in accordance with House Document No. 355, 68th Congress, first session. Modified 1937, 1945, 1954, and 1958.

TYPE OF PROJECT: Navigation

CONTRIBUTION TO CHESAPEAKE BAY: Contributes to Executive Order 13508 goals by innovatively protecting environmental habitat, improving water quality, and expanding public access within the Chesapeake Bay watershed.

PROJECT PHASE: Operations and Maintenance.

CONGRESSIONAL INTEREST: Senators **Mikulski and Cardin (MD),** Representative **Harris (MD-01).**

NON-FEDERAL SPONSOR: Somerset County, Maryland.

BACKGROUND:

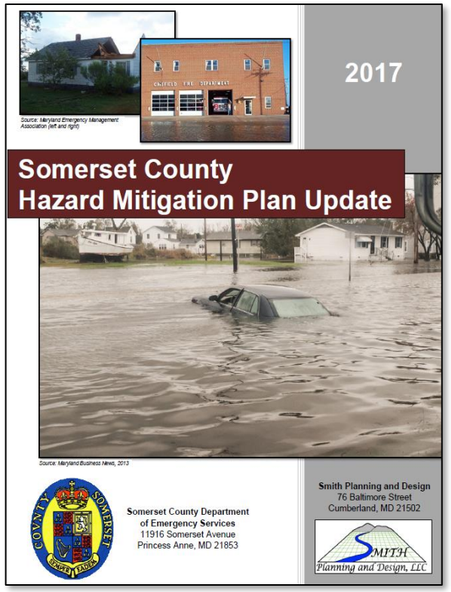
The project is located in Crisfield, Somerset County, Maryland.

The project provides for channels and turning basins 7, 10 and 12 feet deep, serving the City of Crisfield, Maryland. The project length is approximately 6 miles.

The project was last dredged in 1990.

STATUS:

Crisfield Harbor was last surveyed in April 2015. Daugherty Creek was last surveyed in August 2015. Preliminary engineering and design was performed in FY15. During the design process, investigations found the current depth is sufficient for the majority of boat traffic within the channels. The determination was made not to pursue a dredging contract in Crisfield, and $150,000 was reprogrammed to initiate engineering and design for the Pocomoke River project within Somerset County.

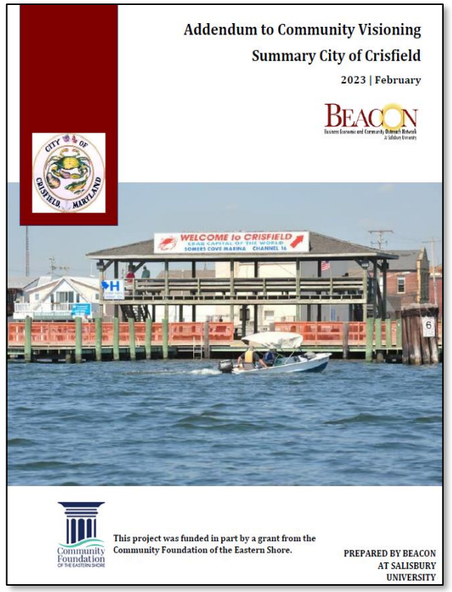


2017

Somerset County Hazard Mitigation Plan Update

Somerset County Department of Emergency Services
11916 Somerset Avenue
Princess Anne, MD 21853

Smith Planning and Design
76 Baltimore Street
Cumberland, MD 21502

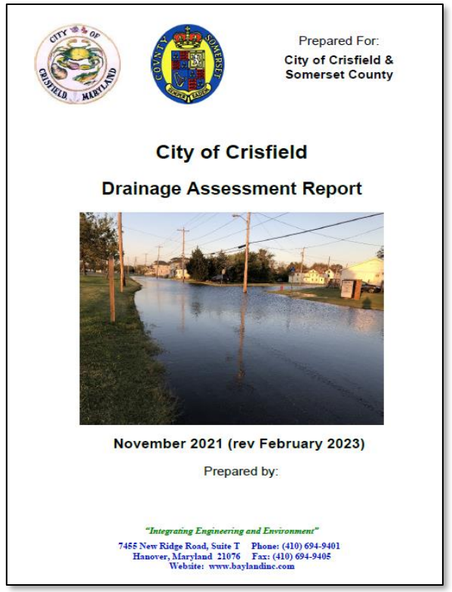


Addendum to Community Visioning
Summary City of Crisfield
2023 | February

BEACON

This project was funded in part by a grant from the Community Foundation of the Eastern Shore.

PREPARED BY BEACON AT SALISBURY UNIVERSITY



Prepared For:
City of Crisfield & Somerset County

City of Crisfield

Drainage Assessment Report

November 2021 (rev February 2023)

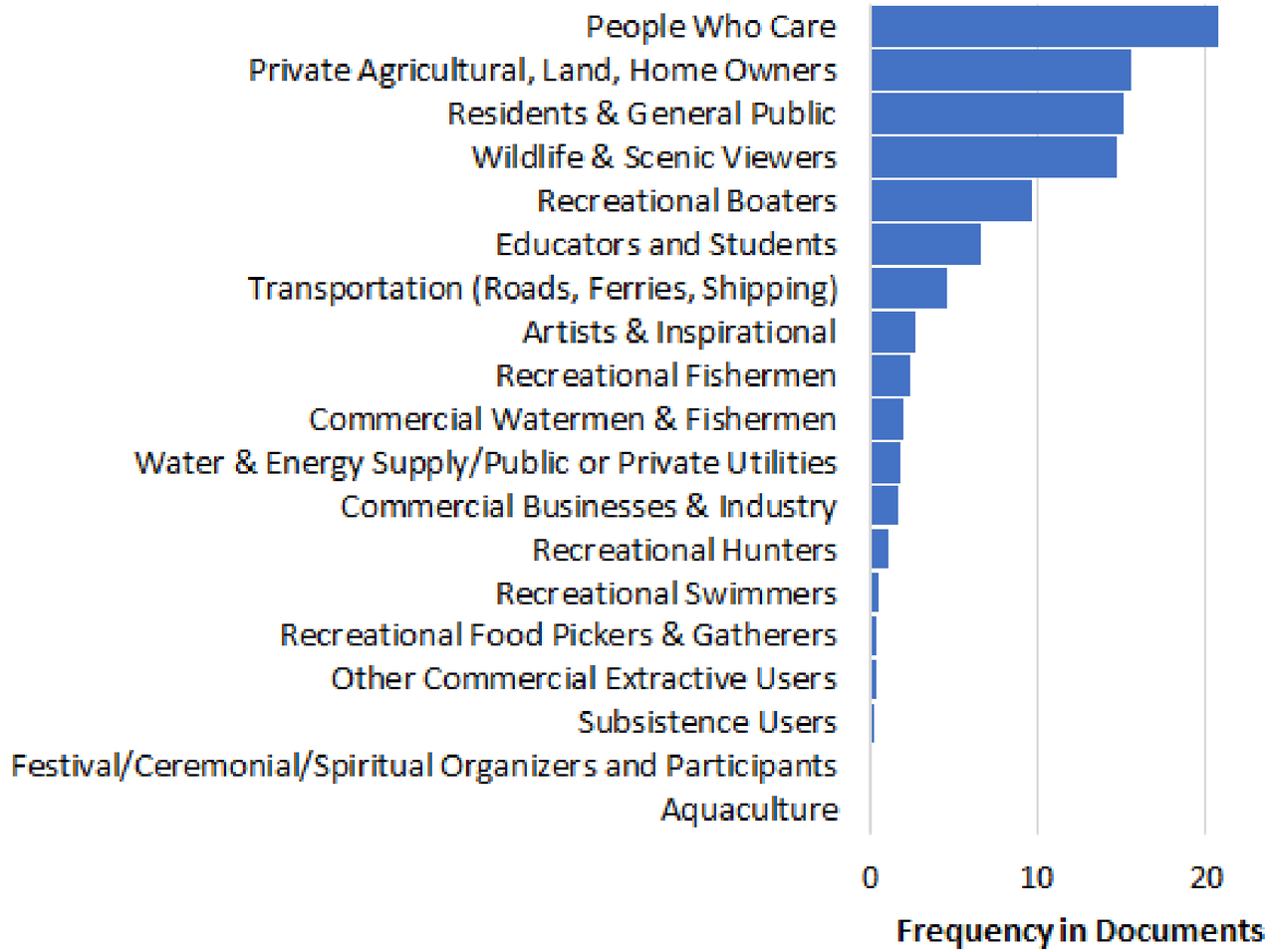
Prepared by:

"Integrating Engineering and Environment"

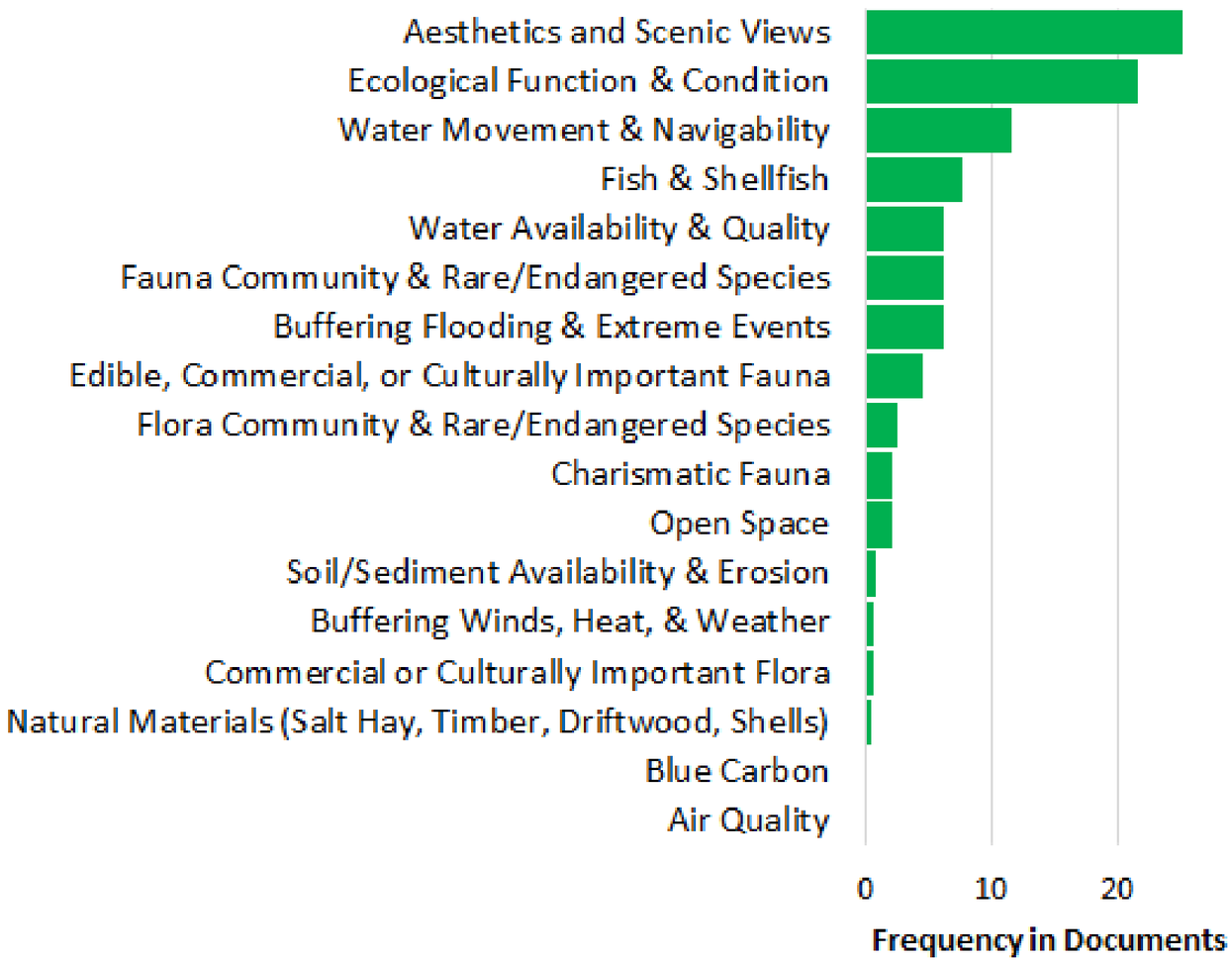
7455 New Ridge Road, Suite T Phone: (410) 694-9401
Hanover, Maryland 21076 Fax: (410) 694-9405
Website: www.baylandinc.com

What Ecosystem Services Matter to Crisfield?

Who is Using or Benefitting from Coastal Habitats?



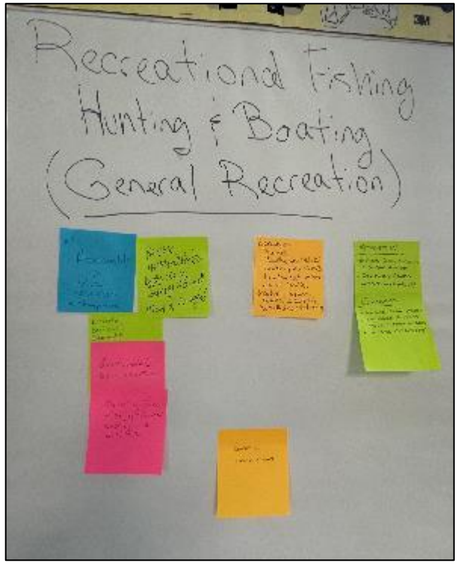
What Attributes do those Users Care about?



Stakeholder Engagement

Decision-Maker Workshop

Public Meeting

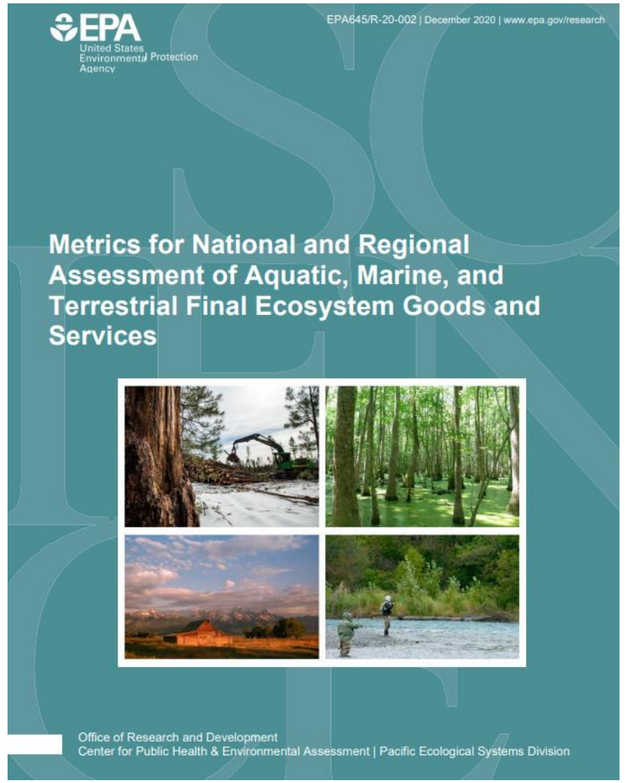


- Flood protection
- Fishing, crabbing, seafood
- Clean water, healthy habitats
- Accessibility for recreation
- Wildlife, control invasive species
- Natural beauty

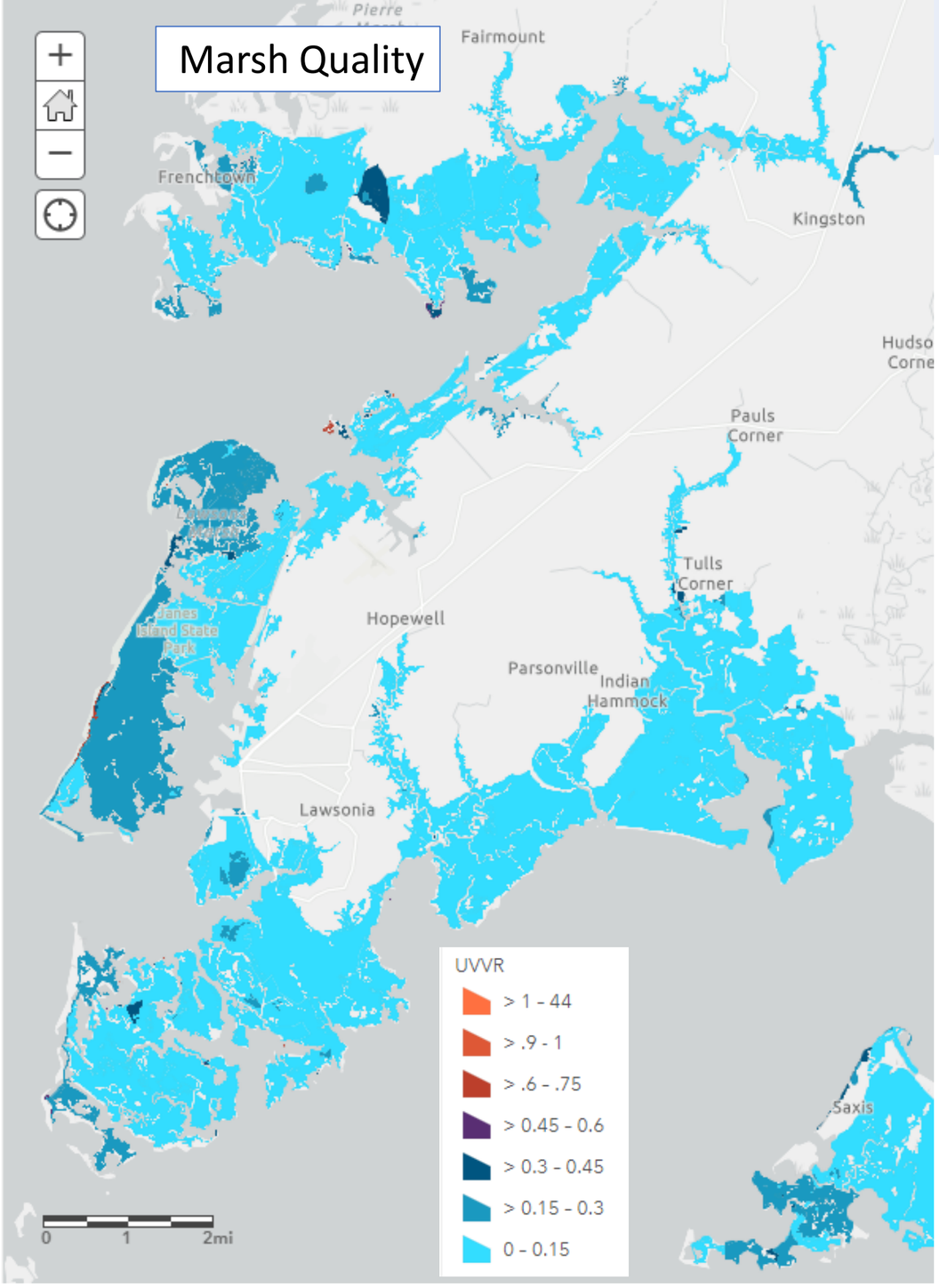
Identifying Relevant Ecosystem Services Metrics

Step 1: What is the ecosystem delineation (what, where, when)?
Step 2: Who is the user group/beneficiary?
Step 3: What attributes does that user care about?
Step 4: What would be an 'ideal' metric or model?
Step 5: What data or models are actually available?

What Matters Directly to this Beneficiary?	Desired Information	Sub-Attribute (Fine Scale)	Ideal Biophysical Data
If in a boat, is it safe and navigable?	Are there any obstructions in the water or along the substrate?	Bottom structure	benthos complexity
	Is it safe to go out? Does the boat captain need a certain level of experience?	Wave Intensity	Wave height, speed and direction
	If in a boat do I have to anchor?	Currents	Tide, weather, wind speed and direction
	Is there sufficient water for my vessel? Can I manuever around?	Water Depth	NOAA bathymetry Charts
	Is it safe to go out?	Wind intensity	weather, wind speed and direction
Is this a good place to go boating?	Is the location aesthetically enjoyable?	Viewscapes	color of water, algae, clarity, smell, sounds
	Will I see something interesting?	Taxa	Species, size, abundance, diversity



How might different Nature-based Strategies impact ecosystem services co-benefits?



Next steps

- Identify what is meaningful to community
- Select and define relevant ecosystem benefits metrics
- Collect data on baseline/current ecosystem services benefits
- Model ecosystem services benefits for alternative NBS options

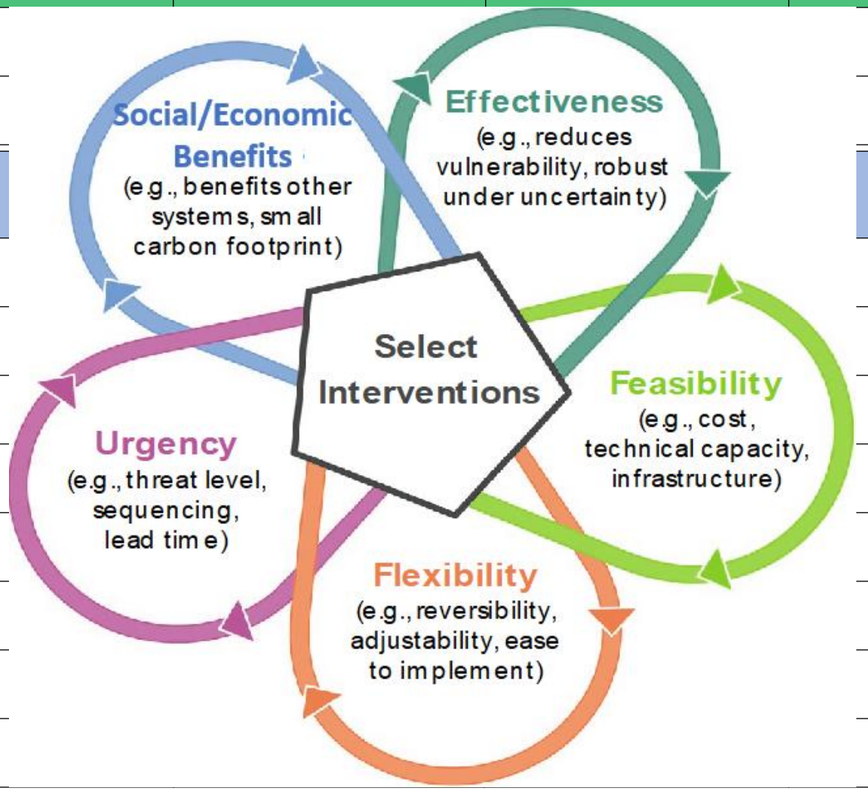
USEPA H2O HYDRO-ECOLOGY GIS

Rapid Benefit Indicators

InVEST Integrated Valuation of Ecosystem Services and Tradeoffs

How do benefits compare across NBS options?

Criteria	Option 1 Status Quo	Option 2 Janes Island Marsh Restoration	Option 3 Cedar Island Marsh Restoration	Option 4 Living Breakwaters	Option 5 Marsh Restoration + Dunes/ Living Shorelines
Effectiveness for Storm Surge					
Wave height reduction					
Rates of coastal erosion					
Social/Economic Benefits					
Fish/Oyster/Crab Abundance					
Charismatic Fauna/Birds					
Native/Rare Plants					
Seagrass/Marsh (Area & Quality)					
Aesthetics/Viewscapes					
Navigable Water (Boating Conditions)					
Water Clarity					
Access for Recreation/Fishing/Education					



Adapted from Shaver et al. (2020)

What Can Ecosystem Services be Used For?

- Setting Local community goals – what ecosystem services do we want to protect or restore?
- Communicating locally relevant benefits to motivate projects or sustain long-term interest
- Comparing restoration options
- Identifying creative opportunities for funding







For More Information

- Rossi, R., et al. 2022. Identifying and Aligning Ecosystem Services and Beneficiaries Associated with Best Management Practices in Chesapeake Bay Watershed. Environmental Management 69:384-409. https://doi.org/10.1007/s00267-021-01561-z
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- National Ecosystem Goods and Services Classification System: www.epa.gov/eco-research/nescs-plus
- Final Ecosystem Goods and Services Scoping Tool: https://www.epa.gov/eco-research/final-ecosystem-goods-and-services-fegs-scoping-tool
- FEGS Metrics Report: https://www.epa.gov/eco-research/final-ecosystem-goods-and-services-fegs-metrics-report
- Ecosystem Services Models Library: https://esml.epa.gov
- EPA H2O: https://www.epa.gov/water-research/ecosystem-services-scenario-assessment-using-epa-h2o
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- Ecosystem Services Tool Selection Portal: https://www.epa.gov/eco-research/ecosystem-services-tool-selection-portal
- Shaver E C, et al. 2020. A Manager's Guide to Coral Reef Restoration Planning and Design. NOAA Coral Reef Conservation Program. NOAA Technical Memorandum CRCP 36, 128 pp. https://www.coris.noaa.gov/activities/restoration_guide

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