The Final Ecosystem Goods and Services (FEGS) Document Reader

A Tool to Extract, Identify, and Prioritize Ecosystem Services and their Beneficiaries from Documents

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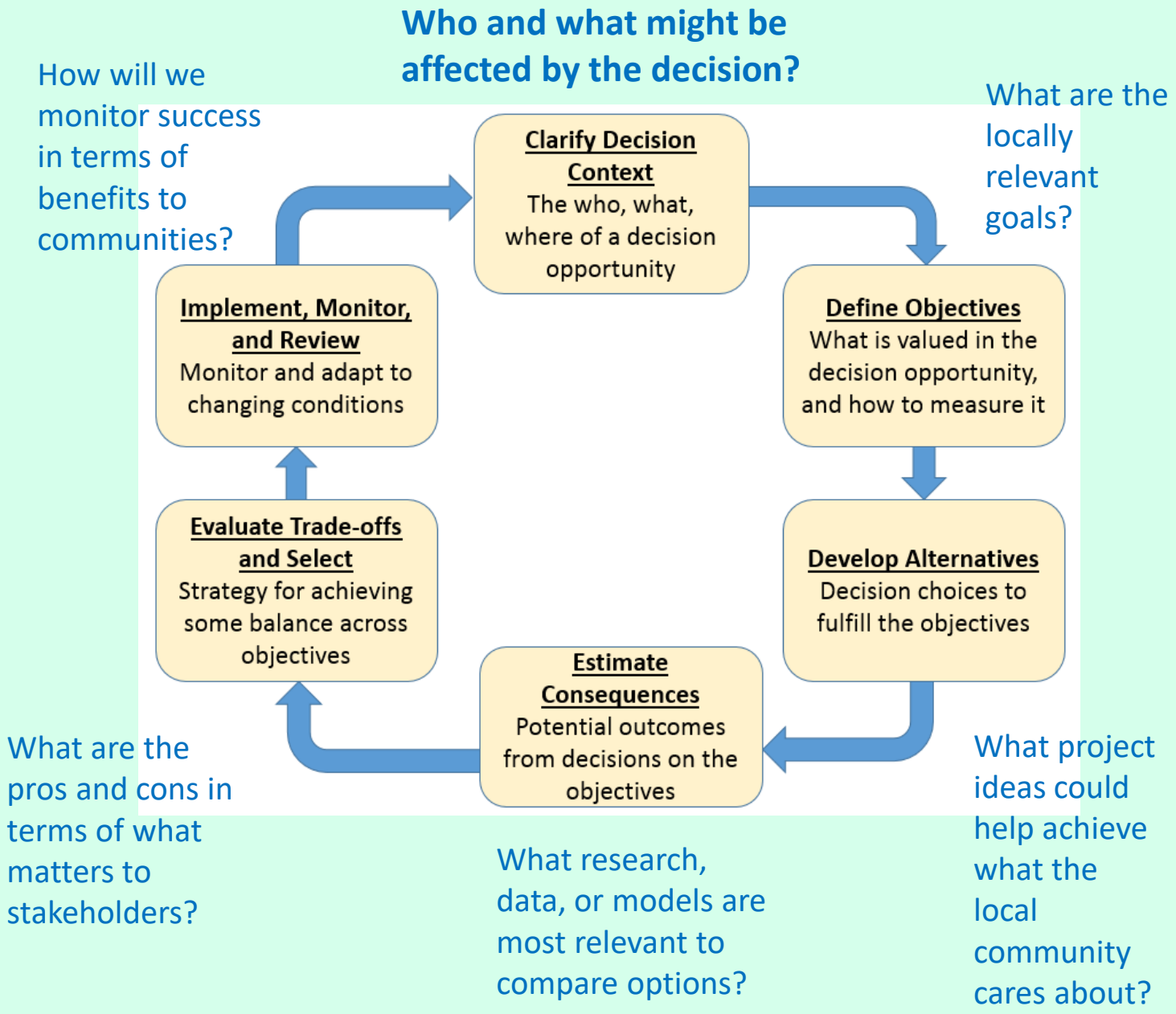
Challenge

Essential first step to effectively integrating ecosystem services into environmental management decisions is to:

- Identify the key stakeholders
- Understand what is important to them

Forms the foundation for steps in a decision process

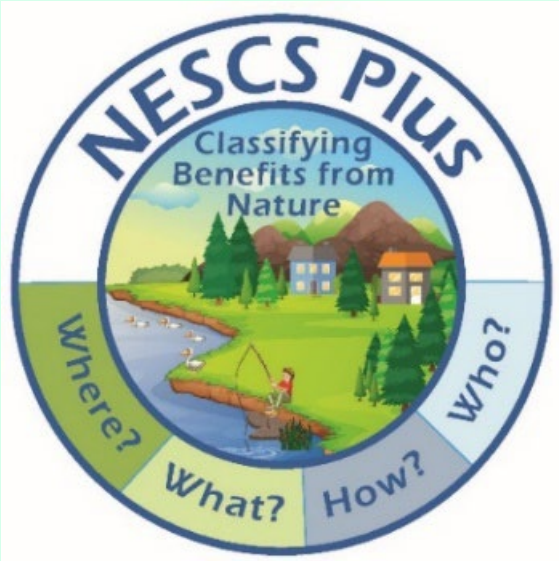


Tools to Help Identify and Prioritize Ecosystem Services

National Ecosystem Services Classification System (NESCS) Plus

- Organize and structure
- Classify ecosystems, users who benefit, attributes they care about
- Comprehensive – make sure key users or ecosystem services are not overlooked

www.epa.gov/eco-research/nescs-plus



Beneficiary
Agricultural
Commercial/Industrial
Government/Residential
Transportation
Subsistence
Recreational
Inspirational
Learning
Non-use
Humanity

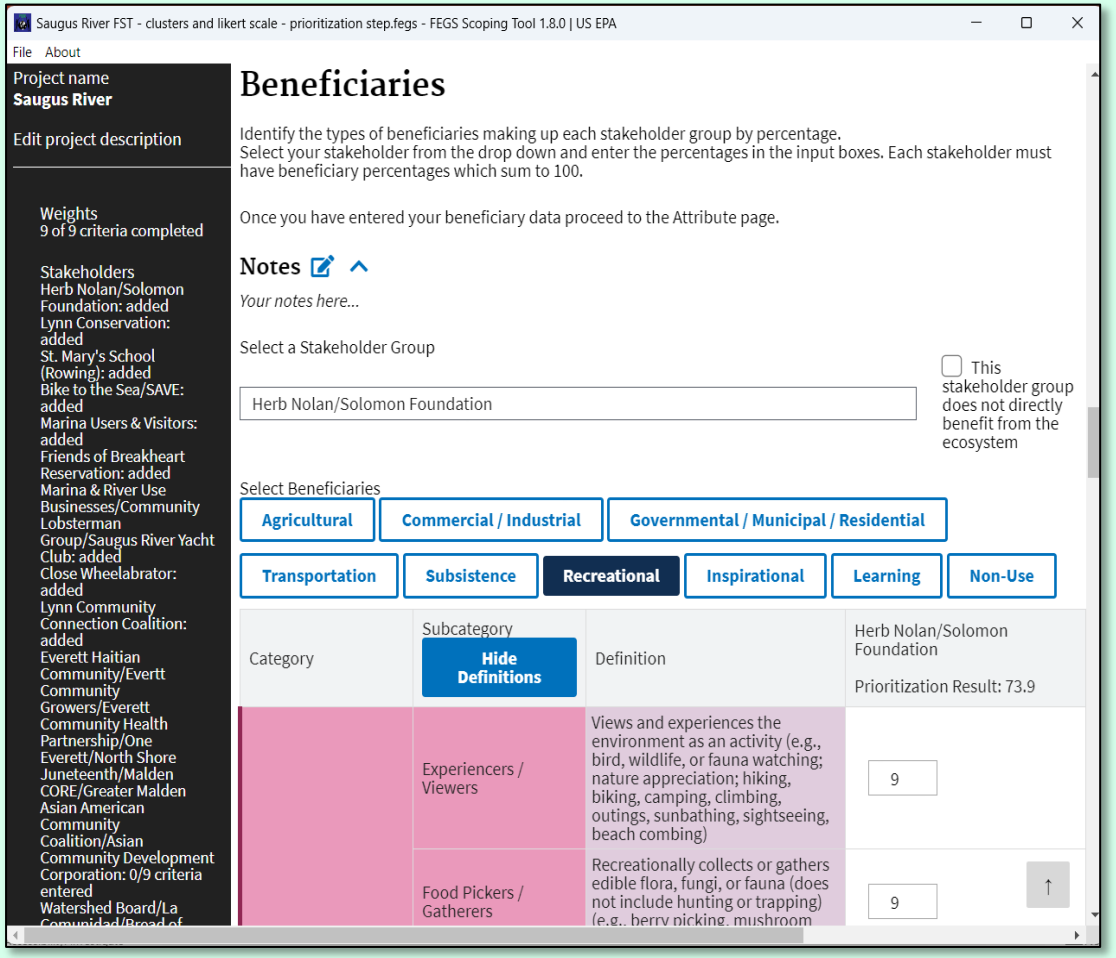
Ecological End Product
Atmosphere
Soil
Water
Fauna
Flora
Fungi
Other Natural Components
Composite

Environment
Rivers and Streams
Lakes and Ponds
Near-coastal/Estuarine
Open Ocean and Seas
Woody Wetlands
Herbaceous Wetlands
Deciduous Forest
Evergreen Forest
Pasture/Hay
Cultivated Crops
Grassland
Shrubland/Scrubland
Lichens
Moss
Sedge
Dwarf Scrub
Perennial Ice/Snow
Developed Open Space
Developed Low/Med/High Intensity
Barren Land

Tools to Help Identify and Prioritize Ecosystem Services

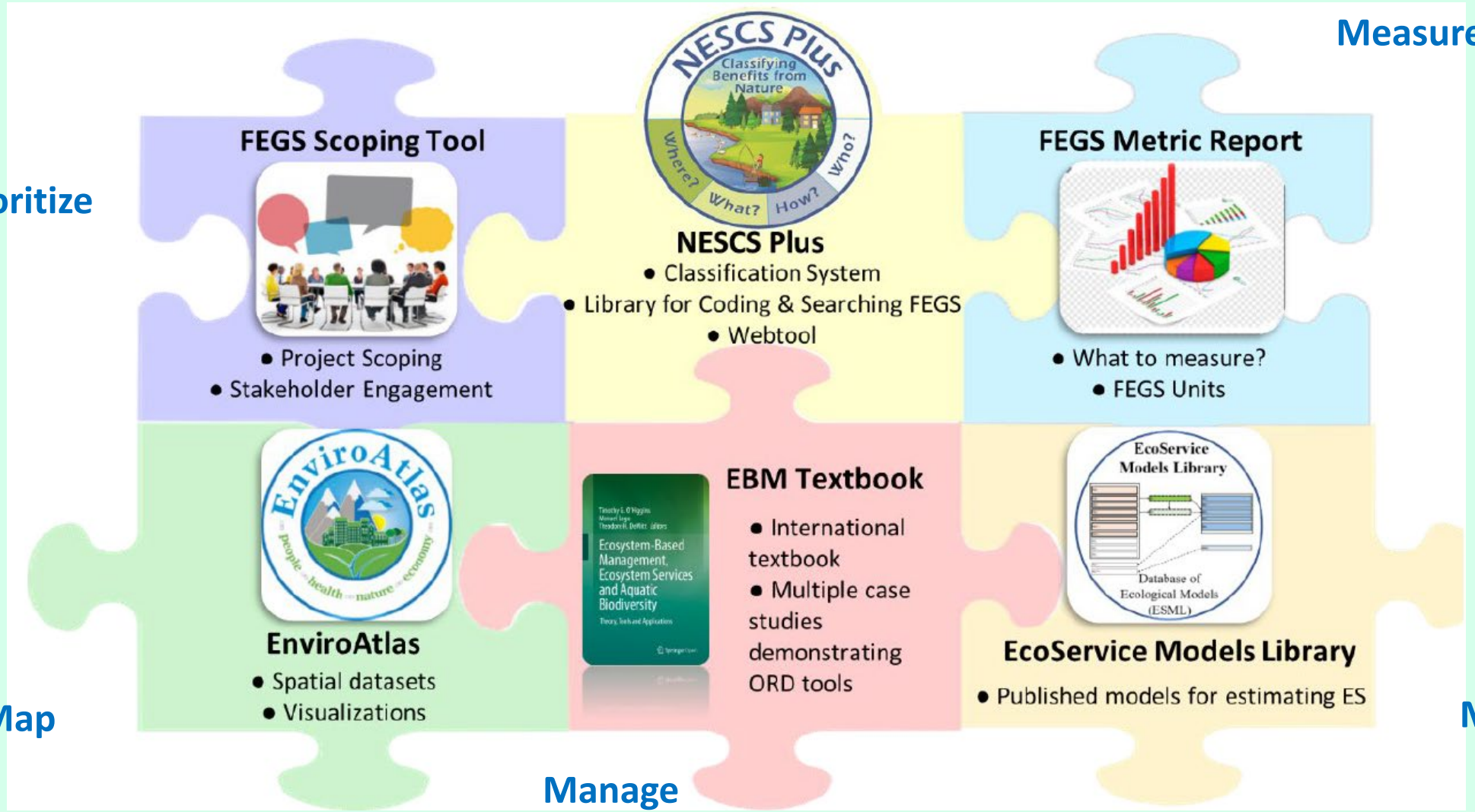
Final Ecosystem Goods & Services (FEGS) Scoping Tool

- Transparent, repeatable, & defendable
- Grounded in multi-criteria decision analysis
- Formal deliberative approach toward stakeholder and ecosystem services prioritization
- User use best/expert judgment to score relative importance



www.epa.gov/eco-research/final-ecosystem-goods-and-services-fegs-scoping-tool

FEGS Family of Tools



Sharpe et al. 2023. Frontiers. https://doi.org/10.3389/fevo.2023.1290662

Why FEGS?

Final Ecosystem Goods and Services (FEGS)

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

Environmental Context

Mangroves

Where?

+

Beneficiary

Recreational Birdwatchers

Who?

+

Ecological Attribute

Charismatic bird species

What?

Why FEGS?

- Clarify what is meant and reduce ambiguity
- Directly relevant to stakeholders

Intermediate Ecosystem Services

Water quality

What?

Where?

For who?

Final Ecosystem Goods & Services

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

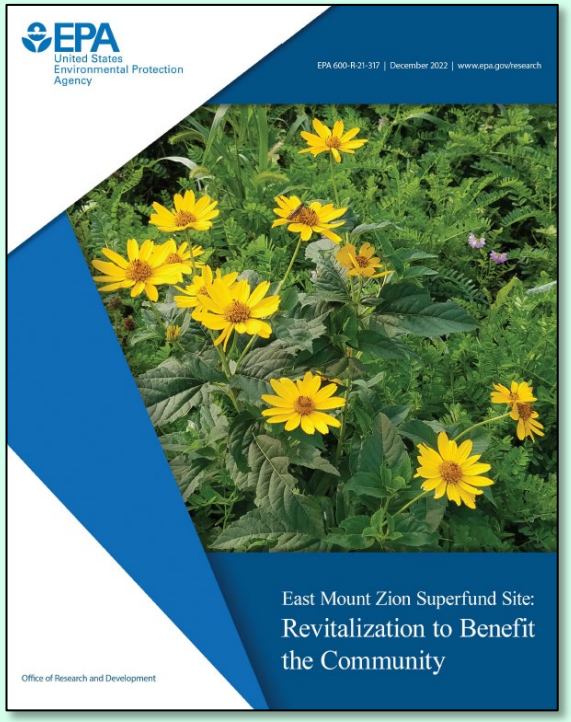
Water temperature in **local streams** used by **industrial processors** for cooling

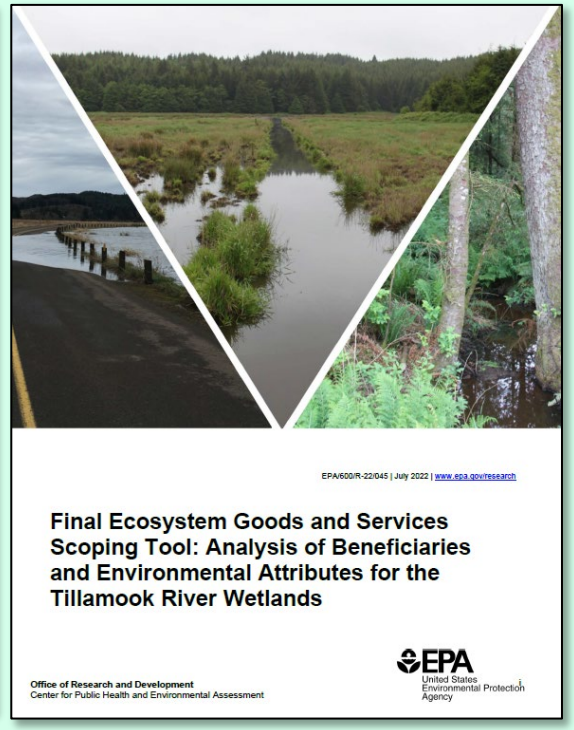
Water turbidity in **coastal waters** that are visited by **snorkelers**

Scoping Priority FEGS

NESCS Plus and FEGS Scoping Tool

- Rely on user to identify and classify important beneficiaries and ecosystem services
- Ideally user works directly with decision-makers and other organizational representatives to elicit their opinions and priorities
- Have been used as part of stakeholder engagement in several case studies





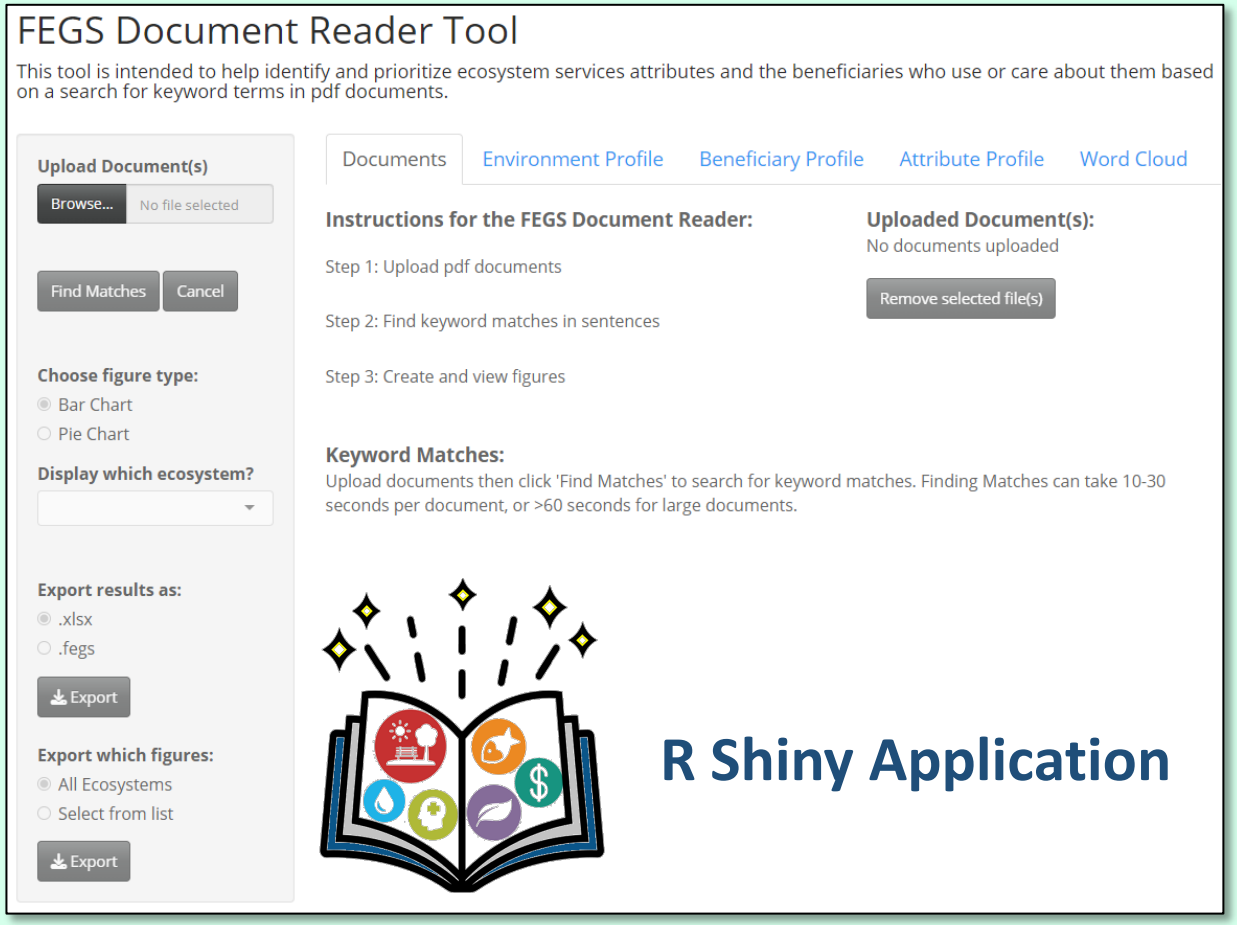
But...

- Learning curve to understanding and applying a classification system
- Stakeholder engagement can be challenging and time consuming
- Importance scoring can be subjective

FEGS Document Reader

New addition to FEGS Tool Family

A deep learning, text-mining technology to accelerate the identification and prioritization of ecosystem services when written information is available



R Shiny Application

Provides an assessment of:

- the relative importance of different ecosystems mentioned in documents
- the types of beneficiaries who use or care about those ecosystems
- the most relevant ecosystem services important to those users

Tool Overview

- Leverages NESCS Plus to classify text
  - the **Environment** providing the service
  - the **Beneficiary** who uses or cares about it
  - the **Ecosystem Attribute** the user cares about
- Classes/SubClasses are defined by >5000 keyword search terms
- Searches sentences for keywords and counts class/subclass frequencies
- Considered a “FEGS” if all 3 (Beneficiary, Ecosystem Attribute, Environment) mentioned in same sentence (±1)

Beneficiary
Agricultural
Commercial/Industrial
Government/Residential
Transportation
Subsistence
Recreational
Inspirational
Learning
Non-use
Humanity

Ecosystem Attribute
Atmosphere
Soil
Water
Fauna
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Other Natural Components
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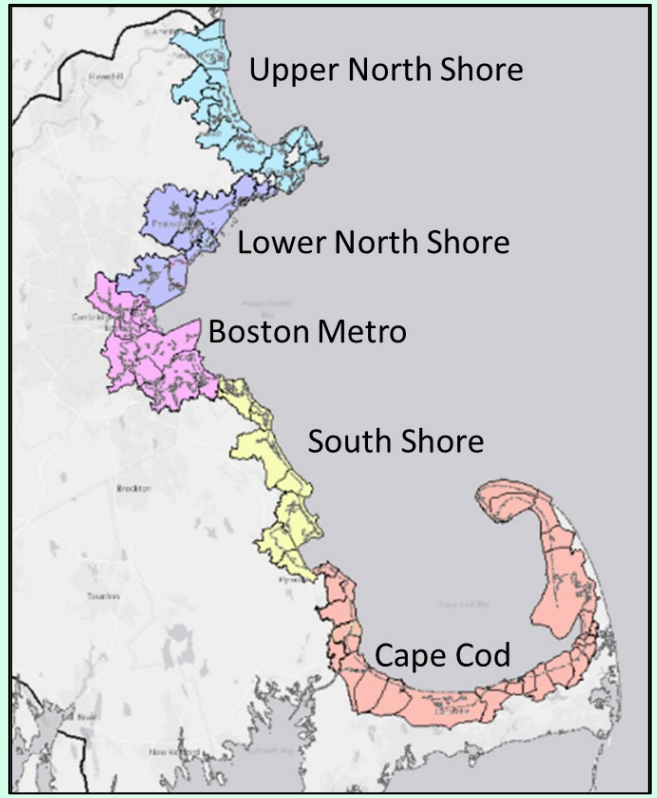
Tool Overview

- Keywords originally developed and refined for coastal case studies
  - Who Benefits from National Estuary Programs (Yee et al. 2019)
  - Community Profiles of Coastal Habitat Use in Massachusetts Embayments (Yee et al. 2023)
  - Regional Differences in Tidal Wetland Management Priorities (Jackson et al. 2024)



Organization Categories	Pacific Northwest	Mid-Atlantic	Northern Gulf of Mexico	Total
Federal Agencies	5	5	10	20
State and Local Agencies	13	18	14	45
Land Stewards	17	23	16	56
Wetland Conservation Organizations	10	4	6	20
Total	45	50	46	**141**

Tool Steps

- Follows the same steps as the FEGS Scoping Tool

Step 1: Documents represent “Stakeholders”
Step 2a: Generate a Beneficiary Profile for each “Stakeholder”
2b: Generate an Average Beneficiary Profile across All Documents
Step 3a: Identify Ecosystem Attributes Relevant to each Beneficiary
3b: Generate an Average Attribute Profile across All Documents
Step 4: Prioritization can be Filtered by Ecosystem and exported as output files (.xls, .fegs)

FEGS Scoping Tool

importance weights are based on frequencies of mentions in documents

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Kinds of documents that may contain ecosystem services information

- Adaptation Plans or Strategies
- Brochures or Guides
- Climate, Resilience, or Vulnerability Plans
- Community or Town Reports
- Conservation or Restoration Projects/Plans
- Economic Plans
- Environmental Impact Reports or Statements
- Feasibility Reports or Studies
- Harbor Plans
- Open Space or Recreation Plans
- Mitigation Plans
- Habitat Assessments
- Landscape or Resource Inventories
- Recovery or Improvement Plans
- Scientific Journal Articles
- Stormwater or Wildlife Management Plans
- Sustainability or Stewardship Plans
- Watershed Plans or Reports
- Water Quality Assessments or Reports
- Website Content
- Workshop Discussion Notes or Summaries

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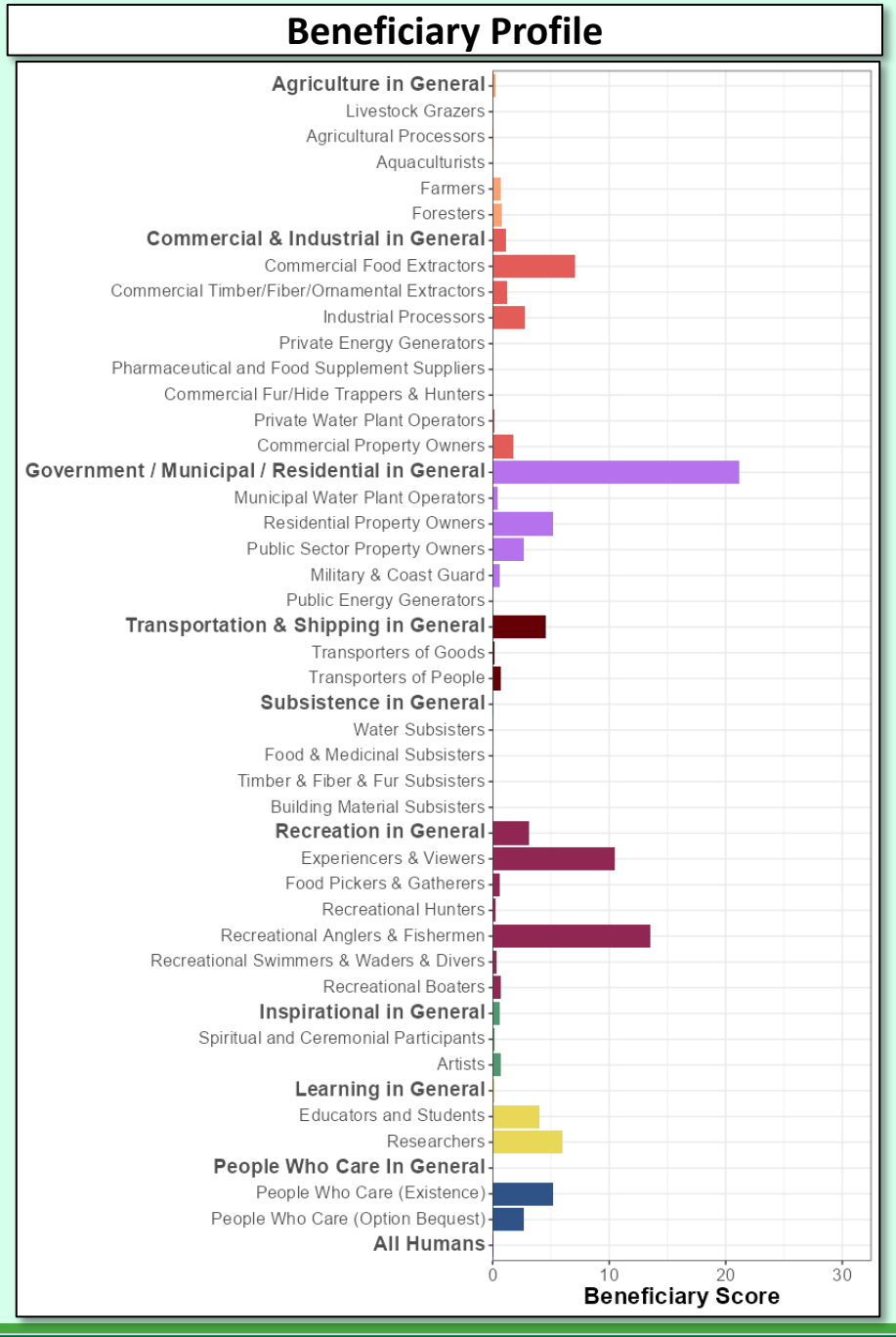

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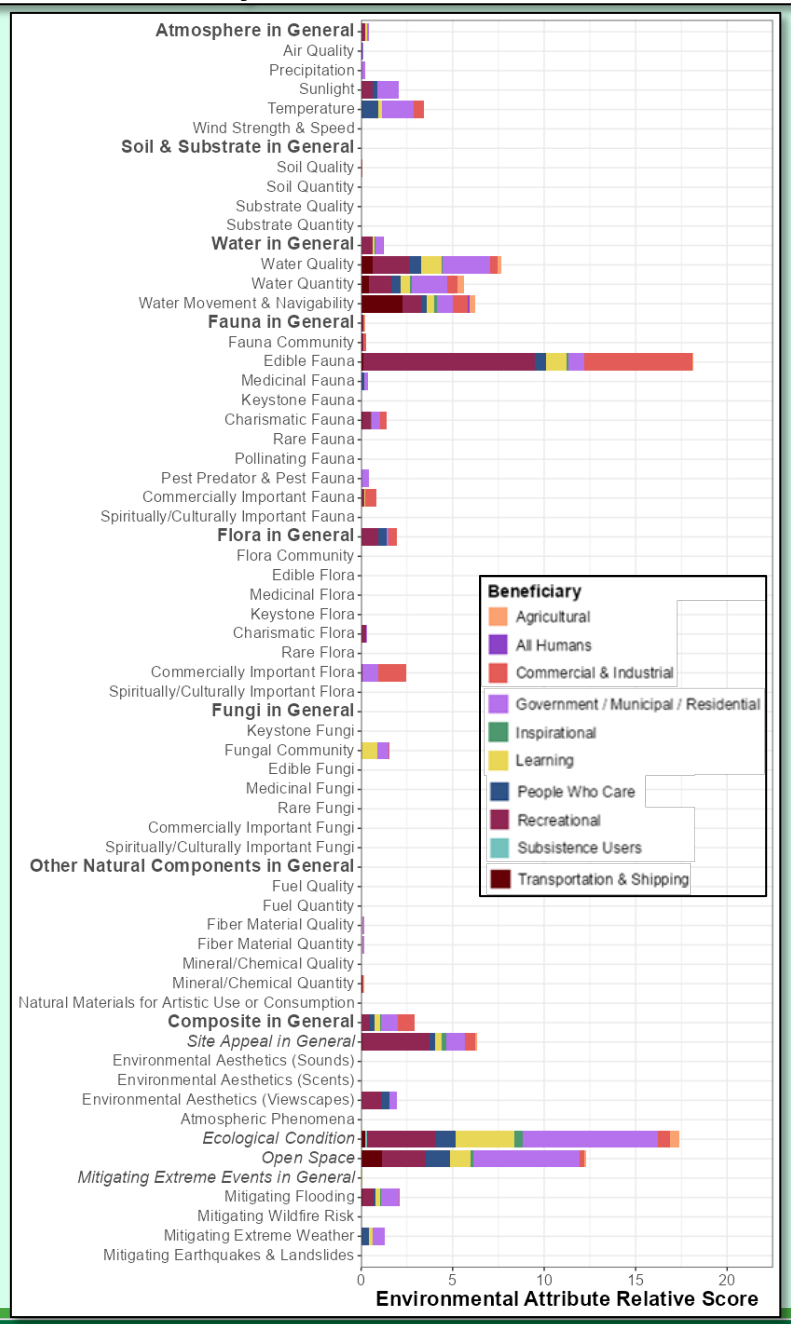
Ecosystem Attribute Profile



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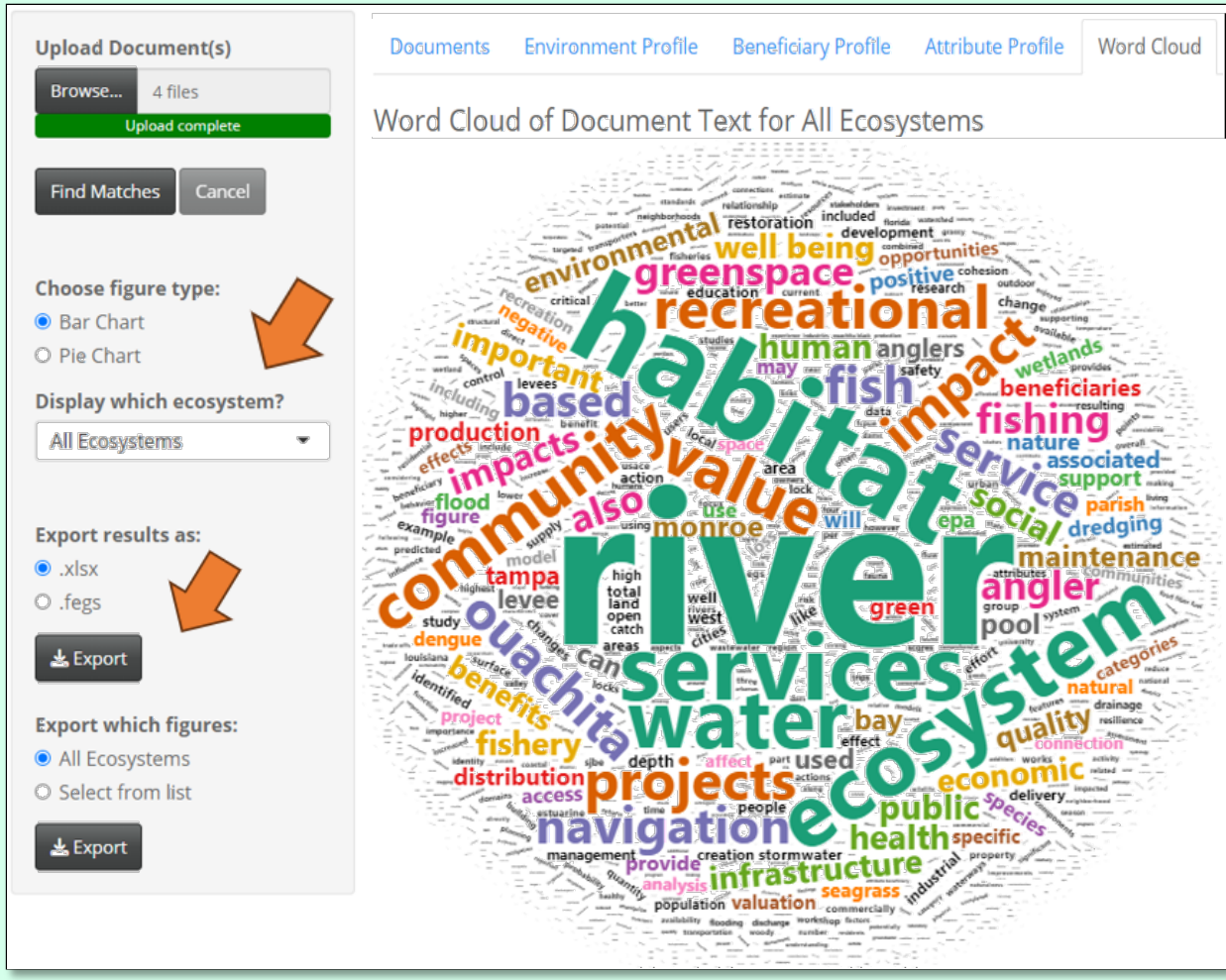
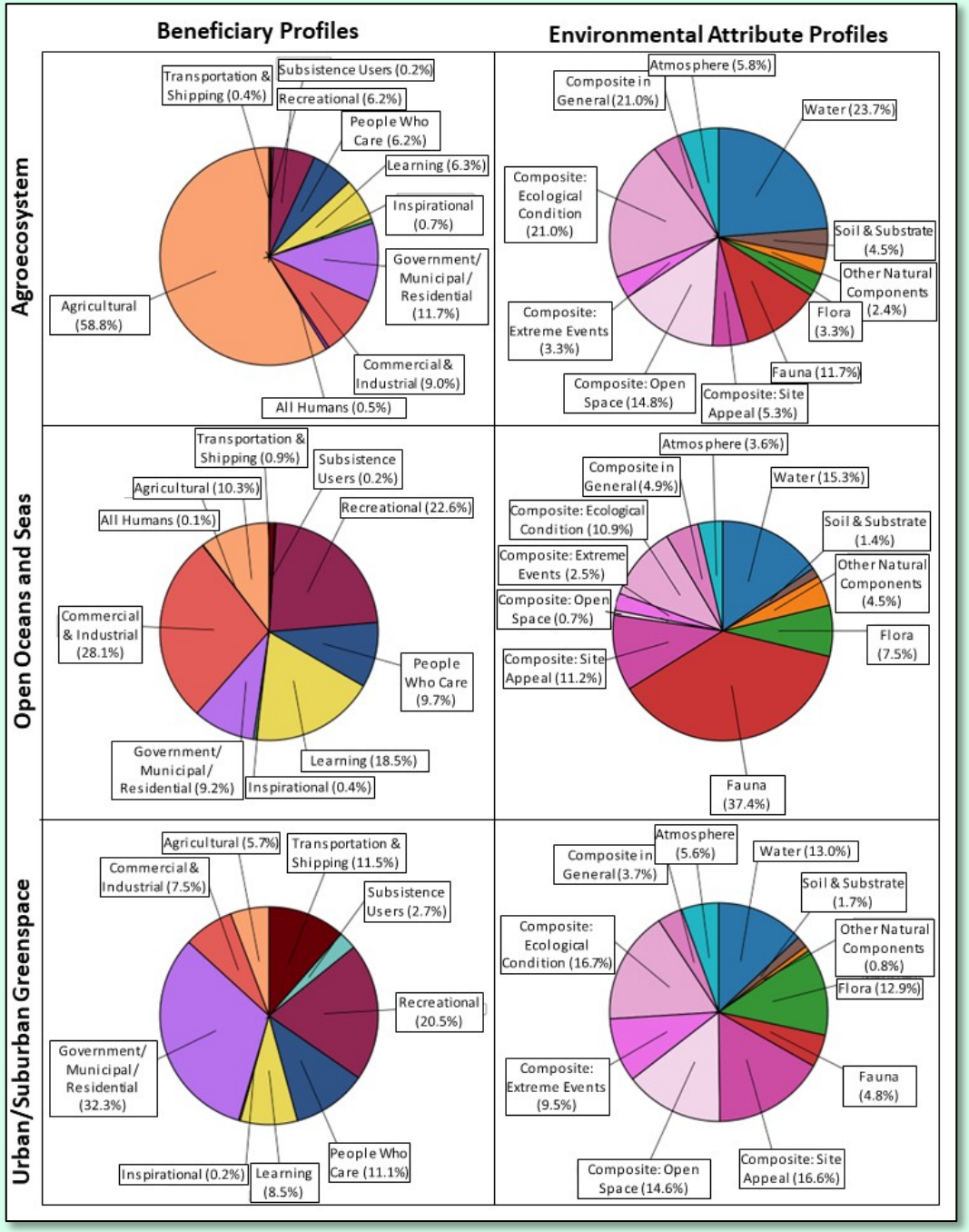
Filtering and Exporting Output



Demonstration 1

Identifying Common Themes in EPA Ecosystem Services Case Study Research

- Around 40 EPA case studies that have conducted ecosystem services assessments
- Characterize ecosystems and associated ecosystem services recent EPA case studies investigated



Demonstration 2

Soliciting Stakeholder Input on Benefits of Nature-Based Solutions in Crisfield, MD

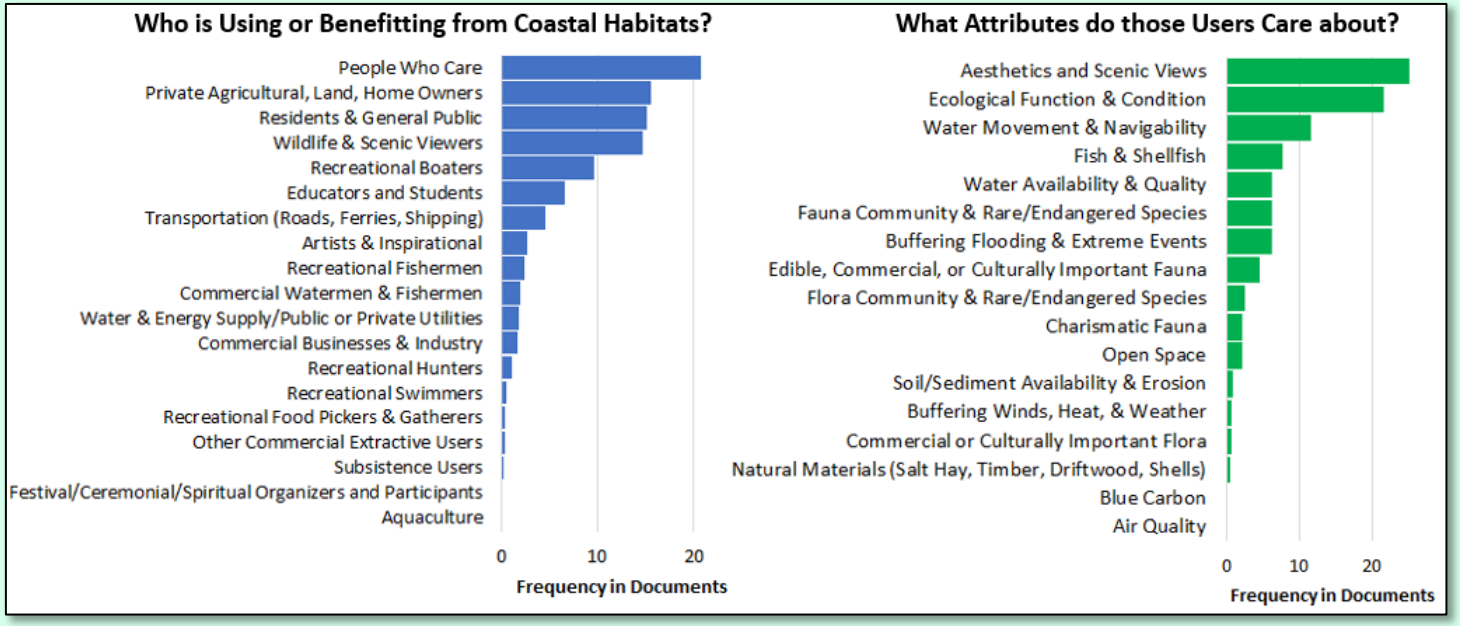
- Living shorelines, dune restoration, salt marsh restoration, living breakwaters, oyster reefs
- Can NBS reduce storm-related flooding?
- What are the co-benefits?

Demonstration 2

Soliciting Stakeholder Input on Benefits of Nature-Based Solutions in Crisfield, MD

- Analyzed 30+ Documents

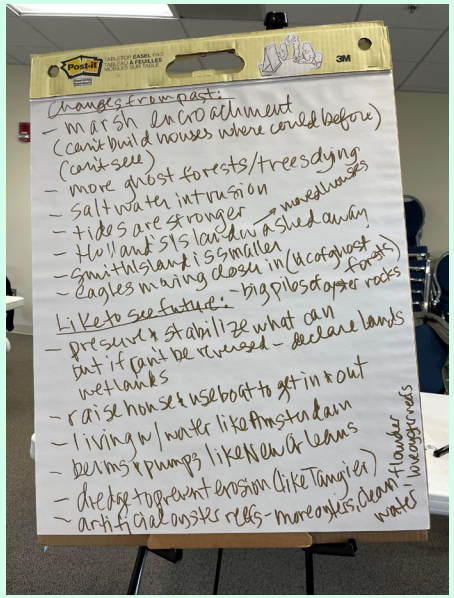
- Example to explain co-benefits based on existing knowledge
- Strawman to react to at meeting with institutional representatives

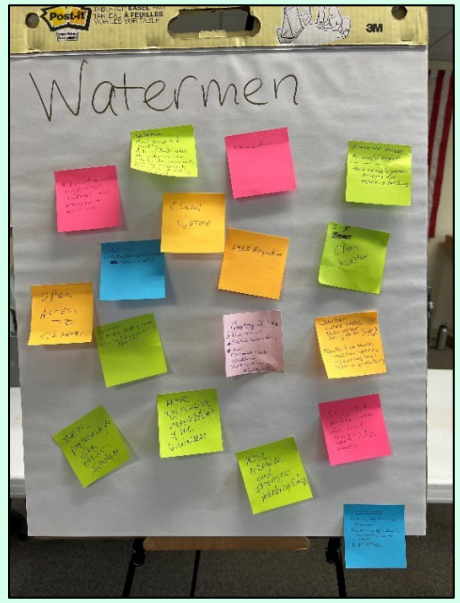


Demonstration 2

Soliciting Stakeholder Input on Benefits of Nature-Based Solutions in Crisfield, MD

- Public meeting free-response breakout groups & activities
- Synthesize notes to generate priority list for quantititative assessment





Natural Beauty	26.3
Ecological Condition	20.5
Target Species for Fishing/Hunting/Seafood Industry	15.0
Water Movement & Navigability	9.0
Flora Community	4.9
Flood Protection	4.2
Water Access	3.3
Charismatic Fauna	3.3
Water Quality	3.1
Fauna Community	2.7
Water in General	2.5
Mold	2.0
Natural Open Spaces	1.0
Natural Materials	0.8
Air Quality	0.6
Weather	0.3
Nuisance & Invasive Species	0.2

Now working to identify metrics & models to compare co-benefits of NBS options

Demonstration 3

Scoping Benefits of Restoration to Key Stakeholders for Saugus River Watershed, MA

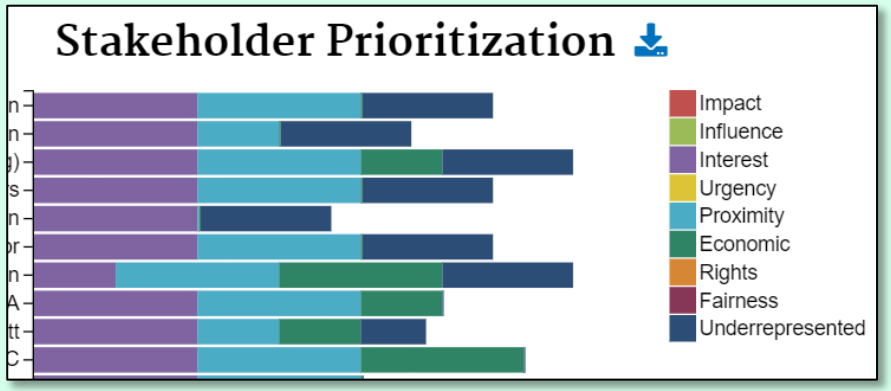
- Identify, compare, and communicate potential benefits of restoration options
- Motivate action and funding

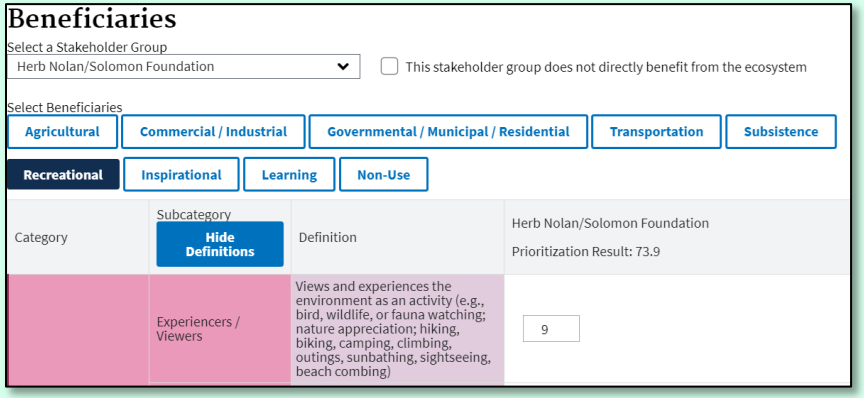
Demonstration 3

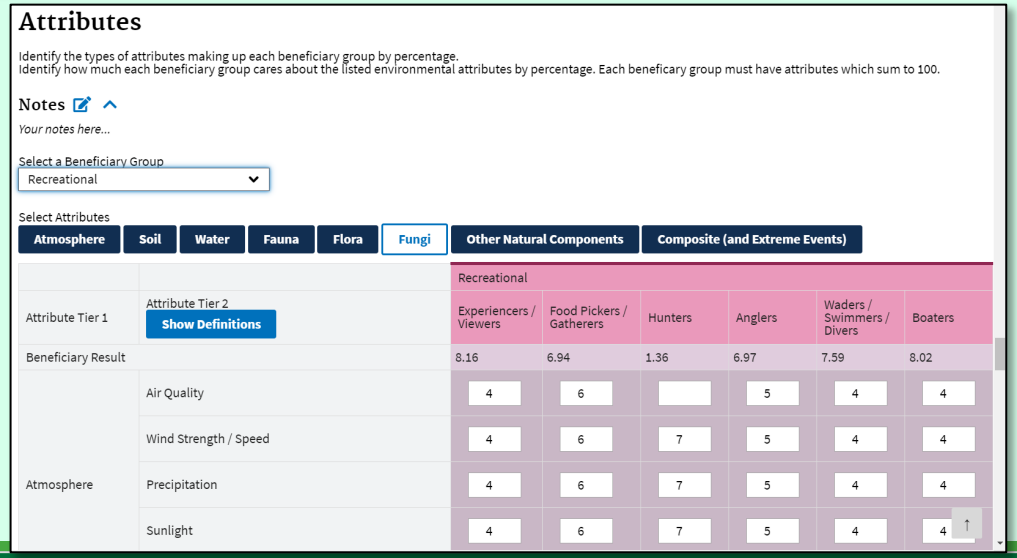
Scoping Benefits of Restoration to Key Stakeholders for Saugus River Watershed, MA

Two Parallel efforts:

- Used FEGS Scoping Tool directly with partners
- ~60 stakeholders
- Worked through FST steps over several weeks







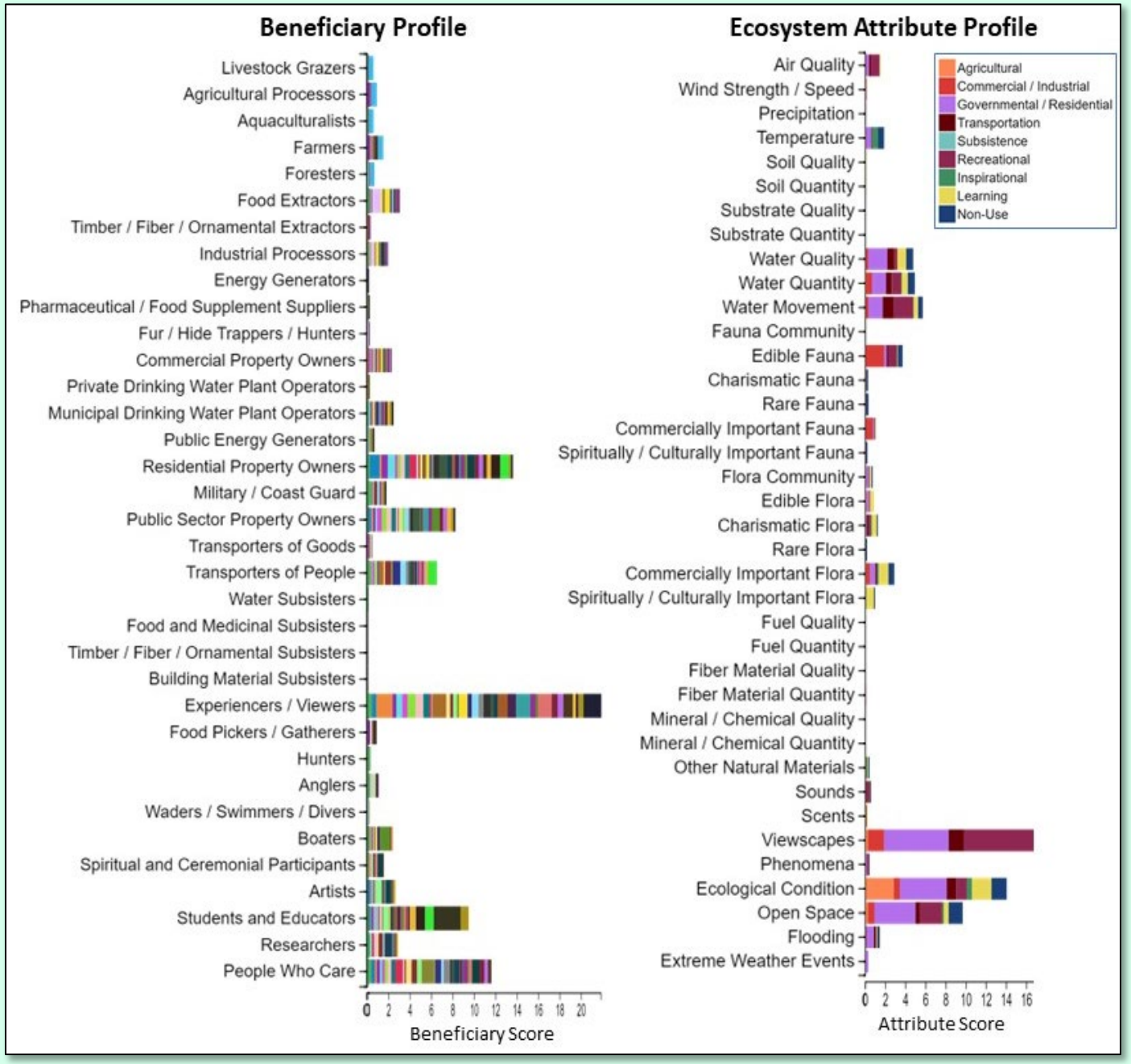
Demonstration 3

Scoping Benefits of Restoration to Key Stakeholders for Saugus River Watershed, MA

Two Parallel efforts:

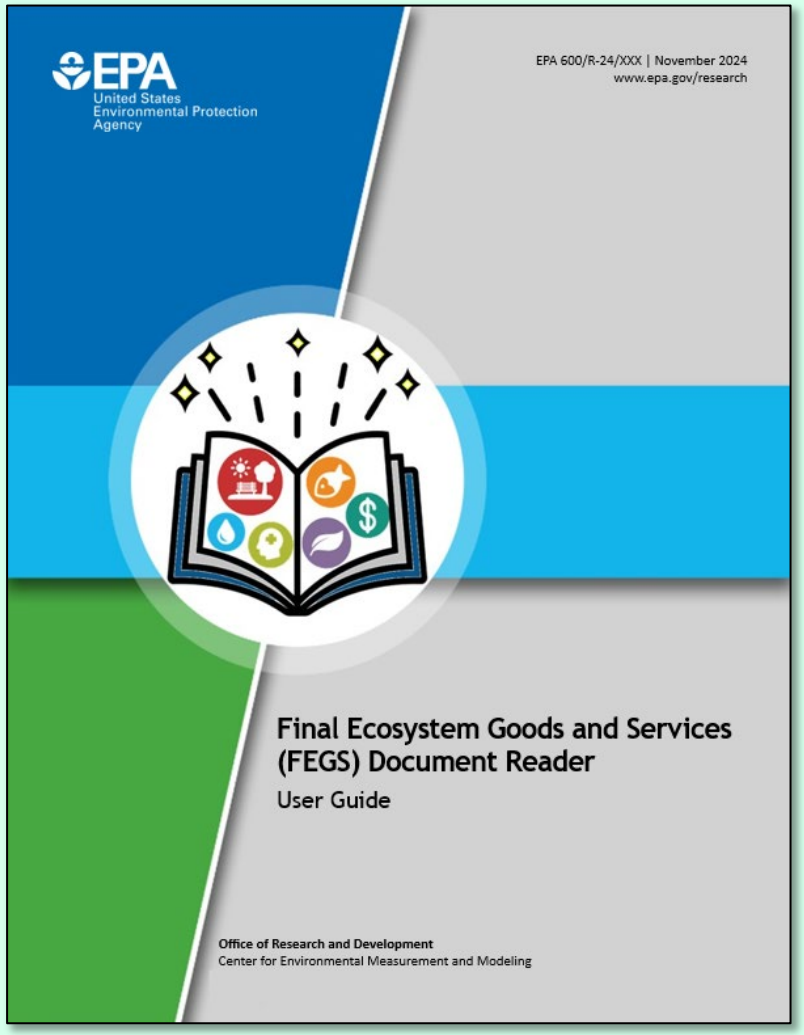
- Identified documents for those same stakeholders
- Investigated whether document analysis provided additional insights over FST

Next steps – comparing benefits of different restoration options



Summary

- Ready to go ‘live’
- Not intended to be a substitute for thoughtful stakeholder engagement
- Can serve as a starting point for more efficient or targeted engagement
- For some applications, a ‘fast’ assessment of existing information may be adequate
- Can provide a consistent approach for investigative analysis of documents (spatial, temporal comparisons)



https://shiny.epa.gov/FEGS_Document_Reader

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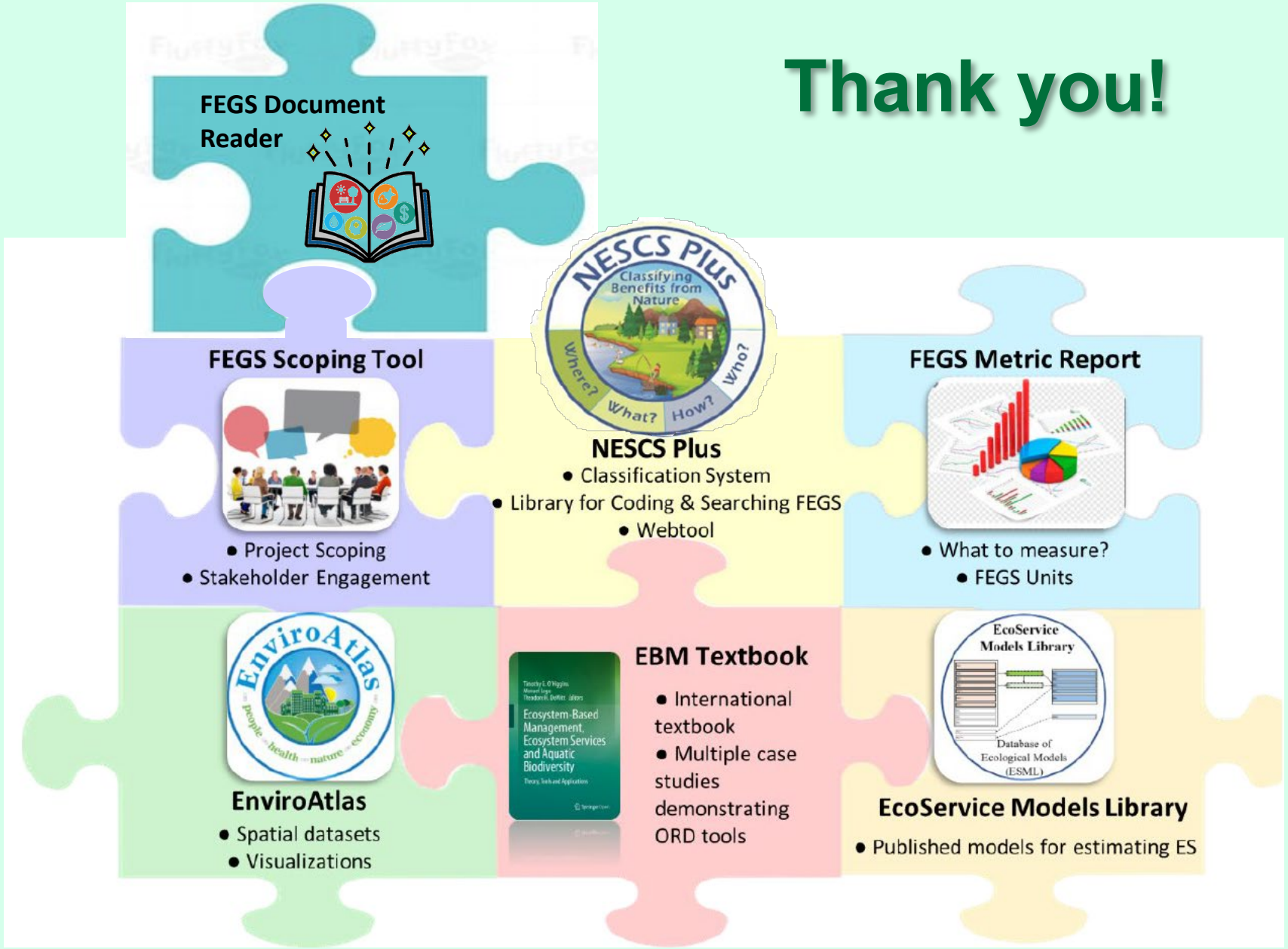
Thank you!



Acknowledgments

- Co-authors on previous publications using earlier versions of document analysis
- Collaborators on FEGS family of tools
- Collaborators on Crisfield, MD research project
- City of Crisfield, MD
- Collaborators on Saugus River, MA research project
- Saugus River Watershed Council