The Ecosystem Service Gradient: An Integrated Approach For Describing Shifts in Ecosystem Service Production

Leah M. Sharpe[1], *Susan H. Yee*[1], *Giancarlo Cicchetti*[2], *Erin McCafferty*[1]

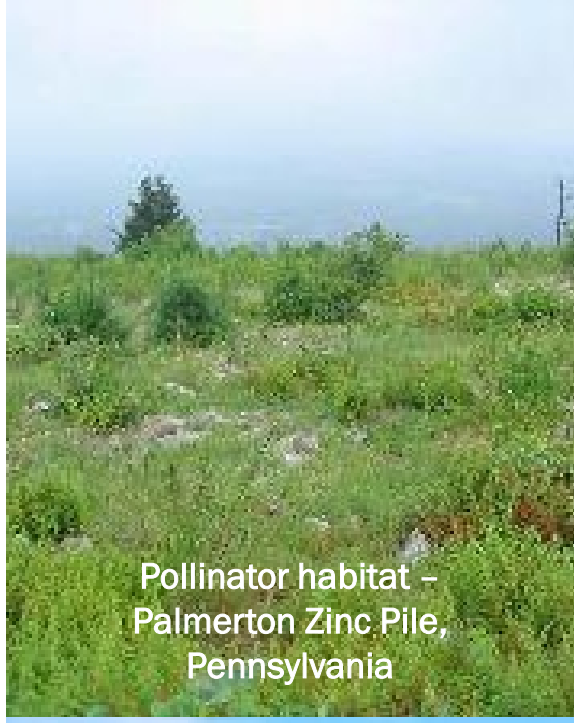
[1]US Environmental Protection Agency, Office of Research and Development, Center for Environmental Measurement and Modeling, Gulf Breeze, FL, USA
[2]US Environmental Protection Agency, Office of Research and Development, Center for Environmental Measurement and Modeling, Narragansett, RI, USA

Cultural heritage – Indian Island, California

Timber production – Black Butte Mine, Oregon

ES & Decision-Making

- ES arise from the connections between the environment and human communities
- Identifying these connections allows managers to consider the full suite of potential impacts arising from actions taken
- Inclusion of ES concepts can lead to:
  - Restoration of the natural environment
  - Reduced operations and maintenance costs
  - Increased site resiliency
  - Increased consideration of stakeholder interests in management decisions
  - Improved communication with communities



Pollinator habitat – Palmerton Zinc Pile, Pennsylvania

Erosion control – Bunker Hill Mining and Metallurgical Complex, Idaho

Ecosystem Services in Decision-Making

- Describing ES for decision-making is complex
- The challenge is to:
  - Describe them consistently
  - Use terms that are clearly understood by stakeholders and meaningful for managers
  - Describe them comprehensively – what is needed from the ecosystem
  - Describe how changes to the ecosystem impact those services

NESCS Plus Framework

- National Ecosystem Services Classification System (NESCS) Plus
- Classification framework
- Contains set lists and definitions of:
  - Environmental classes (Where?)
  - Beneficiary roles (Who?)
  - Ecological end-products/attributes (What?)
- Provides consistent structure and approach across EPA tools

NESCS Plus – Final Ecosystem Goods and Services

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

Where?

Coral Reefs

+

Who?

SCUBA Divers

+

What?

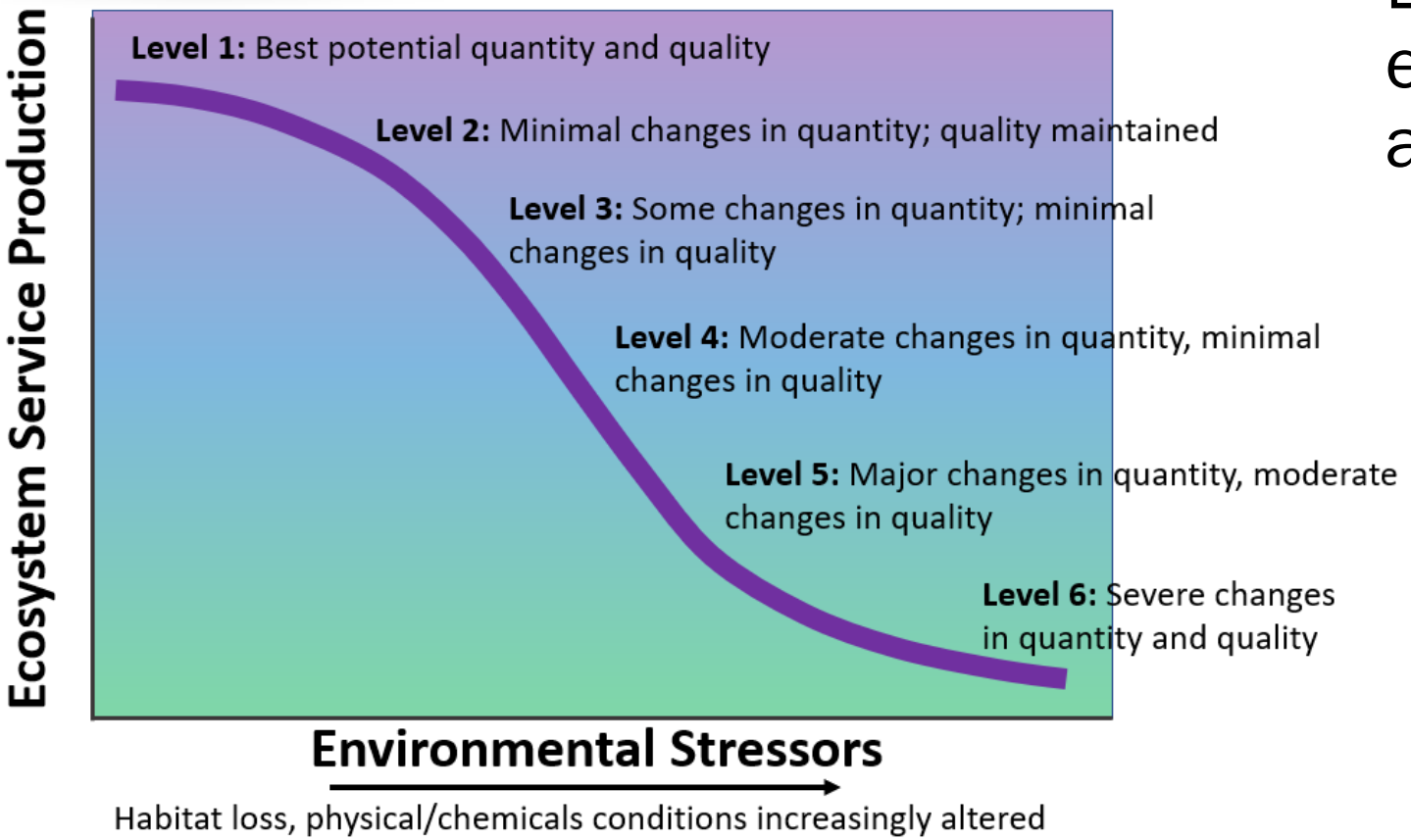
Charismatic Fauna

Beneficiary-Centric Approach

- Focuses on the elements of the ecosystem that are meaningful to stakeholders
  - Easily communicable to wide range of audiences
  - Relevant ecologically
  - Can be operationalized for managers

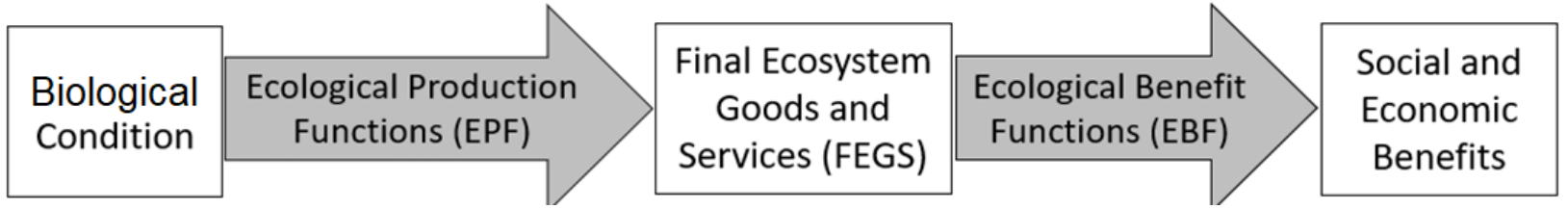
- Requires consideration of ecosystem attributes in the context of use
  - In what combinations
  - At what levels

The Ecosystem Service Gradient



- A descriptive model of ecosystem services
- Based on measurable ecologically important attributes, to describe:
  - A range of ecosystem services production across a gradient (e.g., stressors, condition)
  - Provide a rational and consistent means for setting targets
  - Communicate the consequences of different management choices

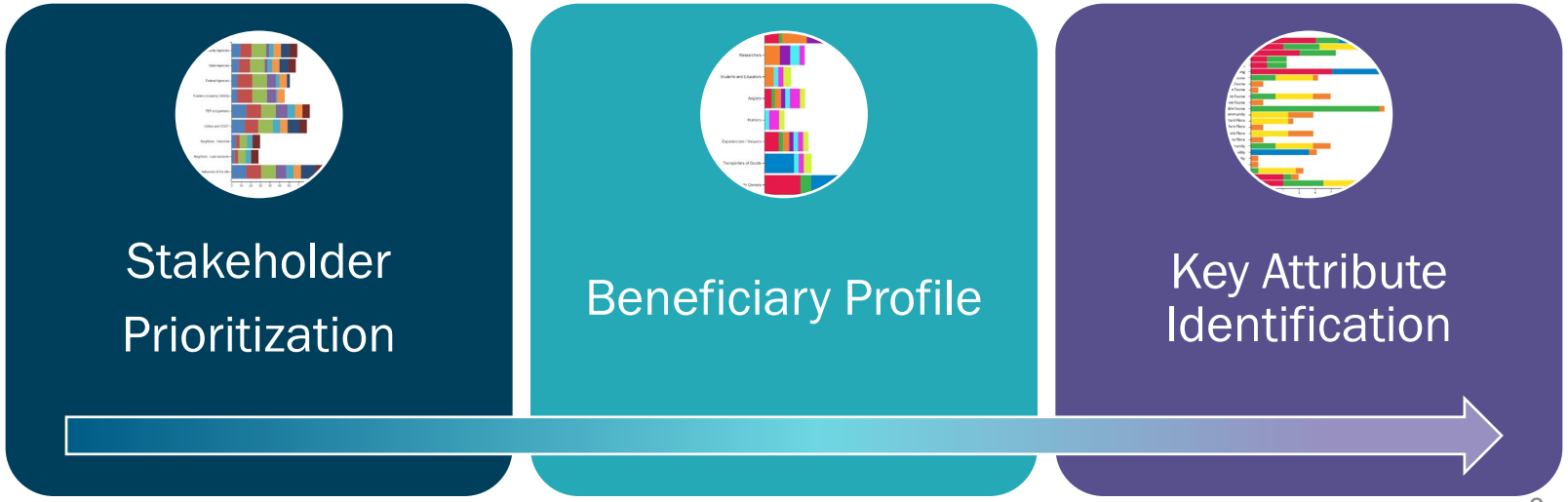
Building an Ecosystem Service Gradient



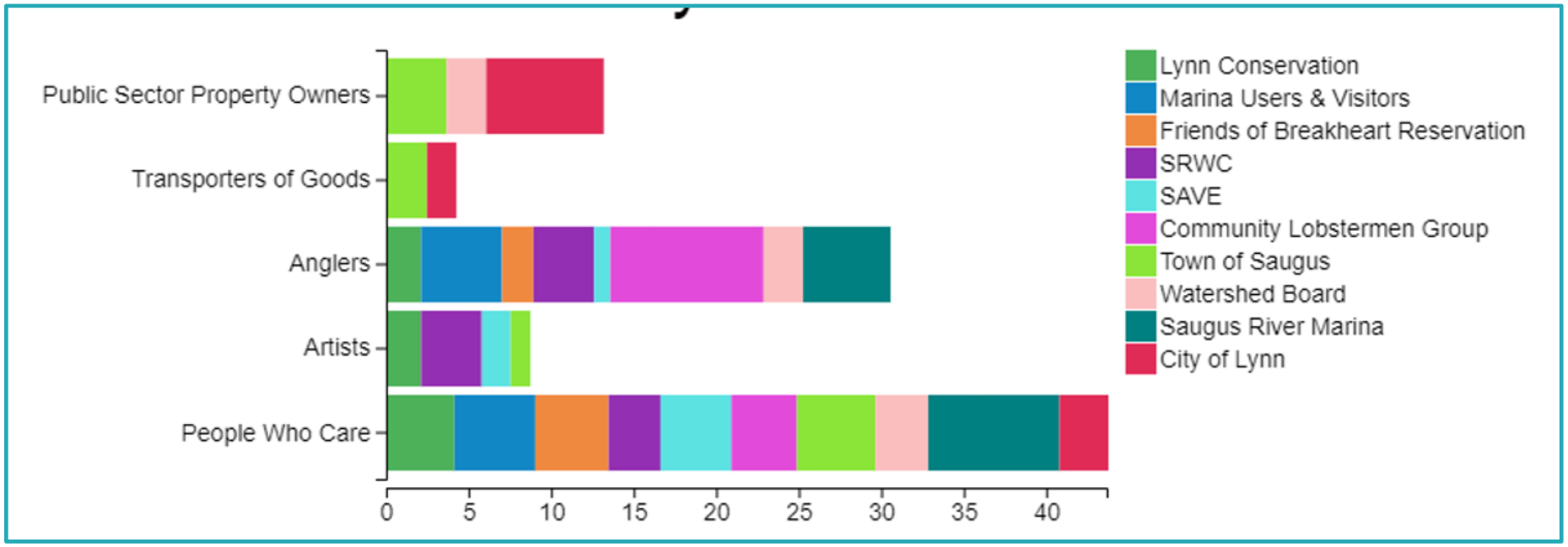
Ecosystem Service Gradient Framework	Generic Process
What ecosystem goods and services are relevant?	Identify and prioritize ES for stakeholders
How will we measure them?	Identify ES metrics and indicators and the biophysical attributes that provide them
What ES do we have now?	Measuring, mapping, and ecological production functions
What ES could we have?	Establish potential availability under a range of scenario
What do we want?	Examine co-benefits and tradeoffs

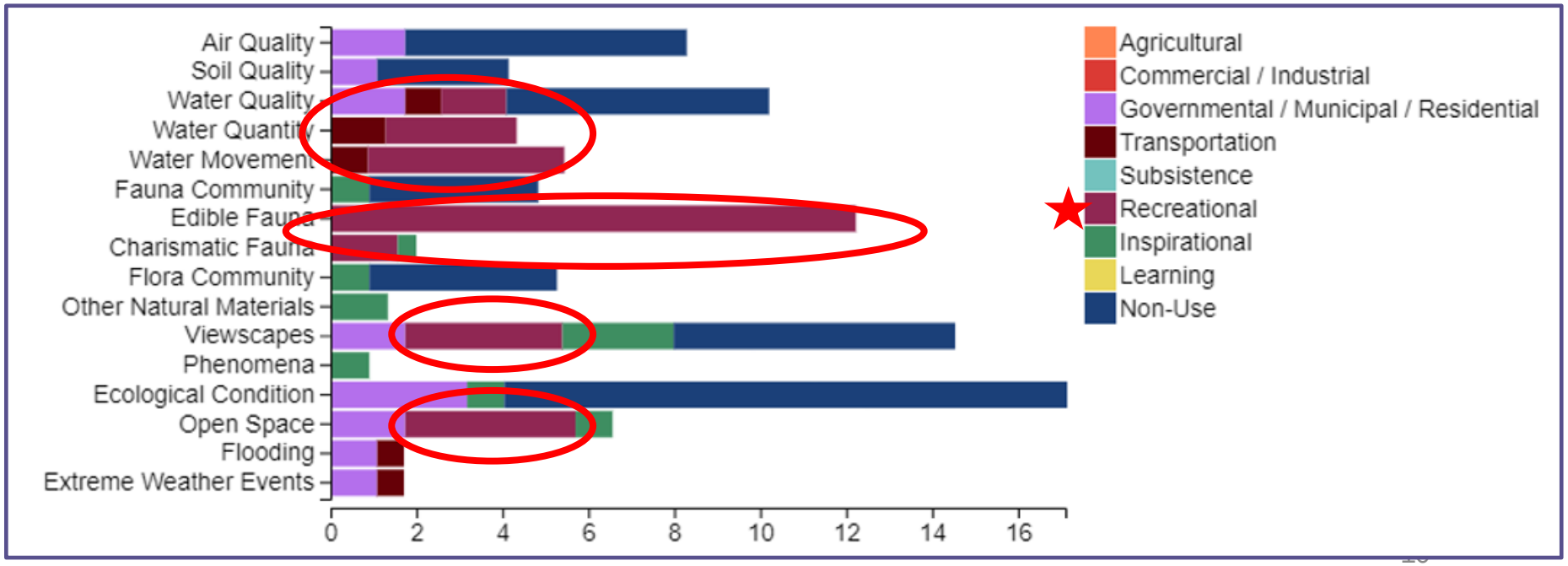
Step 1: What ES are relevant?

- The FEGS Scoping Tool
  - To help identify and prioritize:
    - *Stakeholders*,
    - *The ways they are benefiting from the ecosystem*, and
    - *The environmental attributes necessary to realize those benefits*

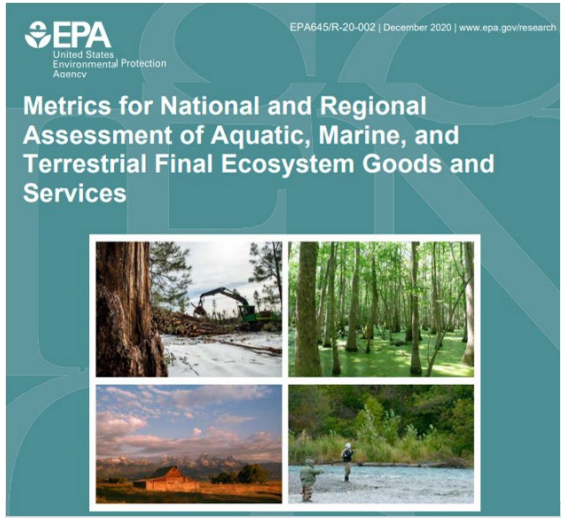


- Priority beneficiary groups
- Priority attributes for each beneficiary group
- Relative importance of attributes for each beneficiary





Step 2: How will we measure them?



- The FEGS Metrics Report
  - A structured process for identifying metrics that:
    - Measure specific tangible biophysical features or qualities relevant for management
    - Require little to no technical explanation to make their value or meaning apparent to beneficiaries

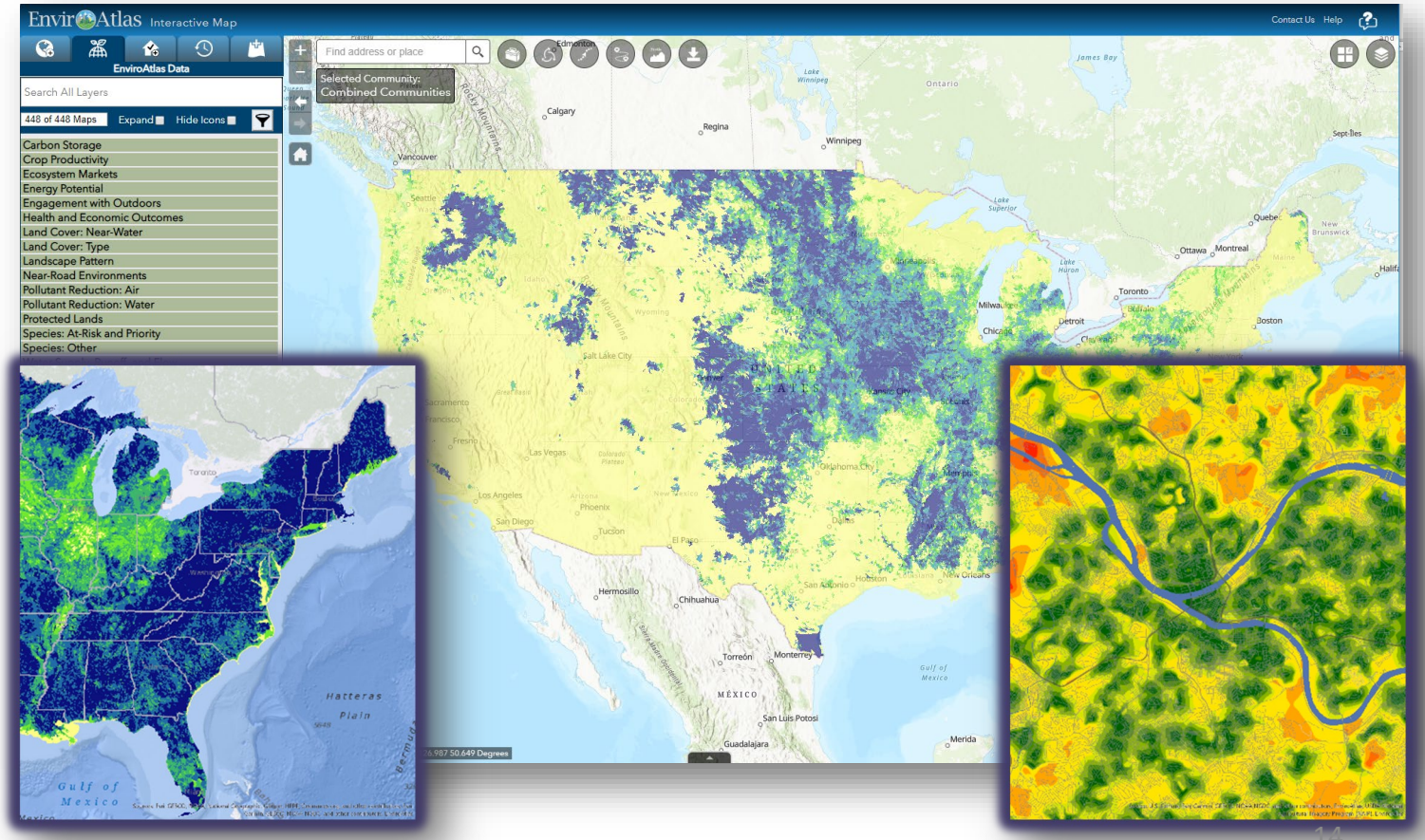
Step 1	Step 2	Step 3	Step 4
Ecosystem Delineation	Beneficiary Specification	Attribute Specification	Metric Specification

Estuaries and wetlands: Anglers: 29 metrics across 7 attribute categories

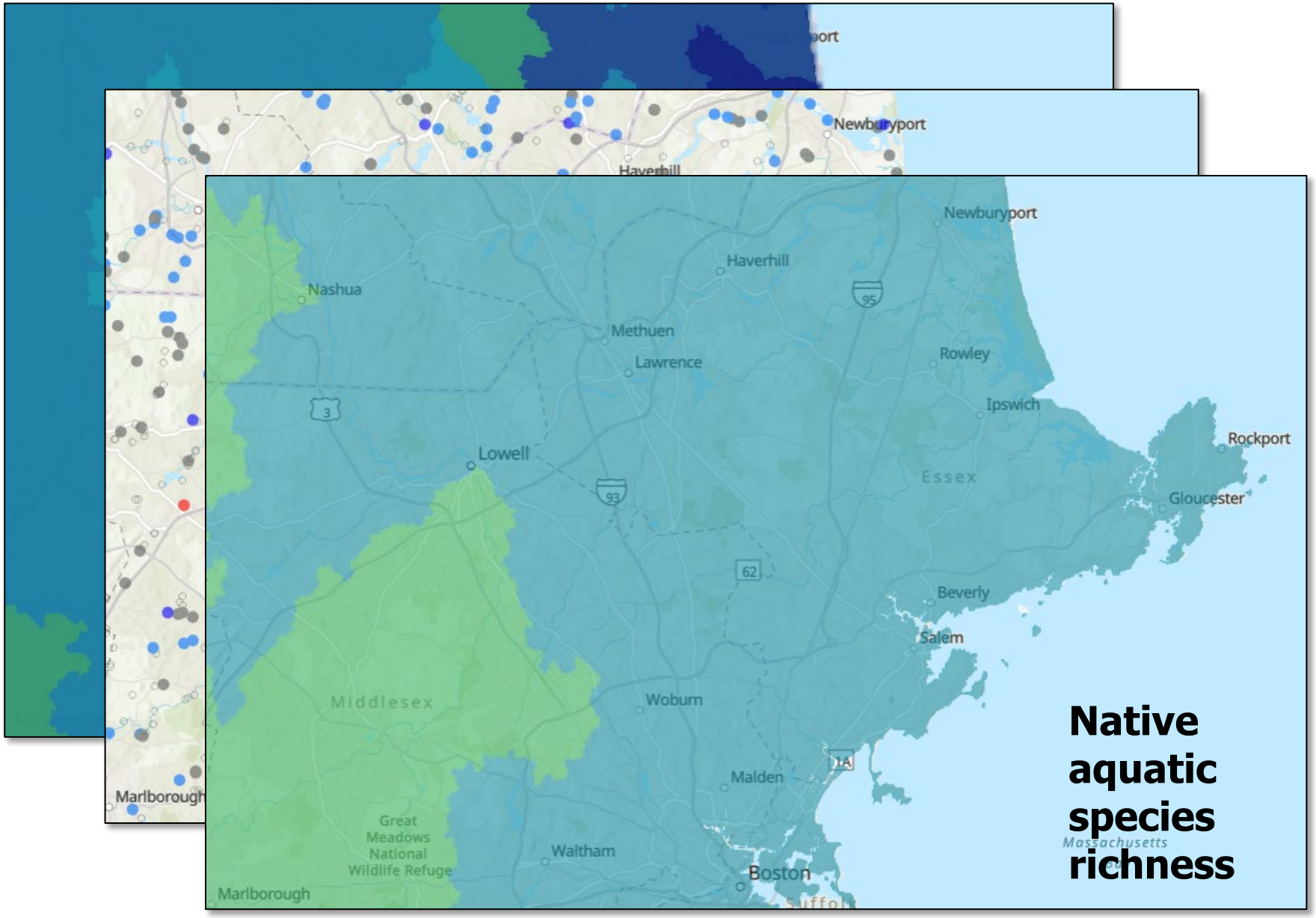
Desired Information	Attributes		Sub-attribute (Fine Scale)	Ideal Biophysical Data (Underlying Desired Information)	Translation of Ideal Biophysical Data to Desired Information	Metric
Is the water safe to be around/in?	**Water**	Water Quality	Chemicals and contaminants	Water contaminants	Poor water quality/ level of safety is directly translated from contaminant concentration	Water quality standards
Is there sufficient water for my vessel?		Water Quantity	Water Depth	NOAA Charts	NOAA charts map and track nautical hazards	Depth
Is it safe to go out?		Water Movement	Wave Intensity	Wave height, speed and direction	Marine advisory report based on wave height	Wave height
Are there hazardous species present that could impact my activities?	**Fauna**	Fauna Community	Hazardous species	Species, abundance, virulence of toxin in species	Presence of toxic/dangerous species increase potential for contact with angler	Hazardous species presence/abundance
Are desired species present? Are they available to be fished?		Edible Fauna	Taxa	Species, size, abundance, diversity	Presence/ abundance of desired species increases potential for catch	Desired species presence and abundance
Will caught fish be safe to eat?		Edible Fauna	Pathogens/toxins/ contaminants/ parasites	Toxins, metals, pathogens and parasites from raw fish	Fish health indicator complies contaminant information for human food safety	Contaminant concentration (edible fish)
Will I catch or observe something interesting?		Charismatic Fauna	Taxa	Species, size, abundance, diversity	Presence/ abundance of large and/or charismatic species translates to angler expectation for good fishing	Charismatic species presence
Is the area aesthetically enjoyable?	**Composite**	Viewscapes	Aesthetics	Color of water, algae, clarity and smell, lack of sound	Local reports reflect angler preference	Site Appeal
Is there available space for angling?		Open Space	Available space	Area open for permits	Publicly accessible are required for angling	% cover of available permitted area

Step 3: What ES do we have now?

- EnviroAtlas
  - Online resource providing geospatial data and other resources related to ecosystem services, chemical and non-chemical stressors, and connections to human health and equity



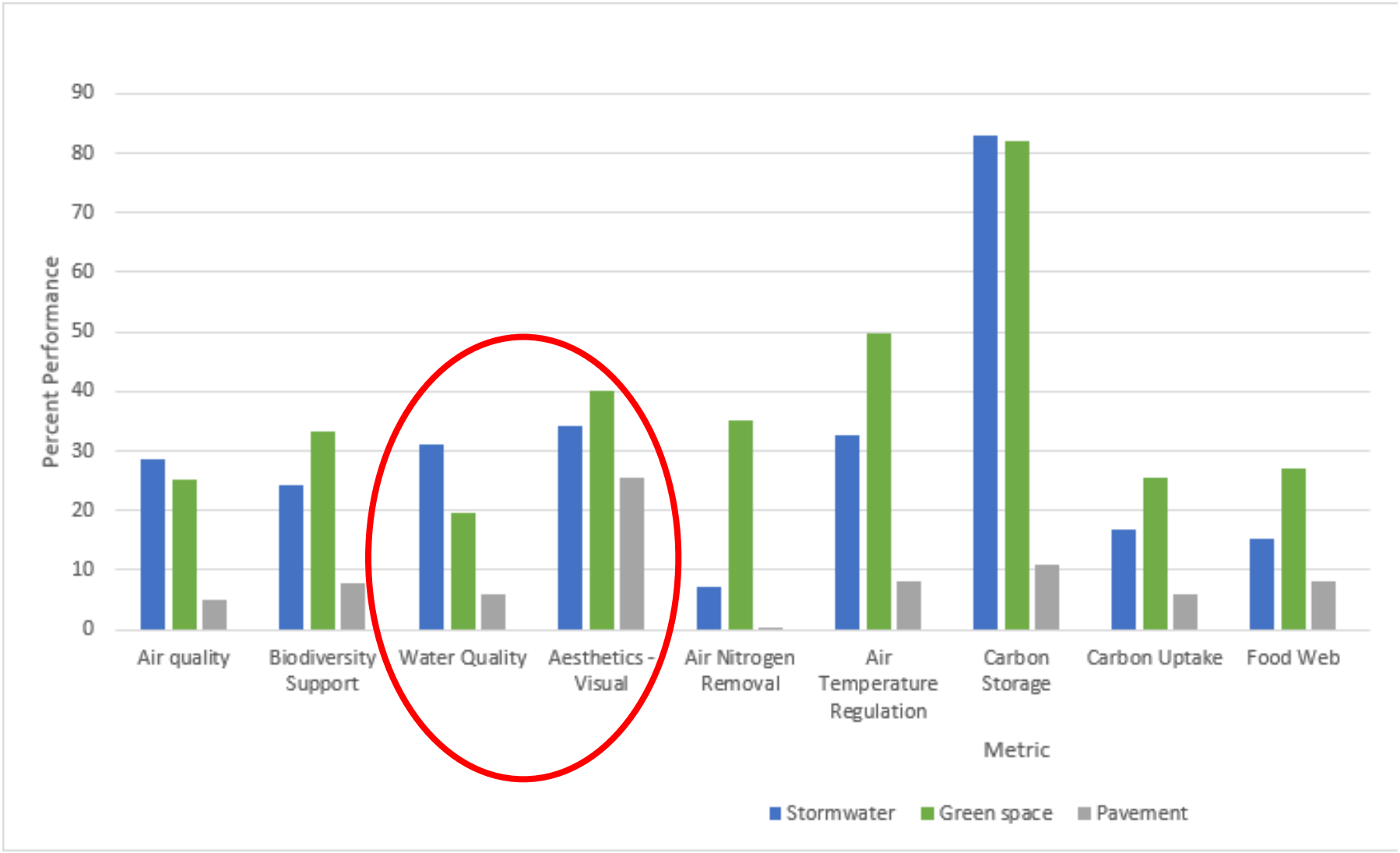
EnviroAtlas maps of the Greater Boston Area



Step 4: What ES could we have?

- The EcoService Models Library
  - Searchable database of ecological models for estimating the production of ecosystem goods and services

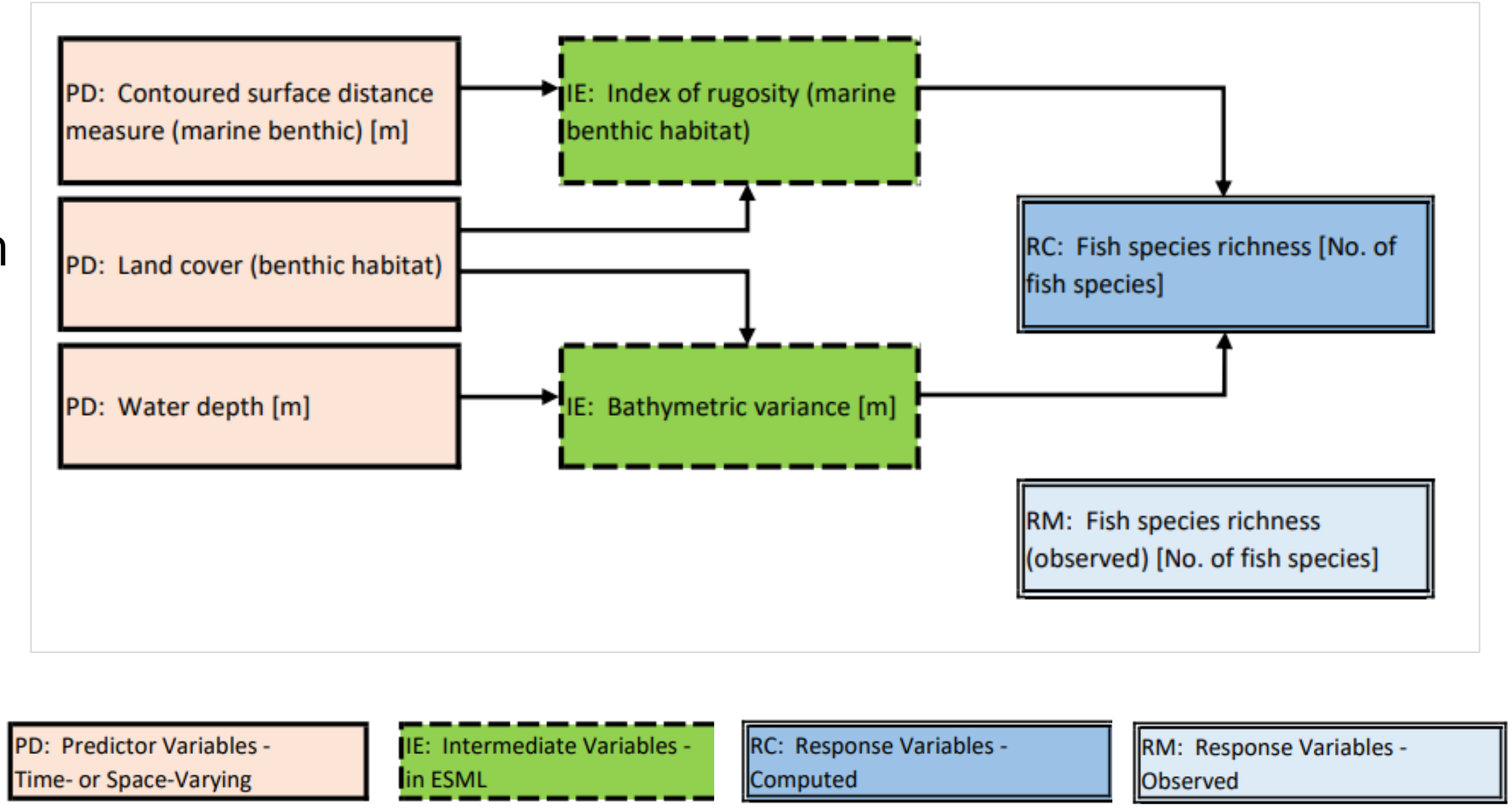
- EM-712
- Looks at impacts to a range of ES under different land use scenarios



Above example results from a landfill redevelopment project

https://www.ecosystemintelligence.com/

- EM-590
- Predicts fish species richness based on substrate, landcover, and water depth



Variable relationship diagram for the model

Developed in Puerto Rico (Pittman et al. 2007)

Step 4: Examining tradeoffs

- What scenarios give us what we want?
- Taking a beneficiary-centric perspective to evaluate tradeoffs

- For any given beneficiary, a suite of ecosystem attributes are required
- For example, recreational fishing requires more than fish
  - Catchable, edible fish
  - Water of sufficient quality for human contact
  - Space for recreating
  - Attractive viewscapes
- When considering how management actions or changes in habitat quality impact ES, the changes to each of these elements must be considered

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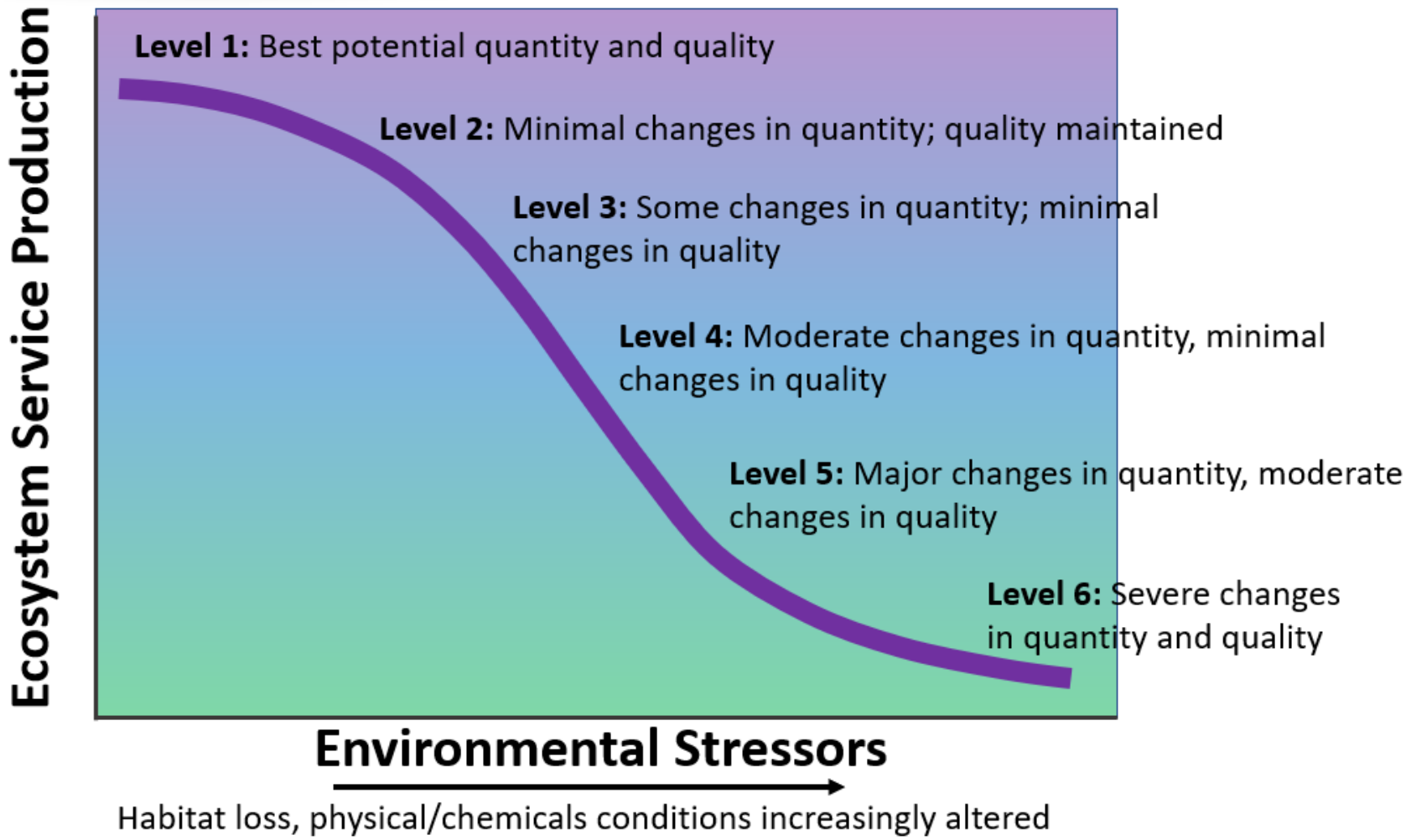
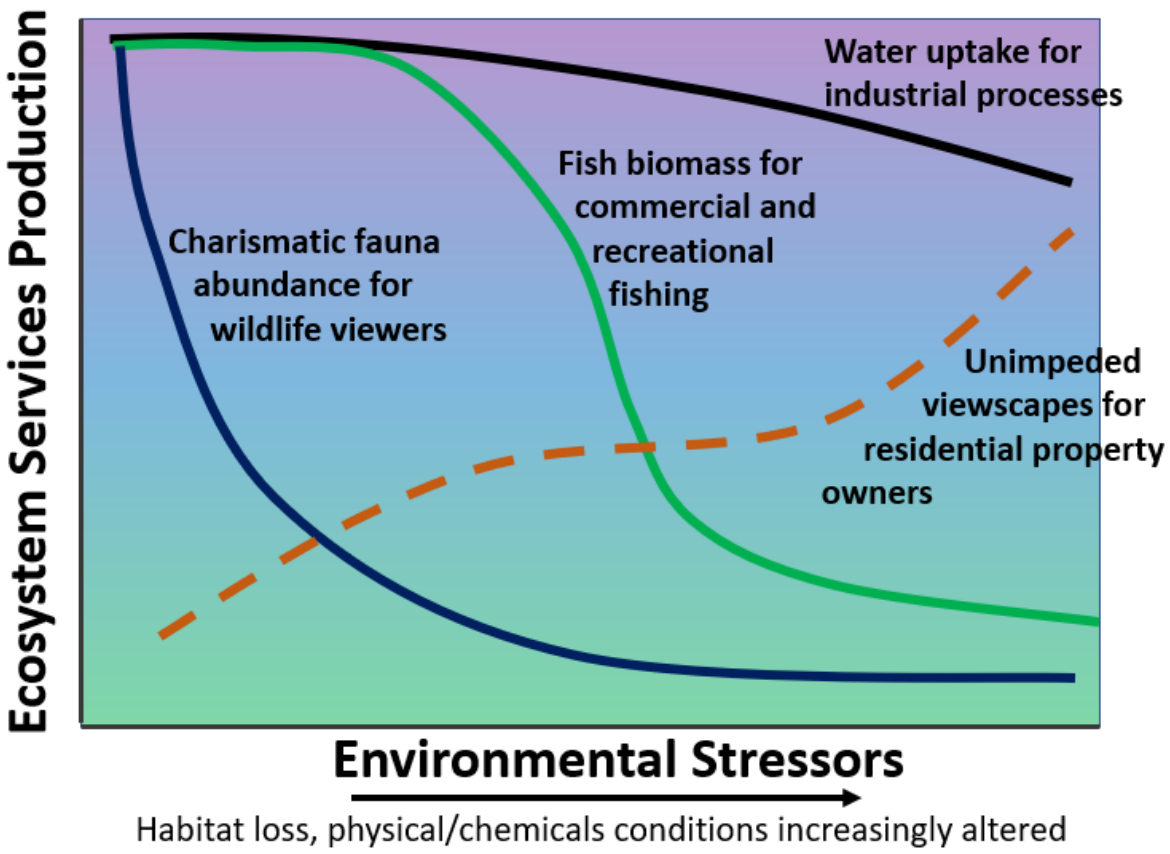


The Ecosystem Service Gradient

- But not all environmental attributes respond to changes in condition in the same way
- Varying across environmental attributes and for each individual beneficiary



The Ecosystem Service Gradient

- Each beneficiary will have their own set of relevant attributes, w
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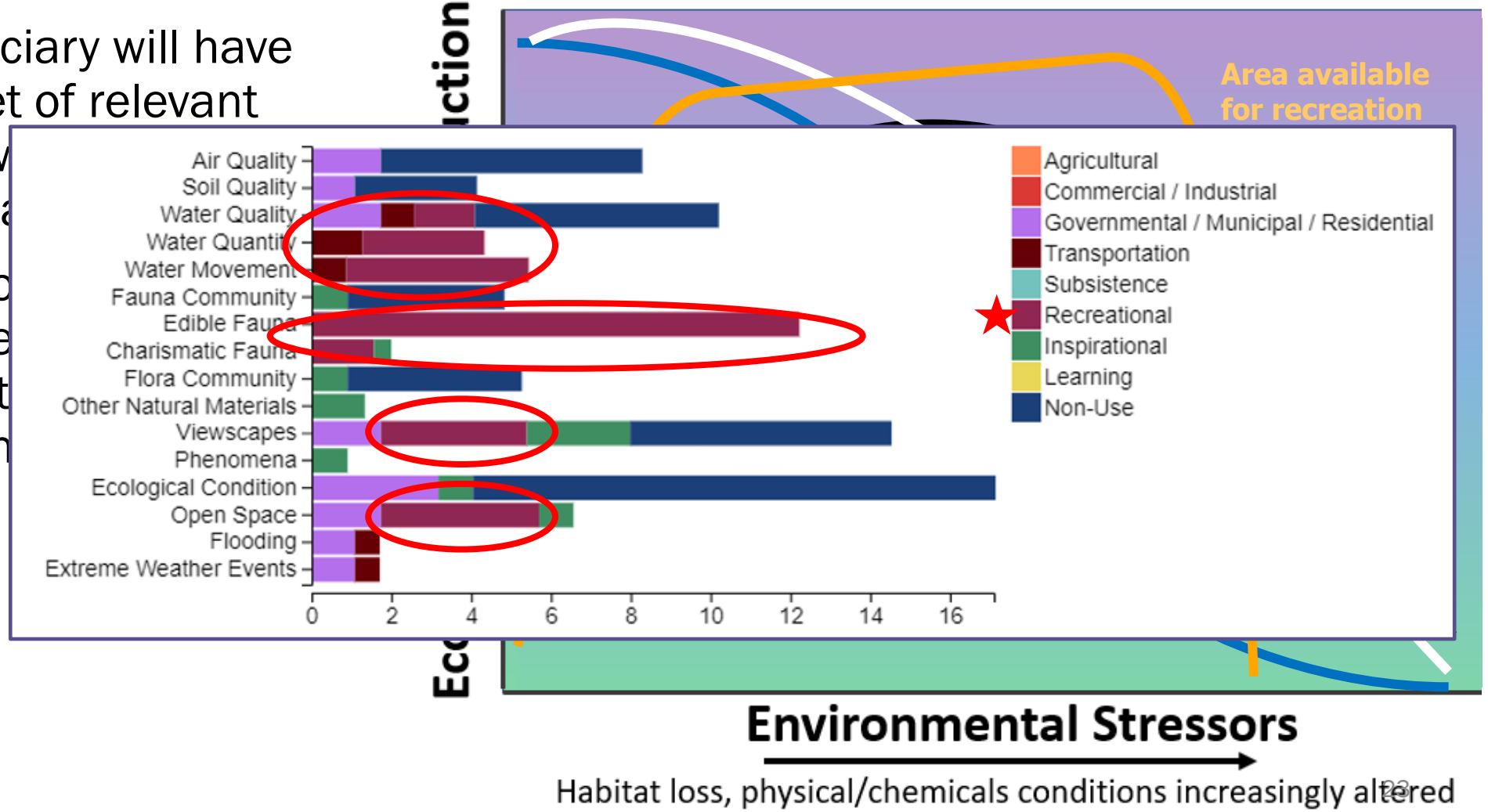

Considerations When Examining Tradeoffs

- The FST results can provide information about the set of attributes valued by the beneficiary and their relative importance
- Substitutions may have to made based on available data, information from metrics development can help guide this
- Each attribute will likely have a threshold, below which the entire benefit becomes unavailable

Key Points

- The Ecosystem Service Gradient is a powerful approach for exploring and communicating complex interactions and impacts
- Considering ES as collections of ecosystem attributes captures the complexity of human interactions with the environment
  - Reduces the likelihood of unforeseen consequences
- It fits into the growing set of connected tools using the NESCS Plus Framework
  - Existing ES decision support tools can be leveraged to build an ESG
  - Consistent use of the NESCS Plus framework facilitates using the tools together

Questions?

Leah Sharpe
Sharpe.Leah@epa.gov
850-934-9323