



United States Environmental Protection Agency
Office of Research and Development

USEPA'S FINAL ECOSYSTEM GOODS AND SERVICES (FEGS) CLASSIFICATION SYSTEM: CONCEPT TO IMPLEMENTATION AND LINKS WITH ENVIROATLAS

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Summary

We started looking at ecosystem services using the MA approach, but we found the standard wanting, therefore we developed the Final Ecosystem Goods and Services Classification System, that seems to be an important improvement; linking this with the EnviroAtlas will make it more functional and available to users.

What is the problem?

- Many definitions and disparate “lists,” “frameworks,” and “perceptions” of ecosystem services
- Miscommunication and discord among disciplines
- Disconnect between environment and human well-being
- Lack of consistency, rigor and a systematic approach; need typology and classification for “framework”

What do people care about?

soil microbes



clean water



habitat



fauna



FEGS

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

Environmental Class + Beneficiary → FEGS



Estuaries and Near Shore Marine



Recreational Food Pickers and Gatherers



Flora and fauna, such as mussels, seaweed, crabs, etc.

DESIRED CHARACTERISTICS OF AN es CLASSIFICATION SYSTEM:

Complete

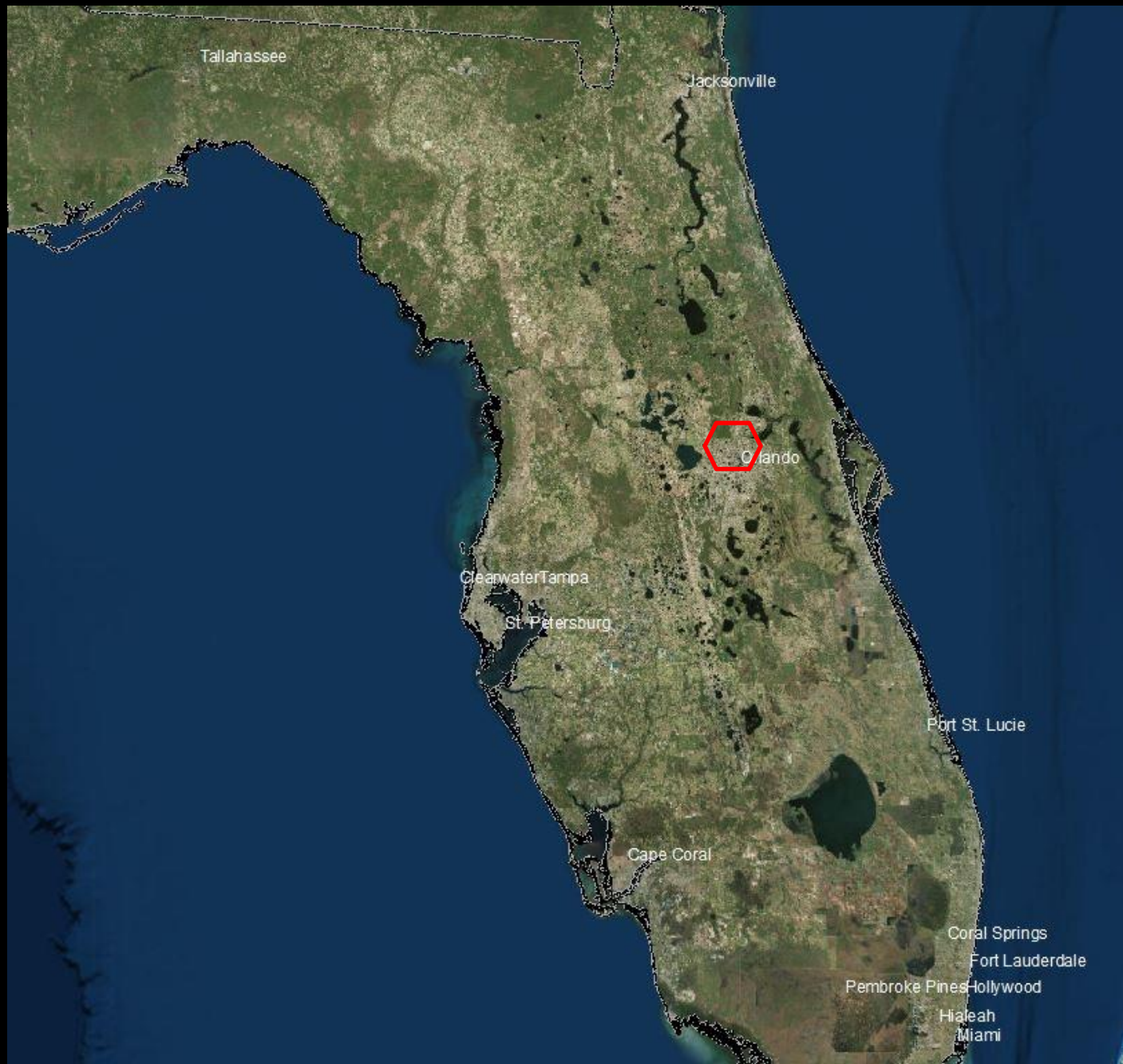
Non-duplicative

Leads to measurements

Identifies the beneficiary (HWB)







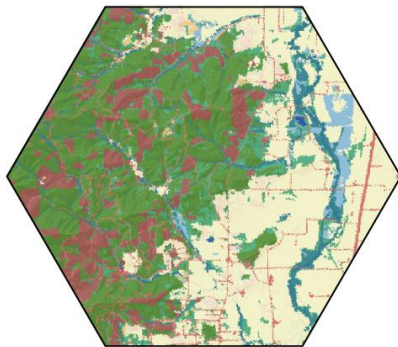
Environmental Classes

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

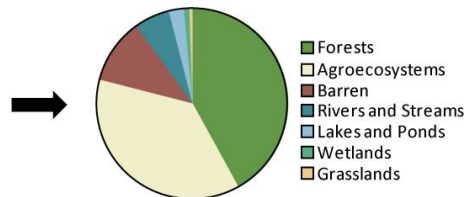
Environmental Class

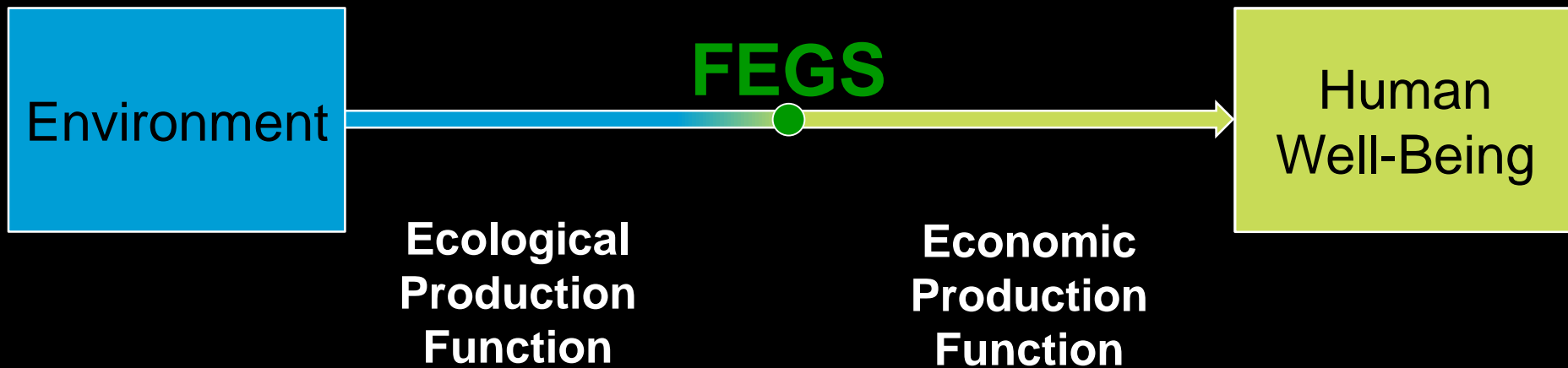
- 15 Environmental Sub-Classes
- Facilitate classification of any area in the world
- Boundaries can be identified and mapped using satellite (mostly)

FEGS Environmental SubClasses



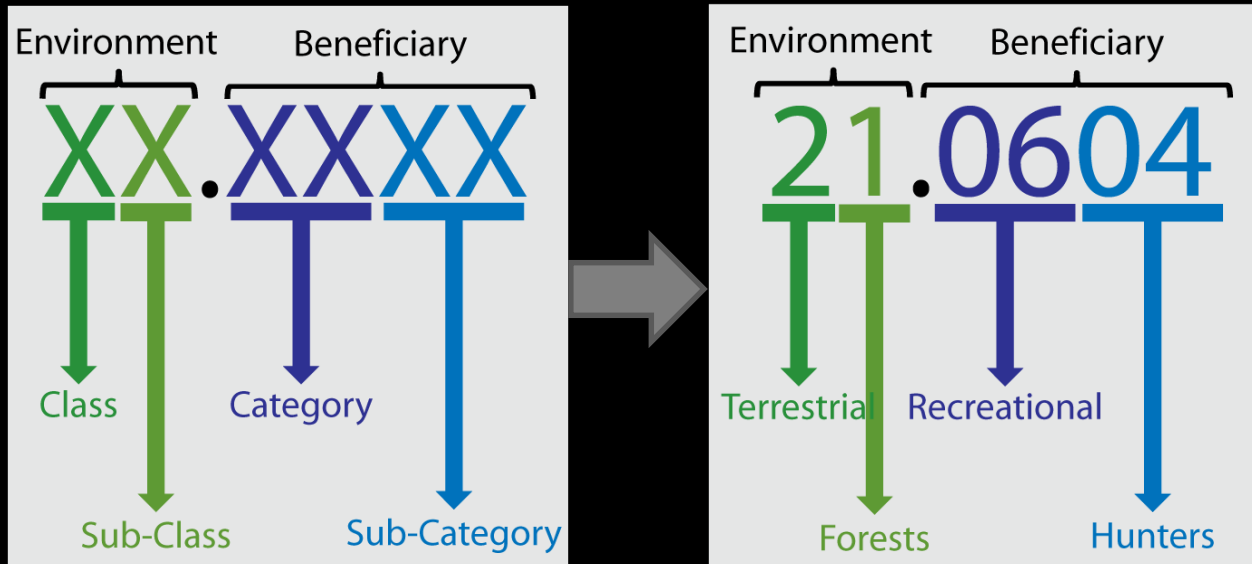
FEGS Environmental SubClass Profile





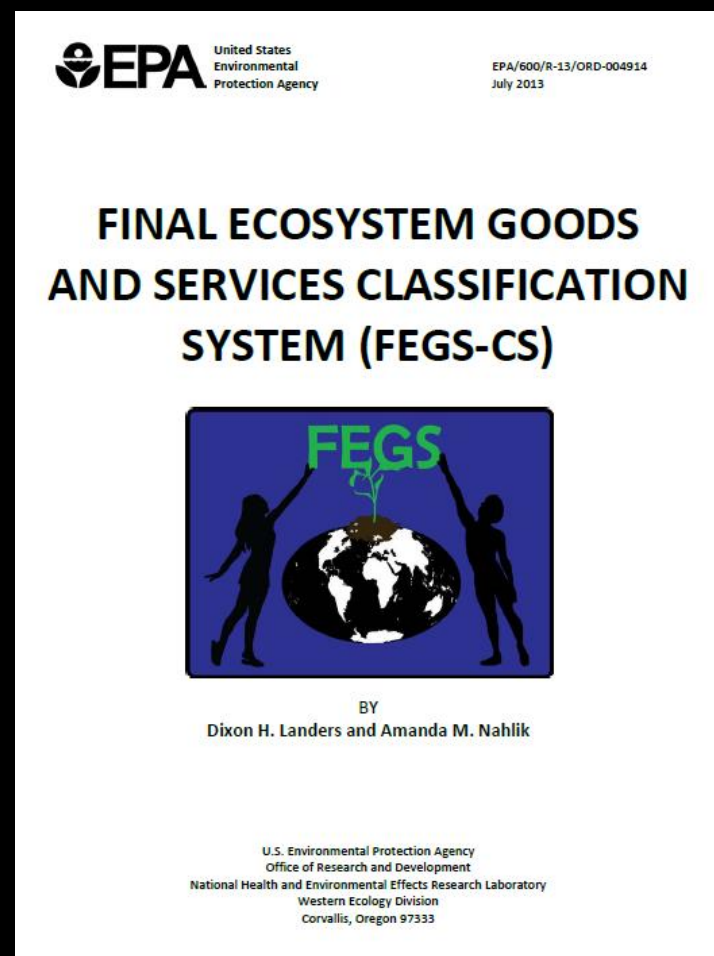
Our Classification Scheme

FEGS Classification Structure	
X	Environmental Class
XX.	Environmental Sub-Class
XX.XX	Beneficiary Category
XX.XXXX	Beneficiary Sub-Category



Identifying FEGS

- By using the FEGS approach, an infinite list of ecosystem services was pared down to 338 FEGS
- FEGS-CS is an operational framework that standardizes identification of ecosystem services at multiple spatial scales
- Published EPA Report
 - Available at cfpub.epa.gov/si/
 - EPA/600/R-13/ORD-004914
- Interactive FEGS-CS website (**LIVE!**)
<http://gispub4.epa.gov/FEGS>
 - Create and download custom checklists of potential FEGS
 - Link with EnviroAtlas, mapping and models
 - Provide comments to the authors
 - Participate in forum discussions



In the 1930s Boxcars moving from Chicago to NYC were counted as one of the first metrics for Gross Domestic Product (80 years ago)





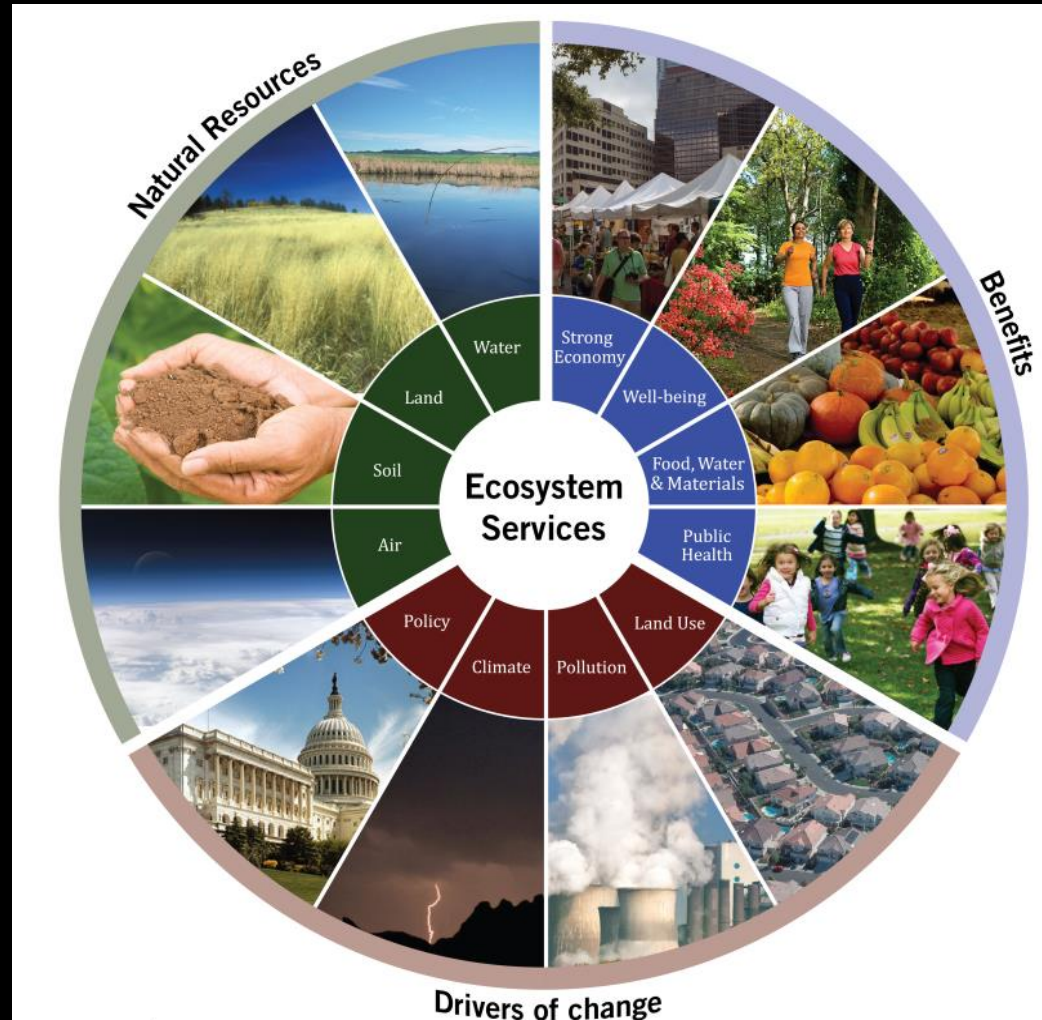
What is EnviroAtlas?

A web tool giving users ability to view, analyze, and download information to help inform decisions concerning the places in which we live, work, derive resources, and play

A multi-agency effort – EPA, DOI, USDA

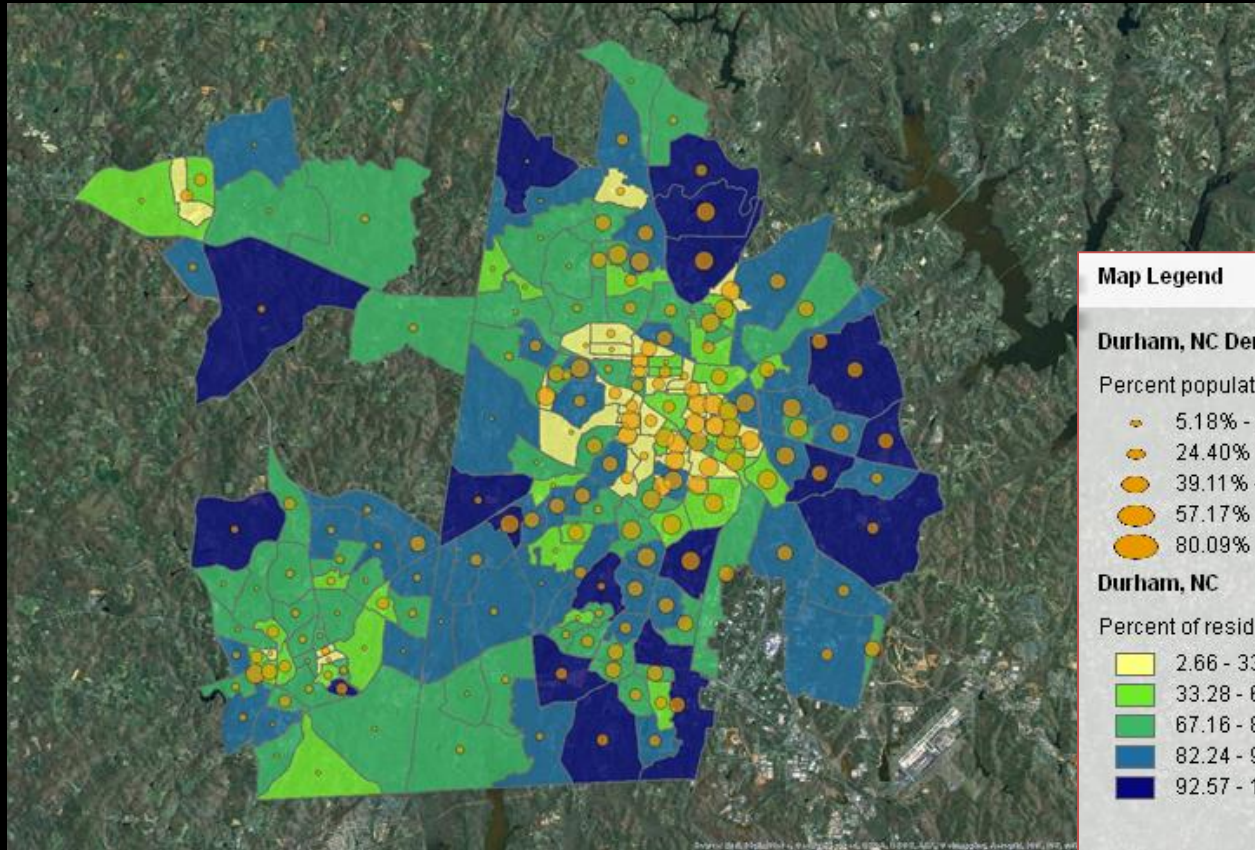
Includes:

- Geospatial indicators and indices of the supply, demand, and benefits
- Drivers of change
- Reference data (e.g., boundaries, land cover, soils, hydrography, impaired water bodies, wetlands, demographics, community design)
- Analytic, mapping, and interpretive tools

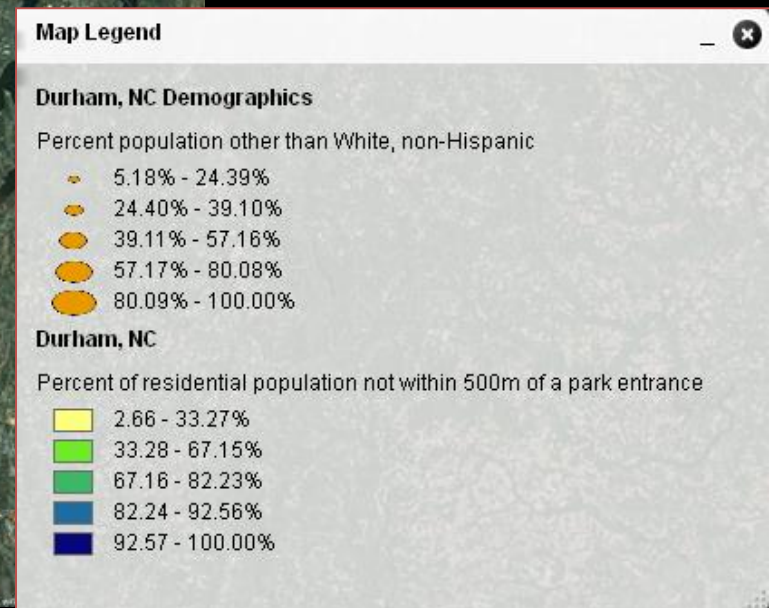


The EnviroAtlas is multi-scaled

- Community: High resolution component for 50 populated places; summarized by US census block groups

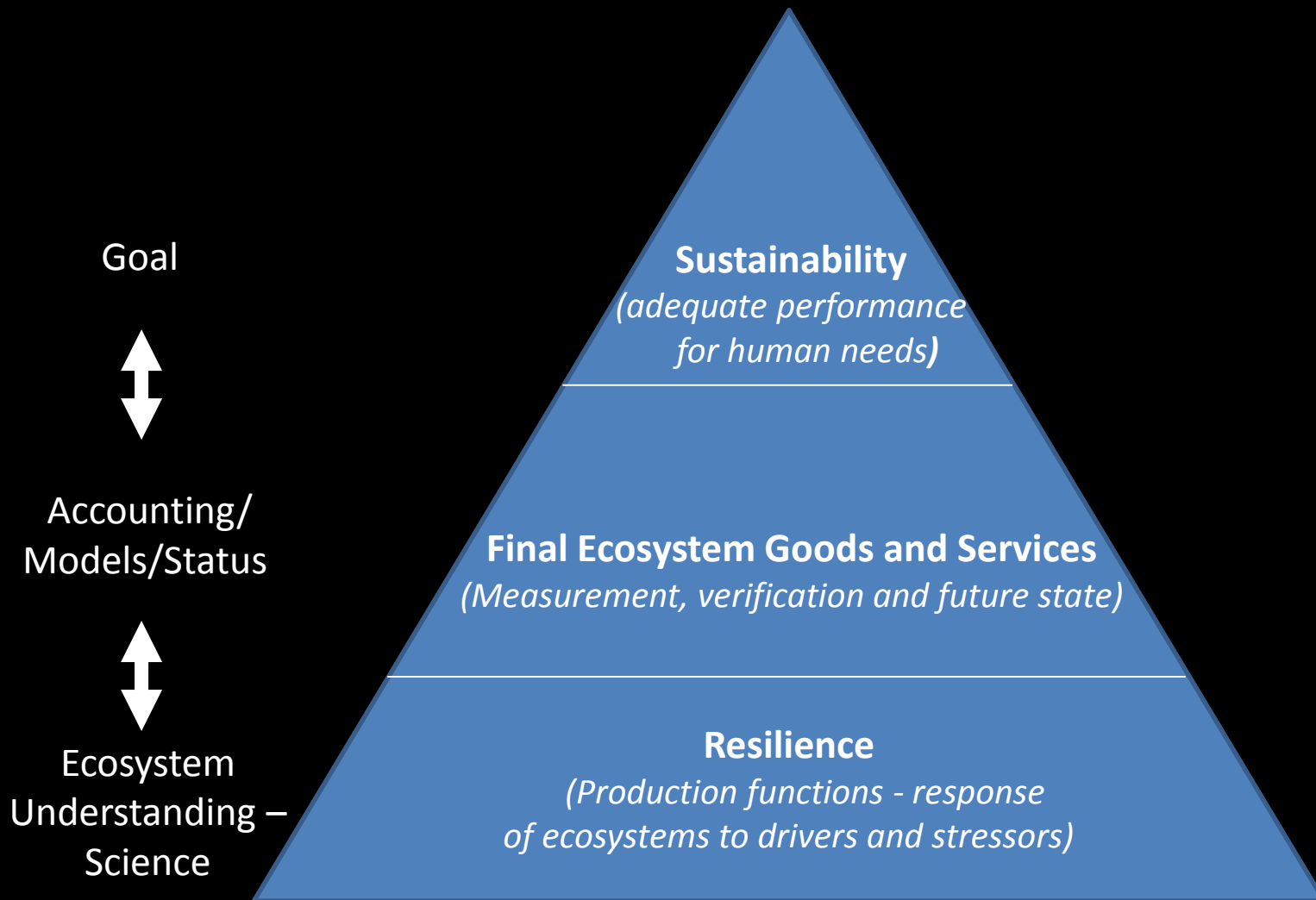


- Demographic, other data can be overlaid



- Over 90 layers for multiple communities
- Every layer published as a service

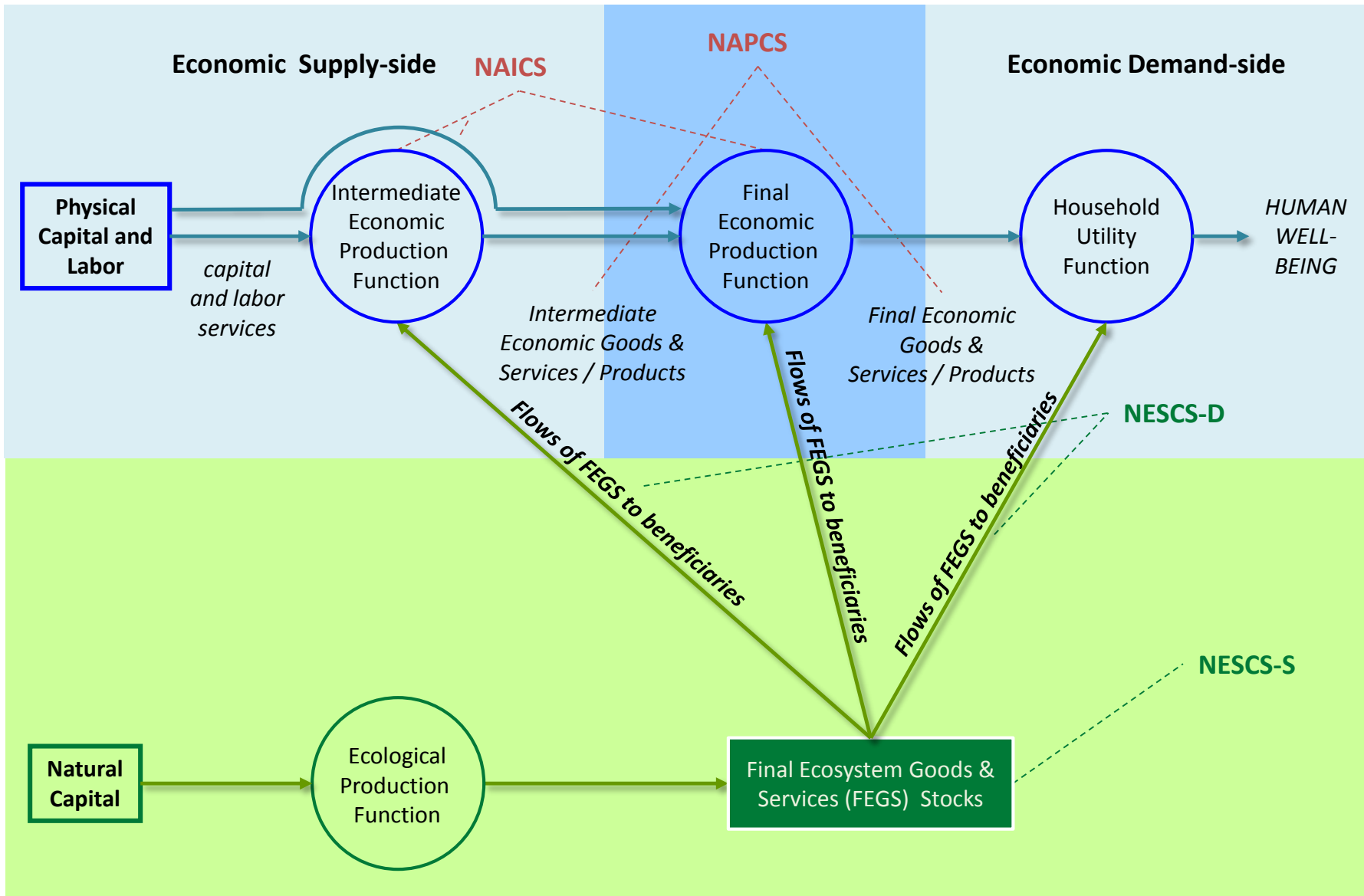
FEGS could well function as the currency of the Ecosystem component of sustainability.



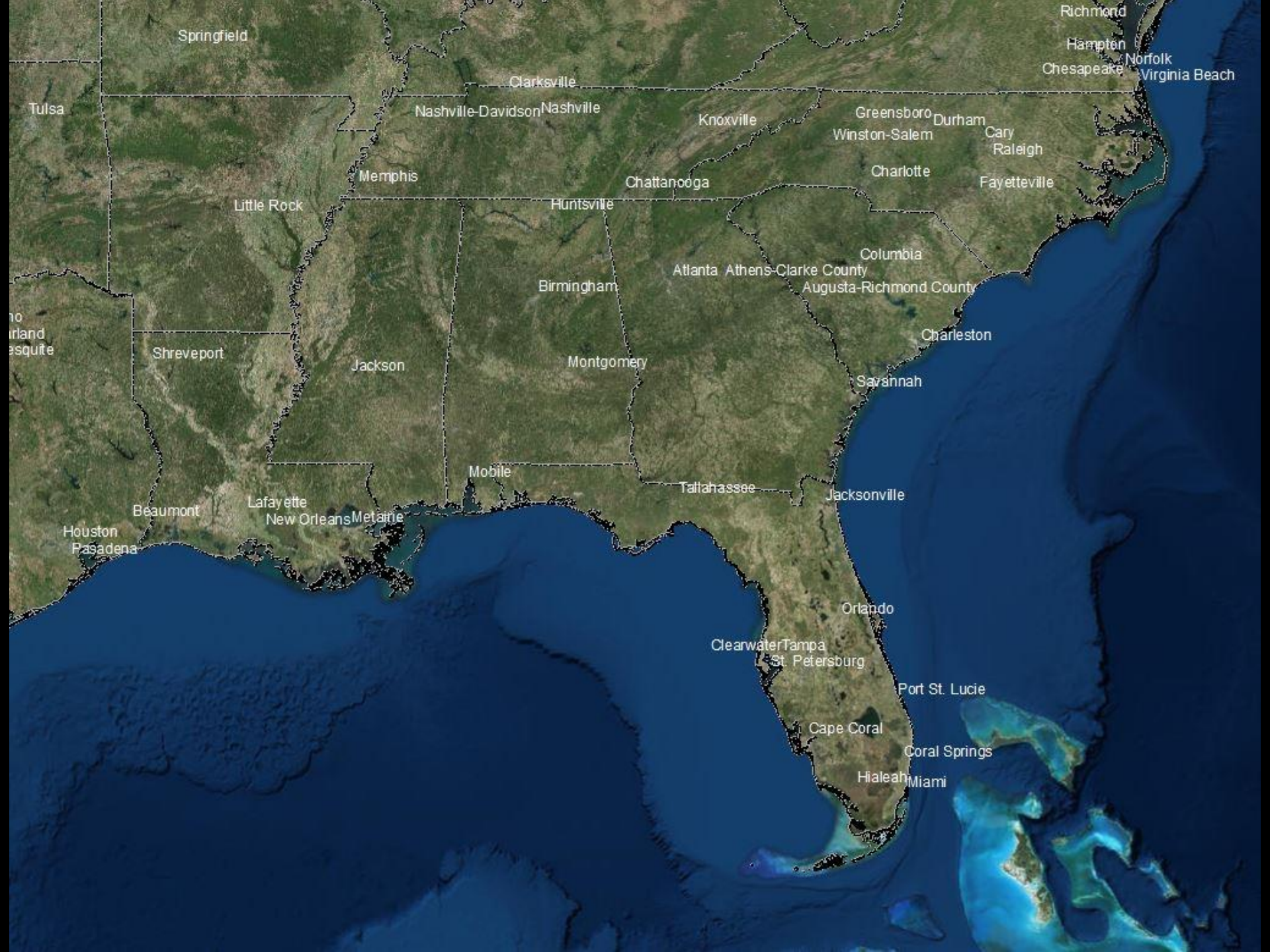
NESCS (linking FEGS with Economic Benefit and Cost Analysis)

Economic Production

Nature's Production



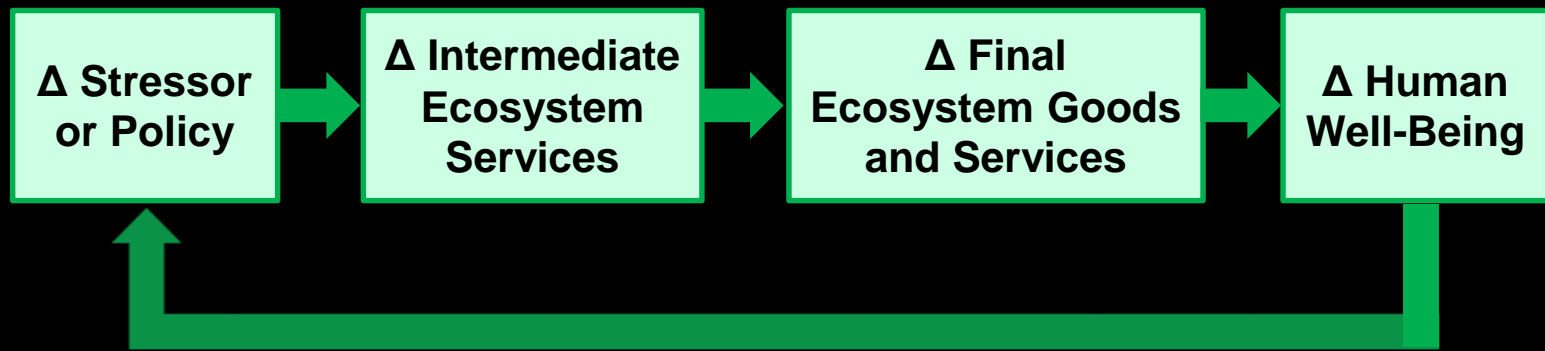
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Final Ecosystem Goods and Services (FEGS)

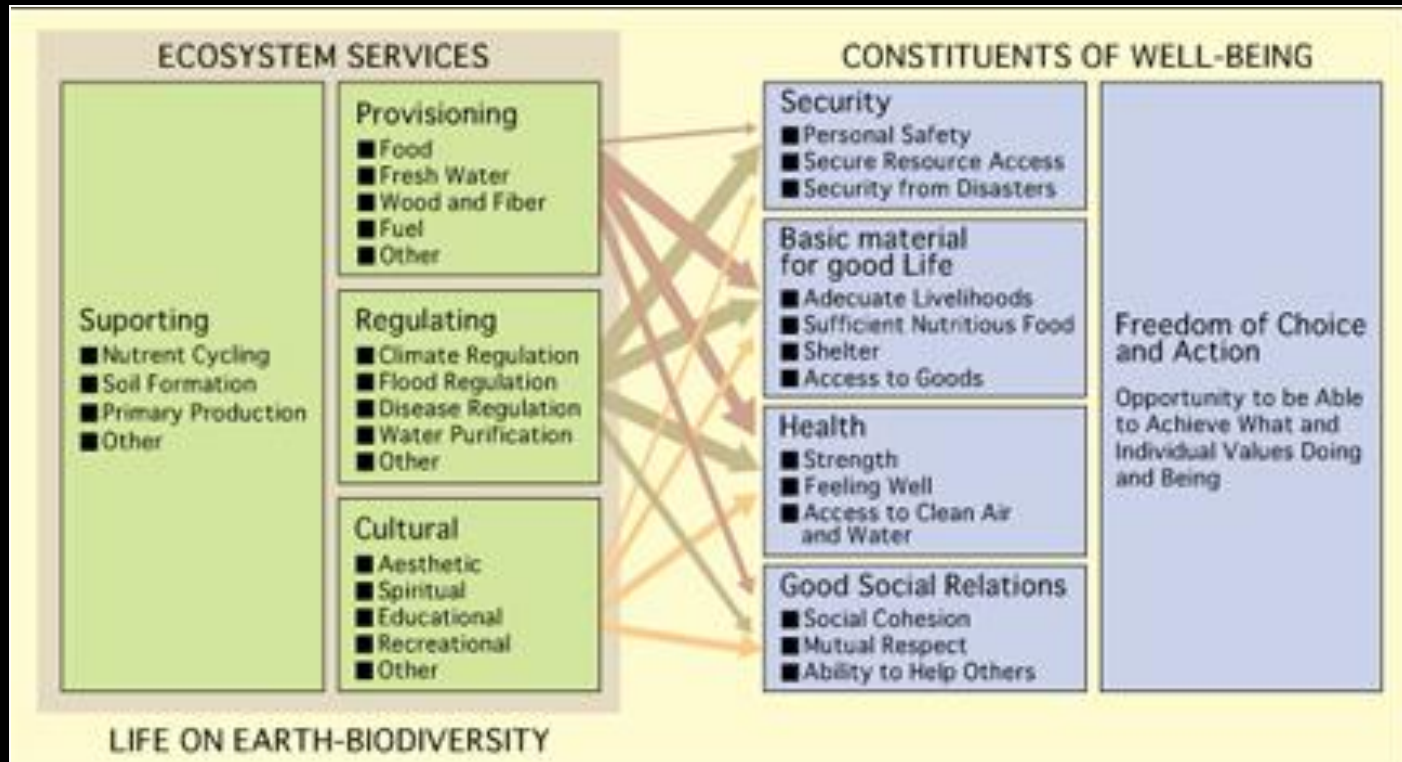
“components of nature, directly enjoyed, consumed, or used to yield human well-being” (*Boyd & Banzhaf 2007*)

- A focused definition
 - Centers on the ecosystems
 - Tied to measures of biophysical features
 - Counts only direct interactions, critical for economic valuation
 - Relates clearly to human beneficiaries and human well-being



Where it all started...

Millennium Ecosystem Assessment (MEA) sparked the vision of using ecosystem services as a tool.



“Ecosystem services are the benefits people obtain from ecosystems.” (MEA 2005)

EnviroAtlas Communities

You are here: [EPA Home](#) » [Research](#) » [Ecosystem Research](#) » [EnviroAtlas Home](#) » [EnviroAtlas Communities](#)



EnviroAtlas Communities

By 2017, EnviroAtlas will grow to include over 50 communities in the United States. EnviroAtlas communities are selected based on geography, ongoing local research, and the ability to leverage other EPA projects. In general, the community boundaries represent the census block groups within the census urban area for the main community in the area. Below, you can access community fact sheets, community boundary areas, and the data download page.

Community FAQs

What is the community component of EnviroAtlas?

Can I upload my own local data?

[More FAQs](#)

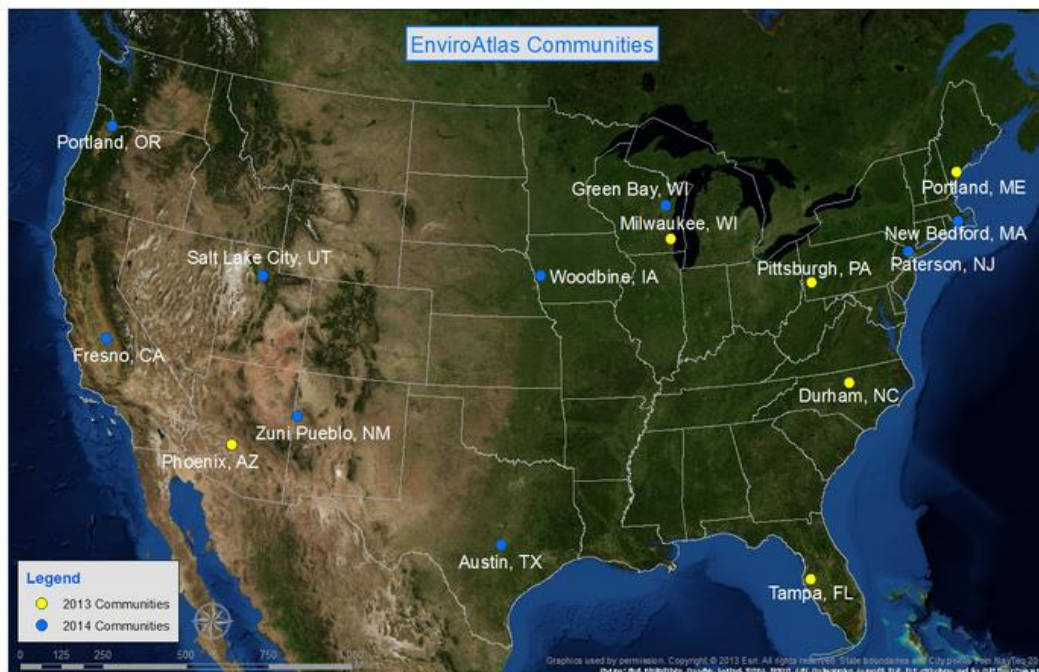
Navigating EnviroAtlas

- What are ecosystem services?
- How to use EnviroAtlas
- EnviroAtlas data
- Downloadable GIS tools
- Resources and publications
- Status of EnviroAtlas
- FAQs
- Tell us what you think

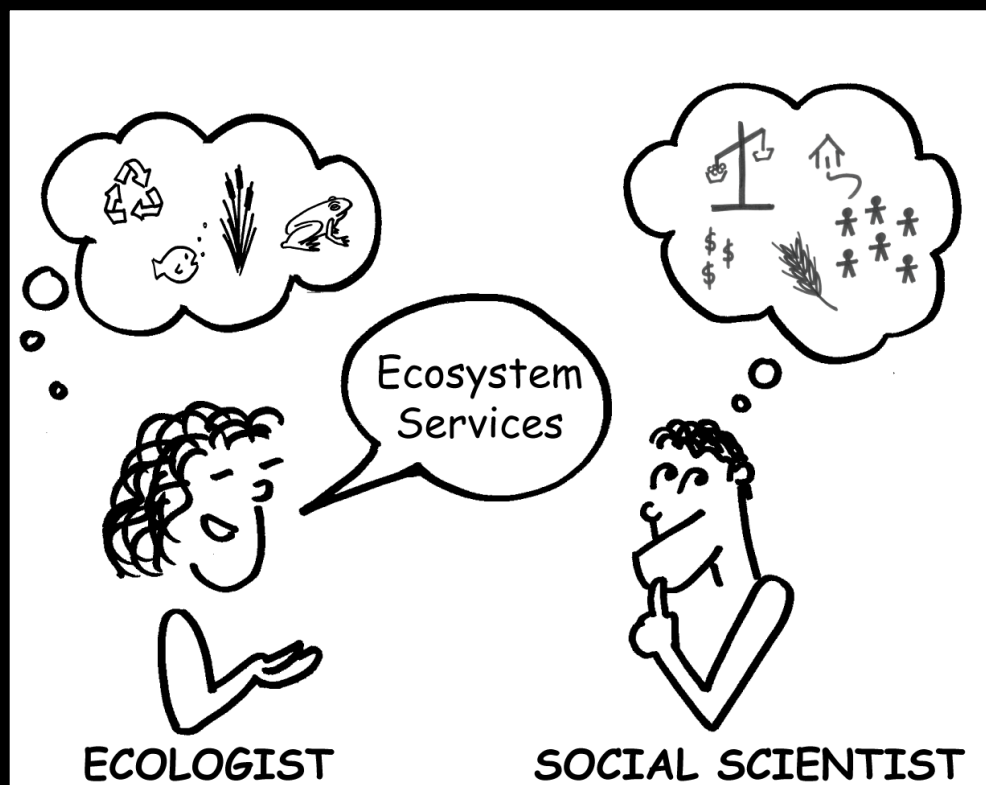
Explore the Interactive Map



View the Eco-Health Browser




The services quantified by ecologists are not necessarily those directly valued by the public.



Connecting ecosystem services to beneficiaries requires interdisciplinary approaches.

How do you identify FEGS?

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



Environmental Class + Beneficiary → FEGS

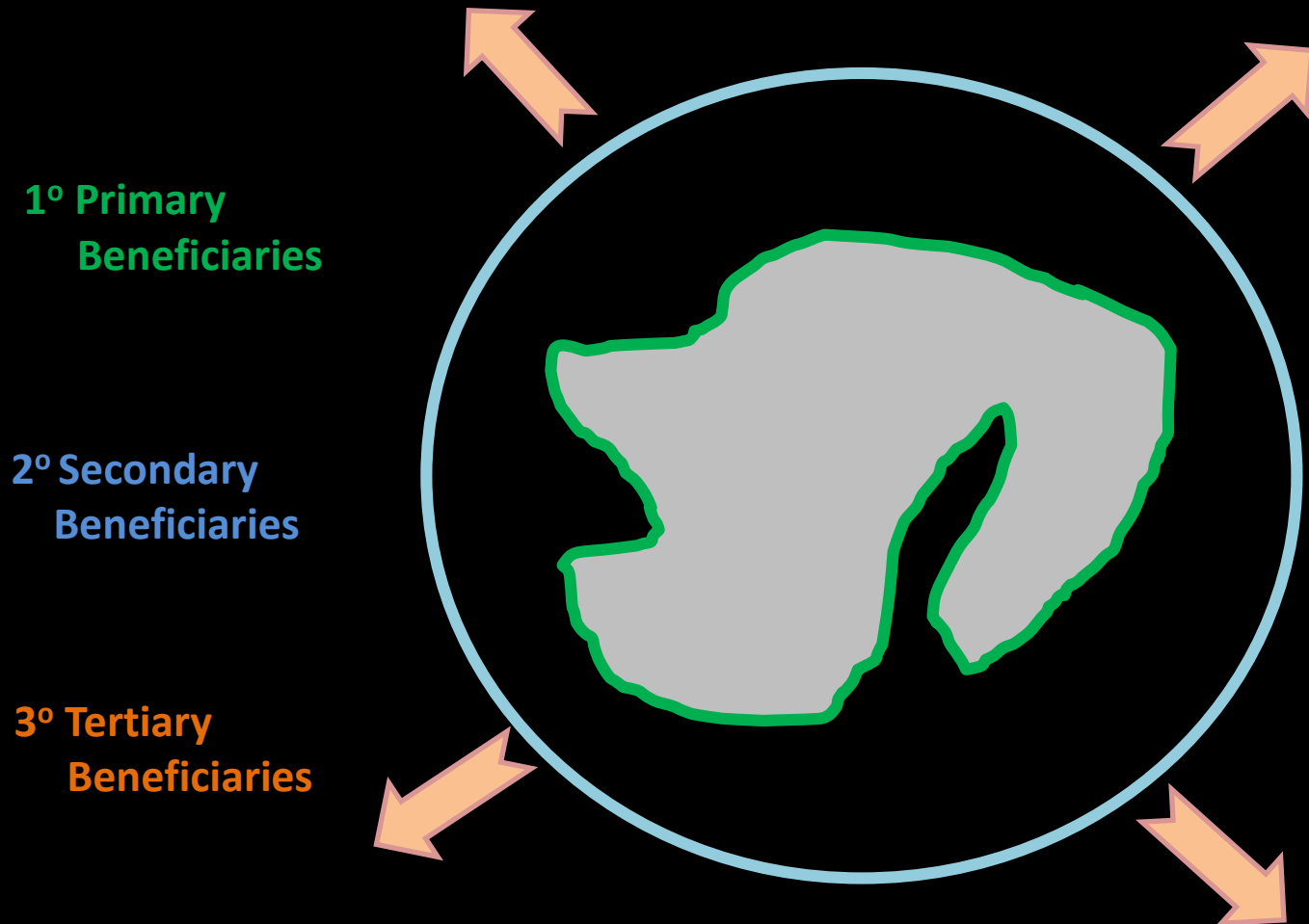
- Three Key Steps:
 1. Clearly define the Environmental Class boundary
 2. Identify Categories of Beneficiaries
 3. For any Beneficiary and Environmental Class, hypothesize FEGS received

CURRENT GOAL

Identify, measure, and quantify **FEGS** in a scientific, rigorous, and systematic way that can be aggregated from local to regional and national scales.

BENEFICIARYSCAPE

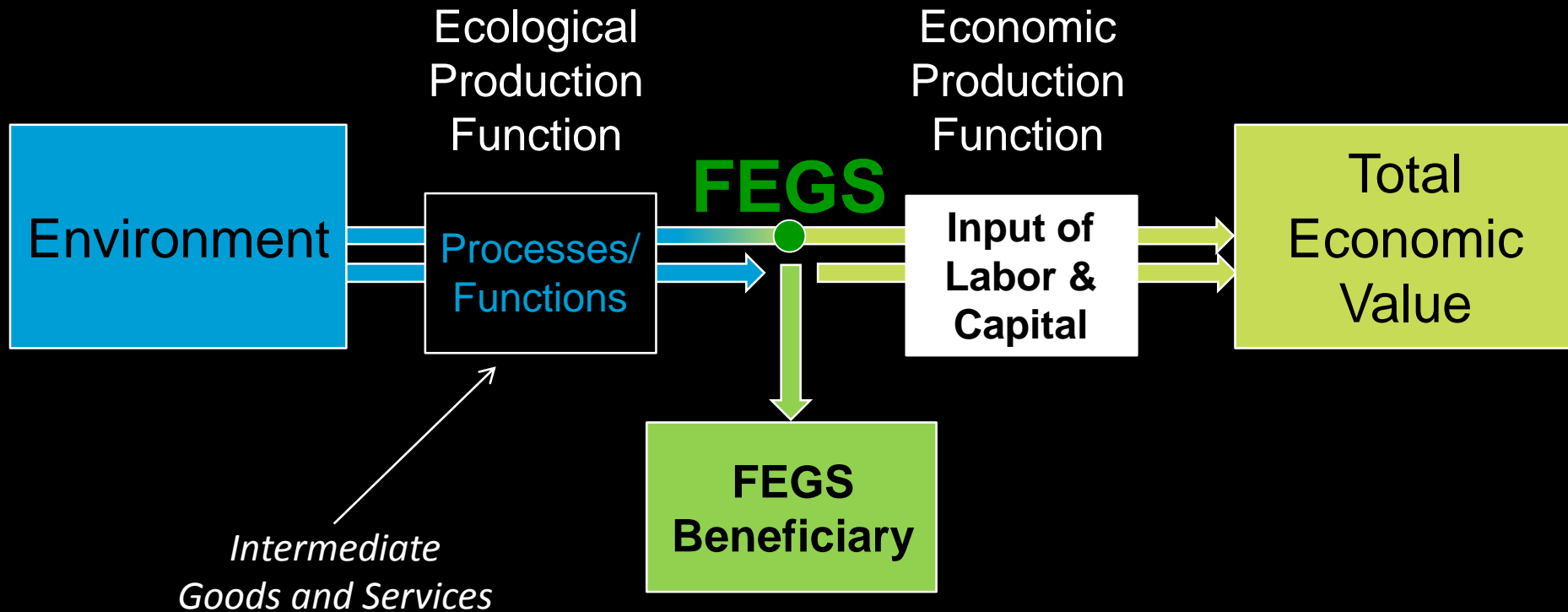
Beneficiaries (utility functions) lead to Valuation



Next Steps

- Begin populating the FEGS-CS with PROVISIONAL metrics and indicators
- Field test the FEGS-CS by applying, integrating and testing it as the ecological currency in specific and diverse place-based demonstration studies (proof of concept) and SHC wide in other capacities.
- Update and maintain the web site as need and based on user feedback (new or additional FEGS; beneficiaries, environmental sub-classes...)
- Collaborate with other researchers interested in the FEGS approach (SHC, ORD, UN SEEA and CICES, Canada, USA Federal Community (PCAST))

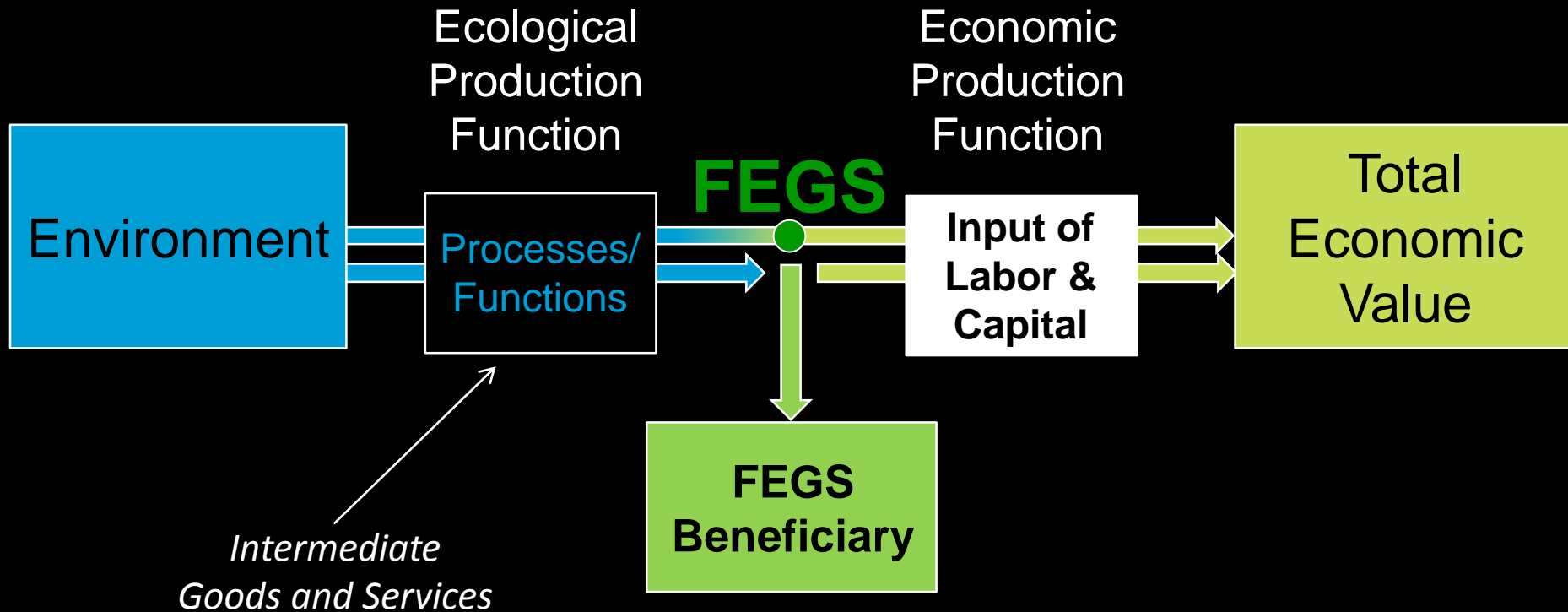
Example 1: Recreational Fishing



What are ecosystem services?



Example 2: Carrot Farming



The Importance of Beneficiary Linkages



Water is often considered an ecosystem service or “Benefit.”



To quantify ecosystem services on the ground, ecologists have to know what to measure.



What to measure depends on the **beneficiary** and what they **directly utilize, consume, or enjoy from the environment.**



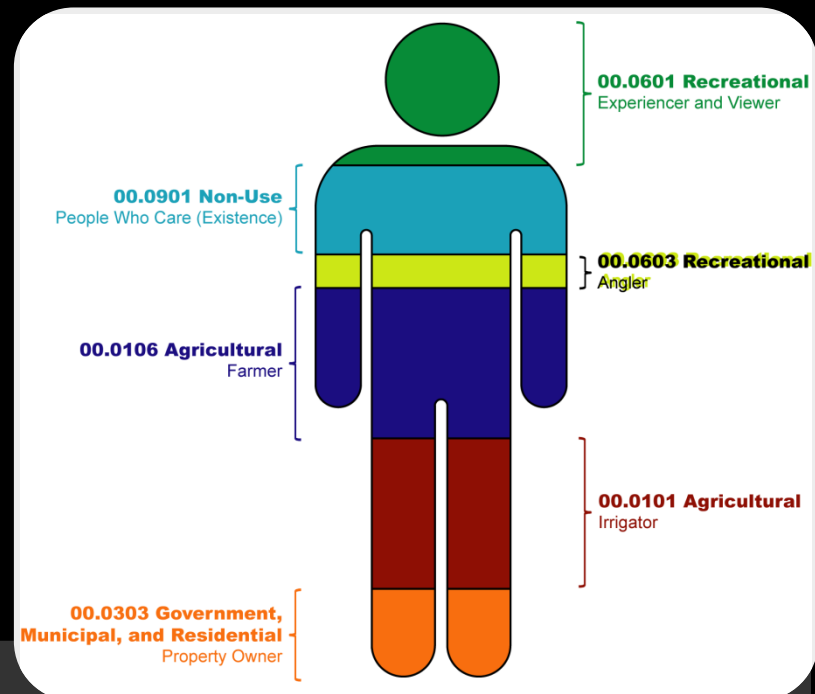
FEGS

Beneficiary Categories

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

Beneficiary

- Beneficiaries are the interests of an individual
- Synonymous with uses, households, or firms
- People are made up of multiple beneficiaries
- Identified 37 Beneficiary Sub-Categories

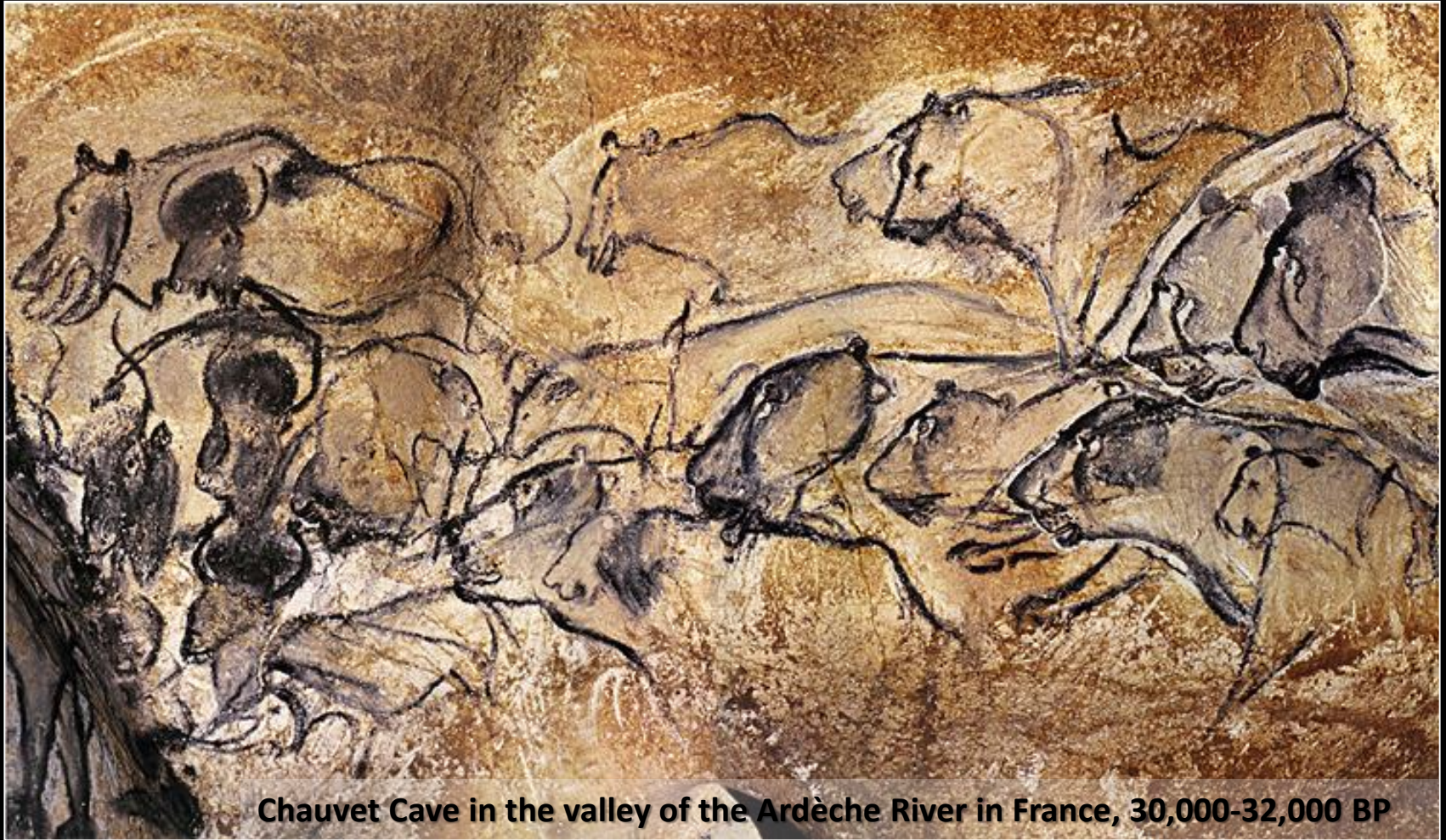


How do we connect
ecosystem services to human
well-being?

ORIGINAL **ES** CLASSIFICATION GOAL

Identify, measure, and quantify **ecosystem services** in a scientific, rigorous, and systematic way that can be aggregated to regional and national scales.

Humans Define and Classify Items of Importance in Order to Communicate

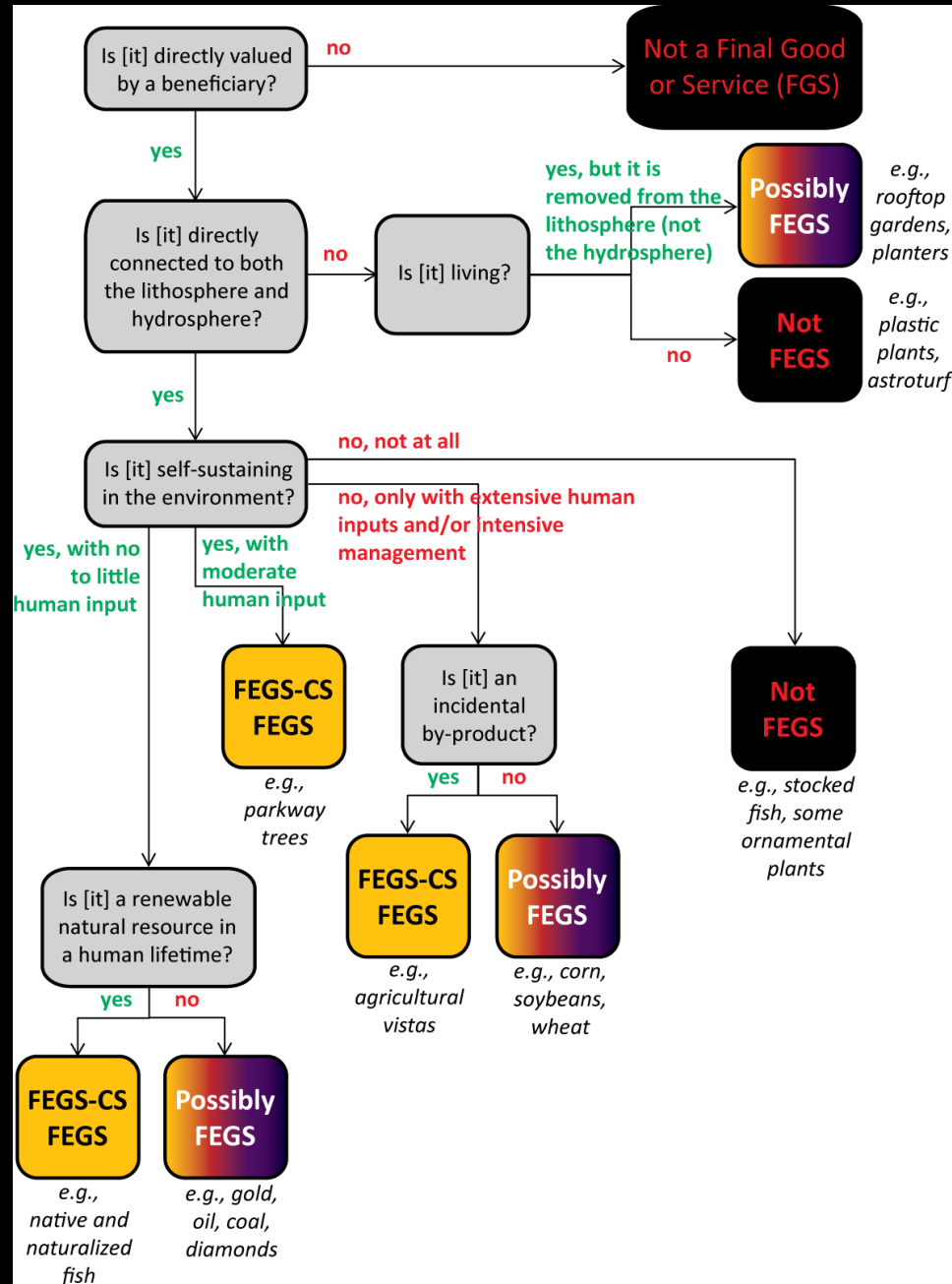


Chauvet Cave in the valley of the Ardèche River in France, 30,000-32,000 BP

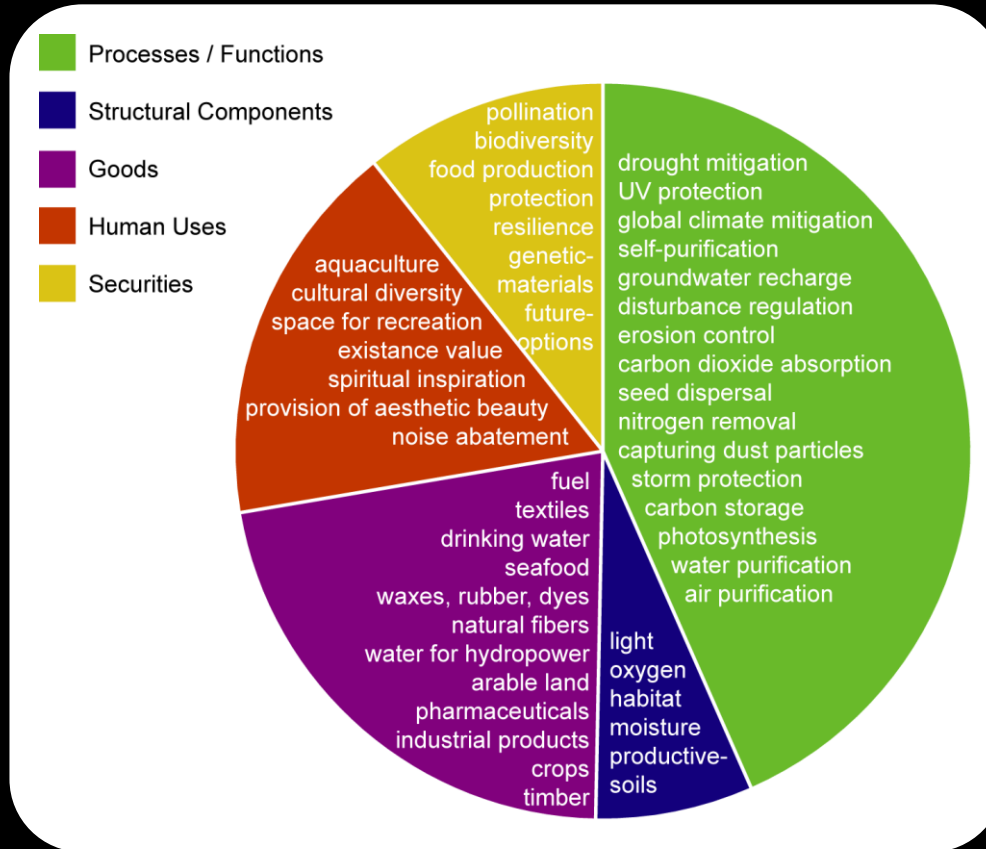
Distinguishing FEGS from Non-FEGS



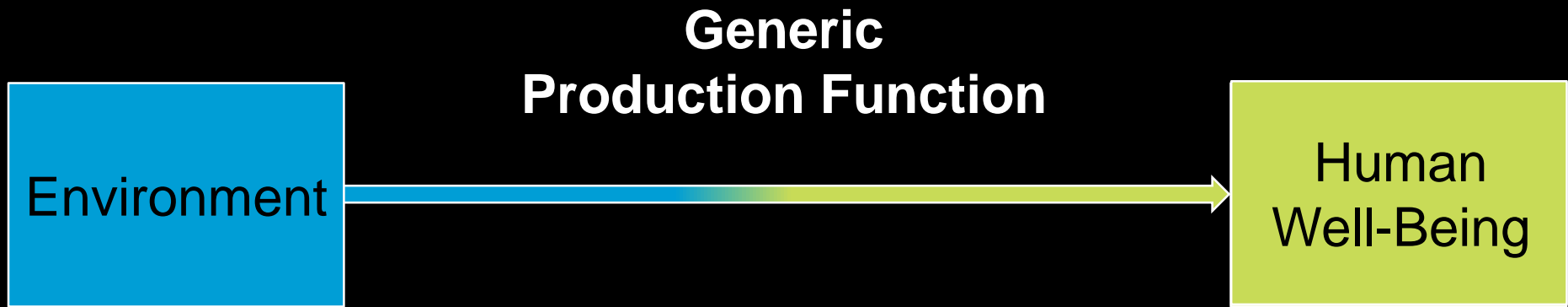
- We used rigid boundaries for FEGS, and made our boundary decisions explicit in FEGS-CS



What ecosystem services do scientists measure from this seemingly endless list?



Nahlik AM, Kentula ME, Fennessy MS, Landers DH. 2012. *Where is the consensus? A proposed foundation for moving ecosystem service concepts into practice. Ecological Economics 77: 27-35.*



Environmental Classes

1. AQUATIC

11. Rivers and Streams

12. Wetlands

13. Lakes and Ponds → ...include (but are not limited to)

14. Estuaries and Near Coastal and Marine • saline lakes

15. Open Oceans and Seas • reservoirs

16. Groundwater → ...include (but are not limited to)

• rechargeable aquifers

• geysers

• water in caves → ...include (but are not limited to)

• uncut and wilderness area forests

2. TERRESTRIAL

21. Forests → ...include (but are not limited to)

22. Agroecosystems

23. Created Greenspace → ...include (but are not limited to)

24. Grasslands

• parks, playgrounds, trees

25. Scrubland / Shrubland

• cemeteries and airfields

26. Barren / Rock and Sand → ...include (but are not limited to)

27. Tundra

• abandoned (dry) quarries

28. Ice and Snow

• dry desert

• beaches, unvegetated dunes

3. ATMOSPHERIC

31. Atmosphere

Beneficiary Categories

00.01. AGRICULTURAL

→ ...including,

00.02. COMMERCIAL / INDUSTRIAL

- 00.0103 Livestock Grazers
- 00.0106 Farmers

00.03. GOVERNMENT, MUNICIPAL, AND RESIDENTIAL

00.04. COMMERCIAL / MILITARY TRANSPORTATION

00.05. SUBSISTENCE

→ ...including,

00.06. RECREATIONAL

- 00.0501 Water Subsisters
- 00.0503 Timber, Fiber, Fur / Hide Subsisters

00.07. INSPIRATIONAL

→ ...including,

00.08. LEARNING

- 00.0701 Spiritual and Ceremonial Participants
- 00.0702 Artists

00.09. NON-USE

→ ...including,

00.10. HUMANITY

- 00.0901 People Who Care (Existence)
- 00.0902 People Who Care (Option / Bequest)

- Under the 10 Beneficiary Categories, there are a total of 37 Beneficiary Sub-Categories

Guiding Questions to Determine FEGS

- For a specific Environmental Sub-Class, which Beneficiary Sub-Categories are present?
 - *Q: Do Recreational Food Pickers and Gatherers utilize Estuaries and Near Shore Marine environments? A: Yes.*
- For a specific Beneficiary Sub-Category interested in a specific Environmental Sub-Class, what are the FEGS? Or, what does the beneficiary utilize or care about that is directly provided by the environment?
 - *Q: What do Recreational Food Pickers and Gatherers utilize from Estuaries that result in a benefit? A: Flora and fauna, such as seaweed, kelp, mussels, crabs, etc.*
- What is the importance of this FEGS to the beneficiary?
 - *Q: Why do Recreational Food Pickers and Gatherers in Estuaries care about flora and fauna? A: These are edible organisms that can be collected for personal use.*

Identifying FEGS

- While using guiding questions to identify FEGS, we also followed a distinct set of principles and rules
 1. *Intermediate goods and services, often structural components, functions, and processes, are not FEGS*
 2. *FEGS are components of the natural, not the built environment*
 3. *Policy endpoints do not create FEGS*
 4. *Human-made infrastructure, buildings, or goods and services with a large input of labor and/or capital are not FEGS*
 5. *Incidental non-marketed by-products of intensively produced goods and services may be considered FEGS*
 6. *Increased value or sense of happiness are not FEGS*
 7. *The environment itself can be a FEGS*

Classifying FEGS

- Identified 338 sets of FEGS
 - *Each associated with a Beneficiary Sub-Category and Environmental Sub-Class*
 - *Potential for more, as FEGS-CS is a “living-document”*
- Each set of FEGS can be identified by a unique, binomial, identification number

11. RIVERS AND STREAMS

Beneficiary Categories and Sub-Categories	Potentially Relevant NAICS Code(s)	General Beneficiary Description	FEGS	Examples of FEGS	Importance of FEGS to the Beneficiary
11.02 Commercial / Industrial					
11.0205 Electric and other Energy Generators	221	This beneficiary relies on the environment for energy or placement of power generation structures, including dams, wind, water, or wave turbines, solar panels, geothermal systems, etc.	<ul style="list-style-type: none"> • presence of the environment • water 		<ul style="list-style-type: none"> • opportunity to install power generation structures, such as dams and water turbines • flowing water that can be used for energy generation

XX.XX Beneficiary Categories				
00.01 Agricultural	00.02 Commercial / Industrial	00.03 Government, Municipal, and Residential	00.04 Commercial / Military Transportation	00.05 Subsistence
XX.XXXX Beneficiary Sub-Categories				
00.0101 Irrigators	00.0201 Food Extractors	00.0301 Drinking Water Consumers	00.0401 Transporters of Goods	00.0501 Water Subsisters
00.0102 CAFO Operators	00.0202 Mineral Extractors	00.0302 Waste Water Treatment Plant Operators	00.0402 Transporters of People	00.0502 Food Subsisters
00.0103 Livestock Grazers	00.0203 Timber, Fiber, and Ornamental Extractors	00.0303 Residential Property Owners		00.0503 Fiber and Fur Subsisters
00.0104 Agricultural Processors	00.0204 Industrial Processors	00.0304 Military / Coast Guard		00.0504 Building Material Subsisters
00.0105 Aquaculturists	00.0205 Industrial Dischargers			
00.0106 Farmers	00.0206 Electric and other Energy Generators			
00.0107 Foresters	00.0207 Business Property Owners			
	00.0208 Pharmaceutical and Food Supplement Suppliers			
	00.0209 Fur and Hide Trappers/Hunters			

XX.XX Beneficiary Categories				
00.06 Recreational	00.07 Inspirational	00.08 Learning	00.09 Non-Use	00.10 Humanity
XX.XXXX Beneficiary Sub-Categories				
00.0601 Experiencers and Viewers	00.0701 Spiritual and Ceremonial Participants	00.0801 Educators and Students	00.0901 People Who Care (Existence)	00.1001 All Humans
00.0602 Food Pickers and Gatherers	00.0702 Artists	00.0802 Researchers	00.0902 People Who Care (Option / Bequest)	
00.0603 Hunters				
00.0604 Anglers				
00.0605 Swimmers, Waders, and Divers				
00.0606 Boaters				

Categories of FEGS Identified in FEGS-CS

- We identified 21 Categories of FEGS

01 water	12 pollinators
02 flora	13 depredators and (pest) predators
03 presence of the environment	14 timber
04 fauna	15 fungi
05 fiber	16 substrate
06 natural materials	17 land
07 open space	18 air
08 viewsapes	19 weather
09 sounds and scents	20 wind
10 fish	21 atmospheric phenomena
11 soil	

- Note that these FEGS are categorical, not actual FEGS, because they are not connected to an environment or beneficiary

Metrics and Indicators for FEGS

- Metrics and indicators will be added as available to the FEGS-CS
- All will be initially marked “Provisional”
- With time and successful usage, some metric and indicators will be considered “Accepted” and will be marked so in the FEGS-CS
- User participation is essential for success

Incorporation of FEGS to USEPA Decision Making

- Key component of ORDs Sustainable and Healthy Community national research program: demonstration and proof of concept applications
- Adopt some NARS (*probability based* - National Aquatic Resources Survey) metrics and indicators (low hanging fruit); augment NARS with some additional metrics and indicators for FEGS
- Collaboration on developing NESCS with Office of Water and Office of Air and Radiation to incorporate FEGS into Benefit/Cost Analyses

The Future of FEGS-CS

- Widespread-release of the FEGS-CS report has generated interest
 - *Safe and Healthy Communities Research Program (SHCRP)*
 - *Office of Water & Office of Air and Radiation*
 - *Other government agencies (e.g., USGS)*
 - *Private Firms (e.g., Earth Economics)*
 - *UN-SEEA-EEA*
 - *World Bank and other NGOs*
 - *Private Sector (Peru Corporation)*
- Continued development of FEGS measures and indicators
 - *Collaborating with NARS groups and other government agencies (NOAA...)*
 - *Common, finite and unique list of metrics and indicators will facilitate on-the-ground collaborative research and site-to-program comparisons*

The Future of FECS-CS – CONTINUED...

- Field (Real World) Place-based Testing
- Defining and weighting the *Beneficiary-scape*
- FECS are the intersect between the environment and people, and as such, they could be used as:
 - a *common linkage AND language* among EPA Programs and their larger SUSTAINABILITY mission
 - the *environmental currency* for policy analysis and future sustainability projections

Contact Information

- Use Google search engine to search for:
 - *FEGS-CS*
 - *Publication Number EPA/600/R-13/ORD-004914*
 - *<http://gispub4.epa.gov/FEGS>*
- Email:
 - *FEGS.CS@epa.gov*
 - *landers.dixon@epa.gov*
 - *nahlik.amanda@epa.gov*