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
“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)

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

Economic Production Function

FEGS

Human Well-Being
Our Classification Scheme

<table>
<thead>
<tr>
<th>FEGS Classification Structure</th>
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<tbody>
<tr>
<td>X</td>
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<tr>
<td>XX</td>
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<tr>
<td>XX.XX</td>
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<tr>
<td>XX.XXXX</td>
</tr>
</tbody>
</table>

Environment: XX.XXXX
Beneficiary: 21.0604
Terrestrial: Forests
Recreational: Hunters
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

- Over 90 layers for multiple communities

- Every layer published as a service

- Demographic, other data can be overlaid
FEGS could well function as the currency of the Ecosystem component of sustainability.
END
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

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.
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.
Beneficiaries (utility functions) lead to Valuation

1º Primary Beneficiaries
2º Secondary Beneficiaries
3º Tertiary Beneficiaries
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

- **Environment**
- **Processes/Functions**
- **FEGS Beneficiary**
- **Input of Labor & Capital**
- **Total Economic Value**

**Intermediate Goods and Services**

**Ecological Production Function**

**Economic Production Function**

Example 1: Recreational Fishing

- Recreational Fishing

What are ecosystem services?
Example 2: Carrot Farming

Environment → Processes/Functions → FEGS Beneficiary

Ecological Production Function

Input of Labor & Capital

Total Economic Value

Intermediate Goods and Services

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

- 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?
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?

Generic Production Function

Environment → Human Well-Being
### Environmental Classes

#### 1. AQUATIC
11. Rivers and Streams
12. Wetlands
13. Lakes and Ponds
14. Estuaries and Near Coastal and Marine
15. Open Oceans and Seas
16. Groundwater

...include (but are not limited to)
- saline lakes
- reservoirs
- quarries

#### 2. TERRESTRIAL
21. Forests
22. Agroecosystems
23. Created Greenspace
24. Grasslands
25. Scrubland / Shrubland
26. Barren / Rock and Sand
27. Tundra
28. Ice and Snow

...include (but are not limited to)
- rechargeable aquifers
- geysers
- water in caves
- uncultivated area forests
- abandoned (dry) quarries
- dry desert
- beaches, unvegetated dunes

#### 3. ATMOSPHERIC
31. Atmosphere
Beneficiary Categories

00.01. AGRICULTURAL
00.02. COMMERCIAL / INDUSTRIAL
00.03. GOVERNMENT, MUNICIPAL, AND RESIDENTIAL
00.04. COMMERCIAL / MILITARY TRANSPORTATION
00.05. SUBSISTENCE
00.06. RECREATIONAL
00.07. INSPIRATIONAL
00.08. LEARNING
00.09. NON-USE
00.10. HUMANITY

...including,
- 00.0103 Livestock Grazers
- 00.0106 Farmers

- 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

<table>
<thead>
<tr>
<th>Beneficiary Categories and Sub-Categories</th>
<th>Potentially Relevant NAICS Code(s)</th>
<th>General Beneficiary Description</th>
<th>FEGS</th>
<th>Examples of FEGS</th>
<th>Importance of FEGS to the Beneficiary</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.02 Commercial / Industrial</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>11.0205 Electric and other Energy Generators</td>
<td>221</td>
<td>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.</td>
<td></td>
<td></td>
<td>* opportunity to install power generation structures, such as dams and water turbines</td>
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### Beneficiary Categories

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

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<thead>
<tr>
<th>00.06 Recreational</th>
<th>00.07 Inspirational</th>
<th>00.08 Learning</th>
<th>00.09 Non-Use</th>
<th>00.10 Humanity</th>
</tr>
</thead>
<tbody>
<tr>
<td>00.0601 Experiencers and Viewers</td>
<td>00.0701 Spiritual and Ceremonial Participants</td>
<td>00.0801 Educators and Students</td>
<td>00.0901 People Who Care (Existence)</td>
<td>00.1001 All Humans</td>
</tr>
<tr>
<td>00.0602 Food Pickers and Gatherers</td>
<td>00.0702 Artists</td>
<td>00.0802 Researchers</td>
<td>00.0902 People Who Care (Option / Request)</td>
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<tr>
<td>00.0603 Hunters</td>
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<tr>
<td>00.0604 Anglers</td>
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<tr>
<td>00.0605 Swimmers, Waders, and Divers</td>
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<tr>
<td>00.0606 Boaters</td>
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</table>
Categories of FEGS Identified in FEGS-CS

• We identified 21 Categories of FEGS

 01 water
 02 flora
 03 presence of the environment
 04 fauna
 05 fiber
 06 natural materials
 07 open space
 08 viewscapes
 09 sounds and scents
 10 fish
 11 soil

 12 pollinators
 13 depredators and (pest) predators
 14 timber
 15 fungi
 16 substrate
 17 land
 18 air
 19 weather
 20 wind
 21 atmospheric phenomena

• 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 FEGS-CS – CONTINUED...

• Field (Real World) Place-based Testing
• Defining and weighting the Beneficiary-scape

• FEGS 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
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  – nahlik.amanda@epa.gov