National Ecosystem Services Partnership

Webinar

How Ecosystem Services Classification Systems Can Help Generate and Improve Lists of Ecosystem Services and Common Metrics

Charles Rhodes - Oak Ridge Institute for Science and Education, participating at EPA
Dixon Landers – U.S. Environmental Protection Agency

January 21, 2016
Updates to NESP guidebook

Best Practices for Integrating Ecosystem Services into Federal Decision Making

Resources

This section of the Federal Management and Ecosystem Services Guidebook provides brief descriptions and links to a number of online resources relevant to implementing an ecosystem services approach. It is updated as new resources become available. The resources highlighted here either complement or supplement this guidebook and the Best Practices for Integrating Ecosystem Services into Federal Resource Management paper. This list should not be considered an endorsement of any one tool or resource, but rather a curated collection of available resources.

- Federal Action on Ecosystem Services
  - The White House CEO released new policy memorandum in the fall of 2015 directing federal agencies to begin incorporating ecosystem services in federal planning and decision making.
  - On November 3 the White House released a memorandum aimed at minimizing impacts on, accelerating restoration of, and incentivizing private investment in our land, water, and wildlife.
  - On August 25, 2014 the White House released the report “Ecosystem-Service Assessment: Research Needs for Coastal Green Infrastructure”
  - In 2013 the White House Council on Environmental Quality (CEQ) released new principles and requirements for federal investments in water resources and include guidance on using an ecosystem services evaluation framework for water resources projects.
  - The U.S. Forest Service’s 2012 Planning Rule requires that planning activities consider ecosystem services as part of an integrated resource management focus.

- Best Practices for Integrating Ecosystem Services into Resource Management:
  - EnviroAtlas
  - A Review of Ecosystem Service Analytical Tools
  - Video Series on Ecosystem Services Valuation
  - State Level Ecosystem Services Assessments
  - NESP Meetings and Webinars
Upcoming NESP Webinars

February 11th, 1-2:30 EST

Oregon Action Framework for the Health and the Outdoors
- Katherine Smith USFS; Bobby Cochran, Willamette Partnership; Steve Kelley, NC State and Kelley Family Foundation

March 3rd, 2-3:00 pm EST

"Cloud-based modeling and big data approaches for ecosystem services assessment: Moving from hype to substance“
- Ken Bagstad, USGS

Recent webinars now posted on line

White House Memorandum on Mitigating Impacts on Natural Resources
- Timothy Male CEQ, Tomer Hasson DOI, Palmer Hough EPA

White House Memorandum on Incorporating Ecosystem Services into Policy
- Sarah Ryker CEQ, Hannah Safford OSTP

NESP webinars are now being posted online. You can view and download past presentations from the Meetings and Webinars page here: https://nicholasinstitute.duke.edu/focal-areas/national-ecosystem-services-partnership
Presenters

- **Charles Rhodes** is an Oak Ridge Institute Science & Education (ORISE) post-doctoral research fellow, participating with US EPA’s Offices of Water and of Research and Development in Washington, DC. His work is single-project on the National Ecosystem Services Classification System, coordinating aspects of tool development and interdisciplinary communication. In this capacity he interacts with academics and ecosystem services practitioners in many trans disciplinary conferences and symposia, exploring classification as a means to standardize definitions and certain methodologies, and to widen the scope of quantitative analyses – including with the UN Statistics Division team working to develop “green accounting” standards for national accounting. His PhD is in agricultural and resource economics.

- **Dixon Landers** is a Senior Research Environmental Scientist (Limnologist) at EPA's National Health and Environmental Effects Research Laboratory, Western Ecology Division, in Corvallis, OR and an Associate Professor in the Department of Fisheries and Wildlife at Oregon State University. He is currently serving as a task leader for developing a Standardized Classification and Indicators for Ecosystem Goods and Services for EPA’s national Sustainable and Healthy Communities Research Program. Previously, he designed and directed the National Park Service’s Western Airborne Contaminant Assessment Project from 2002-2008. His PhD is in Zoology/Limnology.
How to Create Lists of Ecosystem Services

Charles Rhodes, Oak Ridge Institute for Science and Education (participating at EPA)
Dixon Landers, Environmental Protection Agency
Lydia Olander, Duke University, National Ecosystem Services Partnership & Nicholas Institute for Environmental Policy Solutions
NESP webinar Jan 2016
White House memorandum calling on Federal agencies to incorporate ecosystem services into Federal decision making requests:

• a description of current agency practice and work plans to be submitted to the Council on Environmental Quality (CEQ) no later than March 30, 2016 and

• plans for implementation guidance to be developed in collaboration with the agencies by November 30th, 2016. (When it will be released for external review)
How do we select and generate a list of ecosystem services to

1) **Assess ES effects of our proposed project/plan?**
   - e.g., road building, forest plan, dredging and beach nourishment, NEPA
Maybe just think about benefits?

- Likely to miss some
- May not effect all of them
How do we select and generate a list of ecosystem services to

1) Assess ES effects of our proposed project/plan?
   ◦ e.g., road building, forest plan, dredging and beach nourishment, NEPA

2) Compare projects/plans to determine which ones to fund/pursue?
   ◦ e.g., wetland or ecological restorations; invasive species management programs; levee rebuilds
### Common list across agencies: Coastal Wetland Restoration

<table>
<thead>
<tr>
<th>Ecological</th>
<th>Sociological</th>
<th>Hydrological</th>
<th>Geological</th>
<th>Biogeochemical</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide habitat</td>
<td>Provide recreation</td>
<td>Reduce storm surge &amp; flooding</td>
<td>Reduce &amp; control erosion</td>
<td>Improve water quality</td>
<td>Reduce wildfire potential</td>
</tr>
<tr>
<td>Maintain biodiversity</td>
<td>Provide &amp; support navigation</td>
<td>Protect flood storage</td>
<td>Protect &amp; enhance health soils</td>
<td>Sequester and convert nutrients</td>
<td>Protect against wind shear</td>
</tr>
<tr>
<td>Protect T&amp;E</td>
<td>Produce-provide food, feed, etc</td>
<td>Attenuate waves</td>
<td></td>
<td>Reduce haz-tox materials</td>
<td>Attenuate droughts</td>
</tr>
<tr>
<td>Buffer ocean acidification</td>
<td>Provide &amp; improve aesthetics</td>
<td>Provide and store groundwater</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promote env justice</td>
<td>Reduce overtopping</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protect property value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protect cultural heritage</td>
<td>Restore functional hydrology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provide &amp; support education</td>
<td></td>
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<tr>
<td>Provide-support scientific research</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Nearshore shallow; bluff; marsh/wetland; beach/dune; tidal flat; estuaries/ponds; upland watershed; maritime forest/shrubland; riparian zone; hybrid infrastructure (living shoreline)**

**Benefits and beneficiary not clear**

**Could lead to double counting**
What do you want your common list to achieve?

1) Cover all important services (valued by people) that may be significantly affected by this activity (wherever it may occur)

2) Avoid significant double counting that might create unfair advantage for certain projects/activities

3) Be set up for a formal benefits assessment even if not doing one now
   - Critical to avoid double counting and have clearly defined benefits and beneficiaries (final goods and services)

4) Consistency with other decisions, agencies, and databases
   - If agencies are using the same framework for generating lists and databases there will be greater consistency and interoperability
How can FEGS and NESCS help to achieve these goals?

Is this one possible solution?
Ecosystem Services

- inconsistent definition
- hard to measure

One goal of community: strengthen the science needed to apply the Ecosystem Services perspective to policy

“Stronger science” means empirically reproducible results

Empirical reproducibility: uniformity of terminology, and standardization of approach, of method, and record

PUBLIC GOOD – generally free, non-exclusionary, and non-rivalrous

- e.g.: air and knowledge
- standards in commerce – currency, weights and measures, trade, pharmacology, food safety
Approaches to definition and identification of ES seem to split between:

**Those seeking formalization and standardization of ES definitions and identification**
- bound to formal analysis
  - marginal/scenario/cost-benefit analyses
- seek long-term tool development
  - “full-spectrum” identification
  - precise, reproducible, and specific field metrics
  - precise final ES for known users/beneficiaries to value
  - common tracking of relevant ES metrics with the goal of “allowable” benefits transfer

**Ad-hoc pragmatists**
- frustrated with slowness of adoption of ES perspective
- focused on limitations of full-scale ES assessment for very few ES
  - 1 to 6 “ecosystem services”
- question the efficacy of formalizing classification
I. Ad-Hoc / Narrow-Focus Assessment (FEGS-CS/NESCS)

Natural Capital (structures, processes, and functions)

ES identification (definition and rule-based discrimination)

Measures and Quantification (quantitative (Q) and qualitative (q) ecological measures)

Valuation (existence (e), ranking (R), monetization (M); economic, accounting, or policy measures)
• the “final ES” vocabulary and structure may be new to those using *Millennium Ecosystem Assessment, 2005* terms

• use of *FEGS-CS* and *NESCS* to identify final ES is not particularly complicated

• both systems are frameworks for application, each providing a frame that helps define final ecosystem services in a way that should assist in choosing metrics

• by identifying a nearly comprehensive suite of final ES, *FEGS-CS* and *NESCS* intend to solicit more measurements and perhaps wider valuation effort
Core Features for a Desirable Final Ecosystem Services Classification System

**Exhaustive and Mutually Exclusive**

uniquely identifies all structures, processes, functions, and products of natural systems (separate from human-driven systems) that humans use or appreciate

**Non-Duplicative**

focuses attention and measurement on those ecosystem services that humans use or appreciate directly (final versus intermediate ecosystem services), to avoid double-counting

**Practical for Users**

groups or separates candidate elements in a way easy to conceive and use, with clear definitions, and rules for classifying that appeal across disciplines and users – avoiding overwhelming complexity, confusion, fuzzy classification boundaries, and thus avoiding divergent choices for similar cases by similar users

**Helpful for Selecting Appropriate Metrics**

uniquely identifying the environment, the precise flows of ecosystem services, the users, and how they use the ES, all help to determine what ecologists and economists should measure

**Modular**

a “bonus” for practical use, if system interfaces with other standard classification systems or ecosystem service tools without extensive exceptions and patching

**Appropriate to be a Standard**

a “bonus” for practical use, if system is stable, its rules for use are well-explained, and it is practical enough to serve as the standard for many types of applications
Final Ecosystem Goods and Services Classification System (FEGS-CS)

Generating Standard Lists of “Environmental Currency” Applicable to Many Specific Needs

Dixon H. Landers¹ and Amanda M. Nahlik¹,²

¹ US EPA OFFICE OF RESEARCH AND DEVELOPMENT, NATIONAL HEALTH AND ECOLOGICAL EFFECTS RESEARCH LABORATORY, WESTERN ECOLOGY DIVISION, CORVALLIS, OREGON

² KENYON COLLEGE, DEPARTMENT OF BIOLOGY, GAMBIER, OHIO
"components of nature, directly enjoyed, consumed, or used to yield human well-being" (Boyd & Banzhaf 2007)

Identifying Final Ecosystem Goods and Services

Environmental Class + Beneficiary → Type of FEGS

Estuaries and Near Shore Marine
Recreational Food Pickers and Gatherers
Flora and fauna, such as mussels, seaweed, crabs, etc.
By using the FEGS approach, an infinite list of ecosystem services was pared down to 338 FEGS triplets.

FEGS-CS is an operational framework that standardizes identification of ecosystem services at multiple spatial scales.

Published EPA Report
- EPA/600/R-13/ORD-004914

Interactive FEGS-CS website at http://gispub4.epa.gov/FEGS
- Create and download custom checklists of potential FEGS
- Link (eventually) with EnviroAtlas, mapping and models
### Potential FEGS Provided by Wetlands

<table>
<thead>
<tr>
<th>Beneficiary Categories and Sub-Categories</th>
<th>Potentially Relevant NAICS Code(s)</th>
<th>General Beneficiary Description</th>
<th>Types of FEGS</th>
<th>Examples of FEGS</th>
<th>Importance of FEGS to the Beneficiary</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.01 Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.0101 Irrigators</td>
<td>111</td>
<td>Irrigators interact with aquatic environments, as they consume water from aquatic environments for maintaining crops, often moving water through ditches and canals. Note that Farmers and Irrigators are different beneficiaries.</td>
<td>* water</td>
<td>* water for growing and maintaining crops</td>
<td></td>
</tr>
<tr>
<td>12.0103 Livestock Grazers</td>
<td>112</td>
<td>This beneficiary uses the environment to graze livestock. Cultivated vegetation is NOT considered a FEGS. For agroecosystems, &quot;planted&quot; pastures only provide space and opportunity to grow feed (not the vegetation itself).</td>
<td>* water, flora, open space</td>
<td>* salt hay, grasses</td>
<td>* water suitable for livestock consumption * non-cultivated vegetation for livestock consumption * suitable conditions (i.e., land) to graze livestock</td>
</tr>
<tr>
<td>12.0105 Aquaculturists</td>
<td>112</td>
<td>Aquaculturists farm aquatic fauna, such as fish, shrimp, oysters, etc. Those who cultivate aquatic flora are accounted for under the Farmer Beneficiary Sub-Category.</td>
<td>* presence of the environment, * water</td>
<td></td>
<td>* opportunity provided by the environment for cultivating aquatic organisms * medium and conditions (i.e., water quality) provided by the environment for cultivating aquatic organisms</td>
</tr>
<tr>
<td>12.0106 Farmers</td>
<td>111, 113</td>
<td>Farmers may plant annual crops (e.g., corn, soybeans, rice) or introduce cultivars that produce perennial, long-term crops (e.g., hay, grapes, cranberries, watercress, Christmas trees). Note that Farmers and Irrigators are different beneficiaries.</td>
<td>* soil, open space, pollinators, depredators and (pest) predators</td>
<td></td>
<td>* suitable soil in which annual or perennial crops (NOT crops themselves) can be grown * suitable conditions (i.e., land) in which to grow annual or perennial crops (NOT crops themselves) * wild pollinators that provide opportunity to grow annual or perennial crops * wild depredators and (pest) predators that provide opportunity to grow crops</td>
</tr>
<tr>
<td>12.02 Commercial / Industrial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.0201 Food Extractors</td>
<td>114, 311, 312, 454</td>
<td>Food extractors utilize the natural abundance of edible organisms (i.e., non-cultivated or bred) for commercial use or sale. Includes commercial and native hunters (if legal). In aquatic environments, this beneficiary has potential contact with water.</td>
<td>* flora, fauna</td>
<td>* wild rice, lotus root, fish, crawfish, duck</td>
<td>* edible organisms (i.e., flowers, plants, etc.) or associated products (i.e., fruit, greens, tubers, berries, sap) for commercial use or sale * edible organisms (i.e., birds, mammals, reptiles, etc.) for commercial use or sale</td>
</tr>
</tbody>
</table>

- And so on... There are 22 additional FEGS triplets for wetlands
### Formal List of Potential Wetland FEGS (Stocks)

<table>
<thead>
<tr>
<th>Unique FEGS Code</th>
<th>Types of FEGS</th>
<th>Environmental Sub-Class</th>
<th>Beneficiary</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.0101</td>
<td>Water</td>
<td>Wetlands</td>
<td>Irrigators</td>
</tr>
<tr>
<td>12.0103</td>
<td>Water / Flora / Open Space</td>
<td>Wetlands</td>
<td>Livestock Grazers</td>
</tr>
<tr>
<td>12.0105</td>
<td>Presence of the Environment / Water</td>
<td>Wetlands</td>
<td>Aquaculturists</td>
</tr>
<tr>
<td>12.0106</td>
<td>Soil / Open Space / Pollinators / Depredators</td>
<td>Wetlands</td>
<td>Farmers</td>
</tr>
<tr>
<td>12.0201</td>
<td>Flora / Fauna</td>
<td>Wetlands</td>
<td>Food Extractors</td>
</tr>
<tr>
<td>12.0202</td>
<td>Timber / Fiber / Natural Materials</td>
<td>Wetlands</td>
<td>Timber, Fiber, and Ornamental Extractors</td>
</tr>
<tr>
<td>12.0204</td>
<td>Presence of the Environment / Water</td>
<td>Wetlands</td>
<td>Industrial Dischargers</td>
</tr>
<tr>
<td>12.0206</td>
<td>Presence of the Environment</td>
<td>Wetlands</td>
<td>Resource-Dependent Business</td>
</tr>
<tr>
<td>12.0207</td>
<td>Flora / Fauna</td>
<td>Wetlands</td>
<td>Pharmaceutical and Food supplement Suppliers</td>
</tr>
<tr>
<td>12.0208</td>
<td>Fauna</td>
<td>Wetlands</td>
<td>Fur / Hide Trappers and Hunters</td>
</tr>
<tr>
<td>12.0302</td>
<td>Water</td>
<td>Wetlands</td>
<td>Waste Water Treatment Plant Operators</td>
</tr>
<tr>
<td>12.0303</td>
<td>Presence of the Environment</td>
<td>Wetlands</td>
<td>Residential Property Owners</td>
</tr>
<tr>
<td>12.0304</td>
<td>Presence of the Environment / Open Space</td>
<td>Wetlands</td>
<td>Military / Coast Guard</td>
</tr>
</tbody>
</table>

... and so on for an additional **14 FEGS triplets potentially provided by wetlands**
### Potential FEGS Provided by Forests

**Beneficiary Categories and Sub-Categories**

<table>
<thead>
<tr>
<th>Beneficiary Categories and Sub-Categories</th>
<th>Potentially Relevant NAICS Code(s)</th>
<th>General Beneficiary Description</th>
<th>Types of FEGS</th>
<th>Examples of FEGS</th>
<th>Importance of FEGS to the Beneficiary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agicultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.01 Agricultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.0107 Foresters</td>
<td>113</td>
<td>Foresters introduce tree cultivars and nurture those cultivars as they grow into trees, which are harvested. The rotation for the tree crops may be as short as 10 years or many decades.</td>
<td>soil, open space</td>
<td>suitable soil in which trees can be cultivated (NOT cultivated trees themselves)</td>
<td>suitable conditions (i.e., land) in which trees grow and to cultivate trees</td>
</tr>
<tr>
<td>21.02 Commercial / Industrial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.0201 Food Extractors</td>
<td>113, 114, 311, 312, 454</td>
<td>Food extractors utilize the natural abundance of edible organisms (i.e., non-cultivated or bred) for commercial use or sale. Includes commercial and native hunters (if legal). In aquatic environments, this beneficiary has potential contact with water.</td>
<td>flora, fauna, fungi</td>
<td>garlic mustard, pawpaw, blackberries, maple sap, deer, bear, rabbit, elk, grouse, turkey, boar</td>
<td>edible organisms (i.e., flowers, plants, etc.) or associated products (i.e., fruit, greens, tubers, berries, sap) for commercial use or sale, edible organisms (i.e., birds, mammals, reptiles, etc.) for commercial use or sale, edible organisms (i.e., mushrooms, shelf fungus, puffballs, etc.) for commercial use or sale</td>
</tr>
<tr>
<td>21.0202 Timber, Fiber, and Ornamental Extractors</td>
<td>113, 339, 424, 453, 454</td>
<td>Timber, fiber, and ornamental extractors rely on the environment for products used or sold commercially. Only non-cultivated, renewable material (i.e., NOT oil, ore, gems, etc.) are considered FEGS.</td>
<td>fiber, natural materials, timber</td>
<td>cork, rubber, lichens, mosses, firs, pines, oaks</td>
<td>non-cultivated fiber for commercial use or sale, non-cultivated ornamental products or by-products (from cultivation) used ornamentally for commercial use or sale, non-cultivated timber (i.e., trees) for commercial use or sale</td>
</tr>
<tr>
<td>21.0206 Resource-Dependent Businesses</td>
<td>487, 712, 713, 721, 722</td>
<td>Without the environment, this beneficiary would not have the opportunity for businesses, including marinas, stables, and ecotourism (e.g., rafting companies, hot air balloon companies, beach resorts, hot springs, ice hotels) - but not farm or forest land.</td>
<td>presence of the environment</td>
<td>opportunity for placement of infrastructure and reduced/increased risk of erosion, fire, and pest infestation on the property</td>
<td></td>
</tr>
</tbody>
</table>

- And so on... There are **15** additional FEGS triplets for forests
Formal List of Potential Forest FEGS (Stocks)

<table>
<thead>
<tr>
<th>Unique FEGS Code</th>
<th>Types of FEGS</th>
<th>Environmental Sub-Class</th>
<th>Beneficiary</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.0107:</td>
<td>Soil / Open Space – Forests</td>
<td>Forests</td>
<td>Foresters</td>
</tr>
<tr>
<td>21.0201:</td>
<td>Flora / Fauna / Fungi – Forests</td>
<td>Forests</td>
<td>Food Extractors</td>
</tr>
<tr>
<td>21.0207:</td>
<td>Flora / Fauna / Fungi – Forests</td>
<td>Forests</td>
<td>Pharmaceutical and Food supplement Suppliers</td>
</tr>
<tr>
<td>21.0208:</td>
<td>Fauna – Forests</td>
<td>Forests</td>
<td>Fur / Hide Trappers and Hunters</td>
</tr>
<tr>
<td>21.0304:</td>
<td>Presence of the Environment / Open Space – Forests</td>
<td>Forests</td>
<td>Military / Coast Guard</td>
</tr>
<tr>
<td>21.0502:</td>
<td>Flora / Fauna / Fungi – Forests</td>
<td>Forests</td>
<td>Food Subsisters</td>
</tr>
<tr>
<td>21.0602:</td>
<td>Flora / Fauna / Fungi – Forests</td>
<td>Forests</td>
<td>Food Pickers and Gatherers</td>
</tr>
<tr>
<td>... and so on for an additional 7 FEGS triplets potentially provided by forests</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Importance of FEGS and FEGS-CS

• FEGS minimize double-counting by focusing on **FINAL** services versus **INTERMEDIATE** services (e.g., ecological processes and functions).

• FEGS-CS defines specific **Environmental-Beneficiary-Types** of FEGS triplets.

• FEGS-CS facilitates the identification of metrics and indicators.
  – Contact ringold.paul@epa.gov for more information about this effort.

• FEGS-CS provides comprehensive standard lists of potential beneficiaries and/or potential FEGS that can be easily selected and customized.
The FEGS Approach is Broadly Applicable
The NESCS Conceptual Framework – The “Blue-Green Diagram”

Ecosystem Services Supply Side
- Physical Capital and Labor
- Intermediate Economic Production Function
- Final Economic Production Function

Ecosystem Services Demand Side
- Household Utility Function
- Final Economic Goods & Services /Products

Intermediate Economic Goods & Services /Products
- Capital and labor services

Natural Capital
- Ecological Production Function
- Ecological End-Products

Flows of Final Ecosystem Services

Final Economic Goods & Services /Products
- Human Well-Being
### National Ecosystem Services Classification System, Four-Group Structure

#### Environment
- **Aquatic**
  - Rivers and streams
  - Wetlands
  - Lakes and ponds
  - Near coastal marine
  - Open ocean and seas
  - Groundwater

- **Terrestrial**
  - Forests
  - Agroecosystems
  - Created greenspace
  - Grasslands
  - Scrubland/shrubland
  - Barren/rock and sand
  - Tundra
  - Ice and snow

- **Atmospheric**
  - Atmosphere

#### End-Products
- **Water**
  - Snow/ice
  - Liquid water

- **Flora**
  - Specific species of flora

- **Fauna**
  - Specific species of fauna

- **Other Biotic Natural Material**
  - Specific types of natural material

- **Atmospheric Components**
  - Air
  - Solar light/radiation

- **Soil**
  - Specific types of soil

- **Other Abiotic Natural Material**
  - Specific types of natural material

- **Combined End-Products**
  - -Scapes: views, sounds and scents of land, sea, sky
  - Regulation of extreme events
  - Natural phenomena
  - Presence of environmental class

- **Other End-Products**

#### Direct Use/Non-Use

##### Use
- **Extractive Use**
  - Raw material for transformation
  - Fuel/energy
  - Industrial processing
  - Distribution to other users
  - Support of plant or animal cultivation
  - Support of human health and life or subsistence
  - Recreation/tourism
  - Cultural/spiritual activities
  - Information, science, education, and research
  - Other extractive use

- **In-Situ Use**
  - Energy
  - Transportation medium
  - Support of plant or animal cultivation
  - Waste disposal/assimilation
  - Protection or support of human health and life
  - Protection of human property
  - Recreation/tourism
  - Cultural/spiritual activities
  - Aesthetic appreciation
  - Information, science, education, and research
  - Other in-situ use

##### Non-Use
- **Existence**
- **Bequest**

#### Direct User
- **Industries**
  - Agriculture, forestry, fishing and hunting
  - Mining
  - Utilities
  - Construction
  - Manufacturing
  - Wholesale and retail trade
  - Transportation and warehousing
  - Information
  - Finance and insurance
  - Real estate rental and leasing
  - Professional, scientific, and technical services
  - Management of companies and enterprises
  - Administrative support and waste management and remediation services
  - Educational services
  - Health care and social assistance
  - Arts, entertainment, and recreation
  - Accommodation and food services
  - Other services

- **Households**
- **Government**

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**NESCS-S**

**NESCS-D**
Proposed 4-Group NESCS Structure – “Wiring Diagram” with Proposed Metrics By Group

Example: (a) lake, river, or stream water for drinking – m³ fresh water (m³frshw)
(b) same water in composite viewing environment – degree natural/unbuilt

Environment

Aquatic
- Rivers and streams
- Wetlands
- Lakes and ponds
- Near coastal marine
- Open ocean and seas
- Groundwater

Terrestrial
- Forests
- Agroecosystems
- Created greenspace
- Grasslands
- Scrubland/shrubland
- Barren/rock and sand
- Tundra
- Ice and snow

Atmospheric
- Atmosphere

End-Products

Water
- Snow/ice
- Liquid water
- fresh water (13.12., 11.12.)
- metric: m³frshw

Flora
- Specific classes/species of flora

Fauna
- Specific classes/species of fauna

Other Biotic Components
- Specific types of natural material

Atmospheric Components
- Air
- Solar light/radiation

Soil
- Specific types of soil

Other Abiotic Components
- Specific types of natural material

Composite End-Products
- Scapes: views, sounds, scents of land, sea, sky
- beach envrnmt (13.81.)
- metric: degree natural/unbuilt
- Regulation of extreme events
- Presence of environmental class

Other End-Products

Direct Use/Non-Use

Use
- Extractive Use
  - Raw material for transformation
  - Fuel/energy
  - Industrial processing
  - Distribution to other users
  - Support of plant or animal cultivation
  - Support of human health and life or subsistence
  - freshwater (13.12.1106., 11.12.1106.)
  - metric: m³frshw
  - Recreation/tourism
  - Cultural/spiritual activities
  - Information, science, education, and research
  - Other extractive use

- In-Situ Use
  - Energy
  - Transportation medium
  - Support of plant or animal cultivation
  - Waste disposal/assimilation
  - Protection or support of human health and life
  - Protection of human property
  - Recreation/tourism
  - Cultural/spiritual activities
  - Aesthetic appreciation
  - Information, science, education, and research
  - Other in-situ use

Non-Use
- Existence
- Bequest
- Other non-use

Direct User

Industries
- Agriculture, Forestry, Fishing and Hunting
- Mining
- Utilities
- Construction
- Manufacturing
- Wholesale Trade
- Retail Trade
- Transportation and Warehousing
- Information
- Finance and Insurance
- Real Estate Rental and Leasing
- Professional, Scientific, and Technical Services
- Management of Companies and Enterprises
- Administrative Support and Waste Management and Remediation Services
- Educational Services
- Health Care and Social Assistance
- Arts, Entertainment, & Recreation
- Accommodation & Food Services
- Other Services

Households
- fresh water (13.12.1106.201, 11.12.1106.201)
- metric: m³frshw / effort
  satisfaction / $-equiv. source at intake

Government

- fresh water (13.81.1209.201)
- metric: degree natural/unbuilt
  satisfaction / $-equiv. source at intake

- beach environment (13.81.1209.)
- metric: degree natural/unbuilt/access
  satisfaction / $-equiv. source at intake

- Other

Stock indicators, Flow indicators, Quality indicators, Site indicators, Indicators Characterizing
Extreme Events

Flow of Final Ecosystem Services

NESCS-S

NESCS-D
## Inland (Freshwater) Wetland

<table>
<thead>
<tr>
<th>General Wetland Characteristics for “Common List”</th>
<th>Examples</th>
<th>NESCS 4-Group Designation relevant combinations: environment—end-product—use—user</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wildlife</strong></td>
<td>Birds, fish, insects for harvest, catch-and-release, research, or viewing</td>
<td>Wetland-fauna-extractive/in-situ-households</td>
</tr>
<tr>
<td><strong>Vegetation</strong></td>
<td>Wetland plants for harvest, research, or viewing</td>
<td>Wetland-flora-extractive/in-situ-households</td>
</tr>
<tr>
<td><strong>Characteristic Open Space/“-scape”</strong></td>
<td>Wetland as enjoyable or inspirational landscape</td>
<td>Wetland-composite-end-product-in-situ-households</td>
</tr>
<tr>
<td><strong>Water quality</strong></td>
<td>Extraction, distribution, scenic amenity</td>
<td>Wetland-liquid-water-extractive/in-situ-(any)</td>
</tr>
<tr>
<td><strong>Flood surge (reduction)</strong></td>
<td>Protect or support human health or life (1205), protect human property (1206)</td>
<td>Wetland-composite-end-product-(any)</td>
</tr>
<tr>
<td><strong>Groundwater (quantity)</strong></td>
<td>recharge/flow from wetland absorption is <em>intermediate</em> ecological process</td>
<td>Groundwater-liquid-water-extractive/raw material-(any)</td>
</tr>
<tr>
<td><strong>Freshwater (surface flow volume)</strong></td>
<td>recharge/flow from wetland absorption is <em>intermediate</em> ecological process</td>
<td>River/stream-liquid-water-extractive/raw material-(any)</td>
</tr>
<tr>
<td><strong>Existence/bequest for each of previous two</strong></td>
<td></td>
<td>Groundwater-liquid-water-nonuse-households, River/stream-liquid-water-nonuse-households</td>
</tr>
<tr>
<td>Wetland- <strong>fauna</strong>- extractive/in-situ-households</td>
<td>12.31.1yyy.201, 12.31.1yyy.1zzzzzz</td>
<td></td>
</tr>
<tr>
<td>Wetland- <strong>flora</strong>- extractive/in-situ-households</td>
<td>12.21.1yyy.201, 12.21.1yyy.1zzzzzz</td>
<td></td>
</tr>
<tr>
<td>Wetland- <strong>composite end product</strong>- in-situ-households</td>
<td>12.81.1207(/08/09).201</td>
<td></td>
</tr>
<tr>
<td>Wetland- <strong>liquid water</strong>- extractive/in-situ-(any)</td>
<td>12.12.1yyy.1zzzzzz, 12.12.1yyy.201</td>
<td></td>
</tr>
<tr>
<td>Wetland- <strong>composite end product</strong>- in-situ-(any)</td>
<td>12.82.1205(/6).1zzzzzz</td>
<td></td>
</tr>
<tr>
<td>Wetland- <strong>fauna</strong>- nonuse-households, Wetland- <strong>flora</strong>- nonuse-households, Wetland- <strong>composite end product</strong>- nonuse-households, Wetland- <strong>liquid water</strong>- nonuse-households, Wetland- <strong>composite end product</strong>- nonuse-households</td>
<td>12.31.21(/2).201, 12.21.21(/2).201, 12.81.21(/2).201, 12.12.21(/2).201, 12.82.21(/2).201</td>
<td></td>
</tr>
<tr>
<td>Groundwater- <strong>liquid water</strong>- extractive/raw material-(any)</td>
<td>16.12.11yy.1zzzzzz, 16.12.1106.201</td>
<td></td>
</tr>
<tr>
<td>River/stream- <strong>liquid water</strong>- extractive/raw material-(any)</td>
<td>11.12.11yy.1zzzzzz, 11.12.1106.201</td>
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</tr>
<tr>
<td>General Forest Characteristics for “Common List”</td>
<td>Examples</td>
<td>NESCS 4-Group Designation relevant combinations: environment—end-product—use—user</td>
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<td>--------------------------------------------------</td>
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</tr>
<tr>
<td><strong>Wildlife</strong></td>
<td>Mammals, Birds, etc. for harvest, catch-and-release, research, or viewing</td>
<td>Forest-fauna-extractive/in-situ-households</td>
</tr>
<tr>
<td><strong>Vegetation</strong></td>
<td>Forest plants for harvest, research, or viewing</td>
<td>Forest-flora-extractive/in-situ-households</td>
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<tr>
<td><strong>Characteristic Open Space/“-scape”</strong></td>
<td>Forest as enjoyable or inspirational landscape</td>
<td>Forest-compositeendproduct-in-situ-households</td>
</tr>
<tr>
<td><strong>Other Biotic Material</strong></td>
<td>Extraction, distribution, scenic amenity</td>
<td>Forest-otherbioticmaterial-extractive/in-situ-(any)</td>
</tr>
<tr>
<td><strong>Erosion/Flood surge (reduction)</strong></td>
<td>Protect or support human health or life (1205), protect human property (1206)</td>
<td>Forest-compositeendproduct-in-situ-(any)</td>
</tr>
<tr>
<td><strong>Existence/bequest for each of previous five</strong></td>
<td></td>
<td>Forest-fauna-nonuse-households, Forest-flora-nonuse-households, Forest-compositeendproduct-nonuse-households, Forest-otherbioticmaterial-nonuse-households, Forest-compositeendproduct-nonuse-households</td>
</tr>
<tr>
<td><strong>Air purification flows outside of forest</strong></td>
<td>flow of cleaner air away from forest, makes forest air cleansing an intermediate ecological process</td>
<td>Atmospheric-air-in-situ(supportinghealth)-households</td>
</tr>
<tr>
<td><strong>Existence/bequest for previous</strong></td>
<td></td>
<td>Atmospheric-air-nonuse-households</td>
</tr>
<tr>
<td>Formal List of Potential Forest FFES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------</td>
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<td></td>
</tr>
<tr>
<td><strong>NESCS 4-Group Designation</strong></td>
<td><strong>NESCS User Codes and Combinations</strong></td>
<td></td>
</tr>
<tr>
<td>relevant combinations:</td>
<td><em>ww.</em> <em>xx.</em> <em>yyyy.</em> <em>zzzzzz</em></td>
<td></td>
</tr>
<tr>
<td>environment—end-product—use—user</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Forest-fauna</strong>-extractive/in-situ-households</td>
<td>21.31.1yyy.201, 21.31.1yyyy.1zzzzzz</td>
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<tr>
<td><strong>Forest-flora</strong>-extractive/in-situ-households</td>
<td>21.21.1yyy.201, 21.21.1yyyy.1zzzzzz</td>
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<tr>
<td><strong>Forest-composite end product</strong>-in-situ-households</td>
<td>21.81.1207/(08/09).201</td>
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<tr>
<td><strong>Forest-other biotic material</strong>-extractive/in-situ-(any)</td>
<td>21.12.1yyy.1zzzzzz, 21.12.1yyyy.201</td>
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<tr>
<td><strong>Forest-composite end product</strong>-in-situ-(any)</td>
<td>21.82.1205/(6).1zzzzzz</td>
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<td><strong>Forest-fauna</strong>-nonuse-households,</td>
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<td><strong>Forest-other biotic material</strong>-nonuse-households,</td>
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<tr>
<td><strong>Atmospheric-air</strong>-in-situ(supporting health)-households</td>
<td>31.51.1205.201</td>
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<tr>
<td><strong>Atmospheric-air</strong>-nonuse-households</td>
<td>31.51.21/(2).201</td>
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</table>
Questions?

The FEGS-CS and NESCOs teams are looking for other teams within the ES community to assist in the move from lists to wider identification of final ES and of useful metrics.


Dixon Landers – EPA’s Office of Research and Development, Western Ecology Division, Corvallis, OR. landers.dixon@epa.gov; 541-754-4427.

EPA’s Office of Research and Development, as part of the Sustainable and Healthy Communities Program, is working to define metrics and indicators for Final Ecosystem Services both at the community and national scale. Contact for this work is Dr. Paul Ringold at the Western Ecology Division, Corvallis, OR. Ringold.paul@epa.gov; 541-754-4565.