National Ecosystem Services Classification System (NESCS)

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NESCS – Objectives

- Primarily aid in analyzing the welfare impacts of policy-induced changes in ecosystems, e.g. Cost Benefit Analysis (CBA)
- Analyzing the human welfare gains (benefits) of an environmental policy typically entails identifying, quantifying, and, in many cases, valuing changes in ecosystems and their contributions to human welfare (USEPA, 2009)
 - Identification requires systematically linking changes to ecosystems to changes in human well-being
 - Defining and grouping these linkages is the main focus of the ecosystem services classification literature
- Focus of NESCS:
 - Provide a classification system that will primarily support the identification step but, in the process, also facilitate the quantification and valuation steps

Other Ecosystem Service Classification Systems

- Since Daily et al. (1997), a variety of ecosystem service definitions and classification approaches
 - de Groot et al. (2002), Millennium Ecosystem Assessment (MA) (2005),
 Wallace (2007), Boyd and Banzhaf (2007), Fisher and Turner (2008),
 Haines-Young and Potschin (2010), Landers and Nahlik (2013)
- General agreement that human well-being is supported by ecosystems
- Disagreement on where ecosystem services occur along continuum between ecosystems to human well-being
 - ecosystem services vs. intermediate ecosystem processes/functions
 - ecosystem services vs. economic goods vs. human benefits
- Lack of consistency in definition leads to issues in CBA
 - There is "a common lack of clarity in defining and valuing final ecosystem services, which has contributed to inconsistent valuations that double count some benefits and omits others" (Johnston and Russell,2011)

Guidelines for Developing NESCS

- 1. General principles and best practices for classification systems
 - Categories should be exhaustive and mutually exclusive (UN Department of Economic And Social Affairs, 1999)
- 2. Widely-accepted concepts for classification and accounting of service flows in an economic context
 - Unlike goods, services are typically intangible, non-storable, and inseparable from provider and consumer.
 - Services are typically viewed as "flows" from the producer to the consumer and are measured over a period of time
- 3. The concept of final ecosystem services described in Boyd and Banzhaf (2007) and applied in FEGS-CS

Flows of Final Ecosystem Services (FFES)

- NESCS focuses on classifying flows of final ecosystem services (FFES)
 - Direct contributions made by nature to human production processes or to human well-being
- This concept emphasizes key distinctions between
 - intermediate processes, final ecosystem services and economic goods/services
 - stocks and flows
- To identify and define FFES, need to identify producers (or "Supply-Side") and consumers (or "Demand-Side") of the service
 - Similar distinction made in classification systems in economic sector
 - Two complementary components in NESCS :
 - NESCS-S: ecosystems and ecosystem end-products
 - NESCS-D: human uses and users of ecosystems and their end-products
- FFES: Defined at the "point of direct hand-off" between natural and human systems
 - Anything that is produced using human inputs and sold in markets is NOT FFES
 - Some grey areas between two systems e.g., planted forests, national parks

Two Main Tools Provided by NESCS

- <u>Conceptual framework</u> describes the main pathways through which ecosystems impact human well-being
 - Represented by a flow diagram showing linkages between natural systems (ecosystems) and human (market production and household) systems
- <u>Classification structure</u> provides categories and numeric codes that identifies Flows of Final Ecosystem Services (FFES) by defining and combining 4 main classification groups
 - 1. Environment
 - 2. End-products
 - 3. Direct human uses
 - 4. Direct human users

Conceptual Framework for NESCS



Example Illustrating the Conceptual Framework



NESCS 4-Group Classification Structure

Environment

Rivers and streams

Lakes and ponds

Open ocean and

Agroecosystems

Barren/rock and

Grasslands

Created greenspace

Scrubland/shrubland

Groundwater

Near coastal marine

Wetlands

seas

Terrestrial

Forests

sand

Tundra

Atmospheric

Atmosphere

Ice and snow

Aquatic

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End-products

Snow/ice

Water

Liquid water

Flora

· Specific classes/species of flora

Characterizing

Indicators

Quality Indicators, Site Indicators,

Flow Indicators,

Flows of

Final

Ecosystem

Services

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 and scents of land, sea, sky
- Regulation of extreme events
- Stock indicators, 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
- 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, ٠ 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 ٠
- Health Care and Social • Assistance
- Arts, Entertainment, and Recreation
- Accommodation and Food Services
- Other Services

Households

Government

Environmental Classes: Which ecosystems "produce" which ecological end-products?

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

- Same as FEGS-CS
- Reviewed existing classifications for each FEGS-CS category (e.g. Wetlands, etc.)
- Found that there were numerous classification systems built for different purposes
 - Some applied purely biophysical criteria and some applied human use-based criteria for defining categories and subcategories
- At this point, not productive to include more detailed categories

Ecological End-products: What are the biophysical outcomes of nature that humans directly use and care about?

Water

- Snow/ice
- Liquid water

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 and scents of land, sea, sky
- Regulation of extreme events
- Presence of environmental class

Other end-products

Distinguishes between "Final" and "Intermediate"

What is "final" is specific to the ways in they are used by human beings (NESCS –D).
 E.g. water is an end-product when we consider drinking water, but for recreational uses, fish is the relevant end-product.

Challenging to identify exactly what people care about – where to draw the boundaries? Hard to define mutually exclusive categories !

- "Composite end-products": People may care about flora, fauna, water, etc.
 - BUT may care about <u>combinations</u> of these
 - AND different people may care about different combinations

Direct Uses: What are the main ways in which humans directly use and appreciate these end-products?

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
- Other non-use

- Some direct uses may apply to multiple different endproducts
 - E.g., the end -products water and air are both directly used for energy
- Some direct uses may apply to multiple direct users
 - E.g., direct use of water for industrial processing (cooling) could apply to many NAICS categories

Direct Users: Which sectors are involved in direct uses?

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, and Recreation
- Accommodation and Food Services
- Other Services

Households

Government

- Similar to UN and US Census Bureau
 - Industries (NAICS Codes), Households, Government
- One category for households: Households do not specialize, unlike industries
 - If an industrial establishment has multiple activities, then the classification of an establishment is determined by its "primary activity"
 - The primary activity of a hotel is lodging, but it may also include a restaurant serving meals and beverages

NESCS Classification Structure and Numeric Coding

	NESC	S-S	NESCS-D							
Group	Environment	End-product	Direct Use/Non-use	Direct User						
Definition	Landscapes where end-products occur on the surface of the Earth, or producers of "end-products"	Biophysical components of nature that are directly used or appreciated by humans	Different ways in which end-products are used or appreciated by humans	Sectors that directly use or appreciate the end-products						
Hierarchy and Coding System NESCS Category Representation*: WW.XX.YYYY.ZZZZZZZ										
Class	W	WW.X	WW.XX.Y	WW.XX.YYYY.Z						
Sub-Class	WW	WW.XX	WW.XX.YY	WW.XX.YYYY.ZZZ						
Detail			WW.XX.YYYY	WW.XX.YYYY.ZZZZZZ						
Example 1 NESCS Code = 15.12.1202.1483111										
Class	Aquatic: 1	Water: 1	Direct Use: 1	Industry: 1						
Sub-Class	Open Ocean and Seas: 15	Liquid Water: 12	In-Situ Use: 12	Transportation and Warehousing: 148						
Detail			Transportation medium: 1202	Deep Sea Freight Transportation: 1483111						
Example 2 NESCS Code = 11.12.1105.201										
Class	Aquatic: 1	Water: 1	Direct Use: 1	Households: 2						
Sub-Class	Rivers and Streams: 11	Liquid Water: 12	Extractive Use: 11	Households: 201						
Detail			Support of plant or animal cultivation: 1105							

* Note that the 15 digit code is the most disaggregated level of representation. Different levels of aggregation can be used depending on the context

NESCS Applied to Atmospheric N and S Deposition



Applying Framework: Identify Potential Pathways Impacted by Reduced Aquatic Acidification





Environmental and End-products Classes Likely to be Impacted by Acidification

Environmental Class	Environmental Sub-Class	End-product Class	End-product Sub-Class Examples
1. Aquatic	11. Rivers and Streams	3. Fauna	Fish
	13. Lakes and Ponds		Waterfowl
2. Terrestrial	21. Forests	2. Flora Sugar maple trees	
			Red spruce trees

Direct Uses and Users Likely to be Impacted by (Aquatic) Acidification

End-product Sub-Class	Direct Use/Non-use	Direct Use/Non-use		Examples of Direct	Direct User	
Example	Class	Sub-Class	Direct Use/Non-use Detail	Uses/Non-use	Class	Direct User Sub-Class
Fish	1. Direct Use	11. Extractive Use	1104. Distribution to other users	Commercial fishing	1. Industry	111. Agriculture, Forestry, Fishing and Hunting
			1106. Support of human health and life or subsistence	Subsistence fishing	2. Households	201. Households
			1107. Recreation/tourism	Recreational fishing	1. Industry	148–49. Transportation and Warehousing
						171. Arts,
						Entertainment, and
						Recreation
						172. Accommodation
						and Food Services
					2. Households	201. Households
		12. In-situ Use	1207. Recreation/tourism	Catch and release fishing	1. Industry	148–49. Transportation and Warehousing
				Ū.		171. Arts,
						Entertainment, and
						Recreation
						172. Accommodation
						and Food Services
					2. Households	201. Households
	2. Non-use	21. Existence	2101. Existence	Existence use	2. Households	201. Households
		22. Bequest	2201. Bequest	Bequest use	2. Households	201. Households

NESCS can support CBA in the following main ways:

- Conceptual framework helps provide consistency and clarity in defining FFES
- Designed to avoid double counting of ecosystem services and omitted categories
- NESCS-S and NESCS-D provide links to ecological and valuation models
- Numeric codes and framework help reference and illustrate pathways easily
- Provides tools and structure for storing values obtained from elsewhere

Other Applications:

Not primary focus but... may provide useful framework for different types of green accounts

- Green GDP accounts:
 - Expand NIPA accounts to include ecosystem services
- Private sector micro-level environmental accounts:
 - Account for the role ecosystem services in corporate performance
 - Measure the impacts of private sector activities on ecosystem services

• Questions?? Comments??