Presentation for the E3B Graduate Seminar

Ecological Foundations of Payment for Ecosystem Service Schemes

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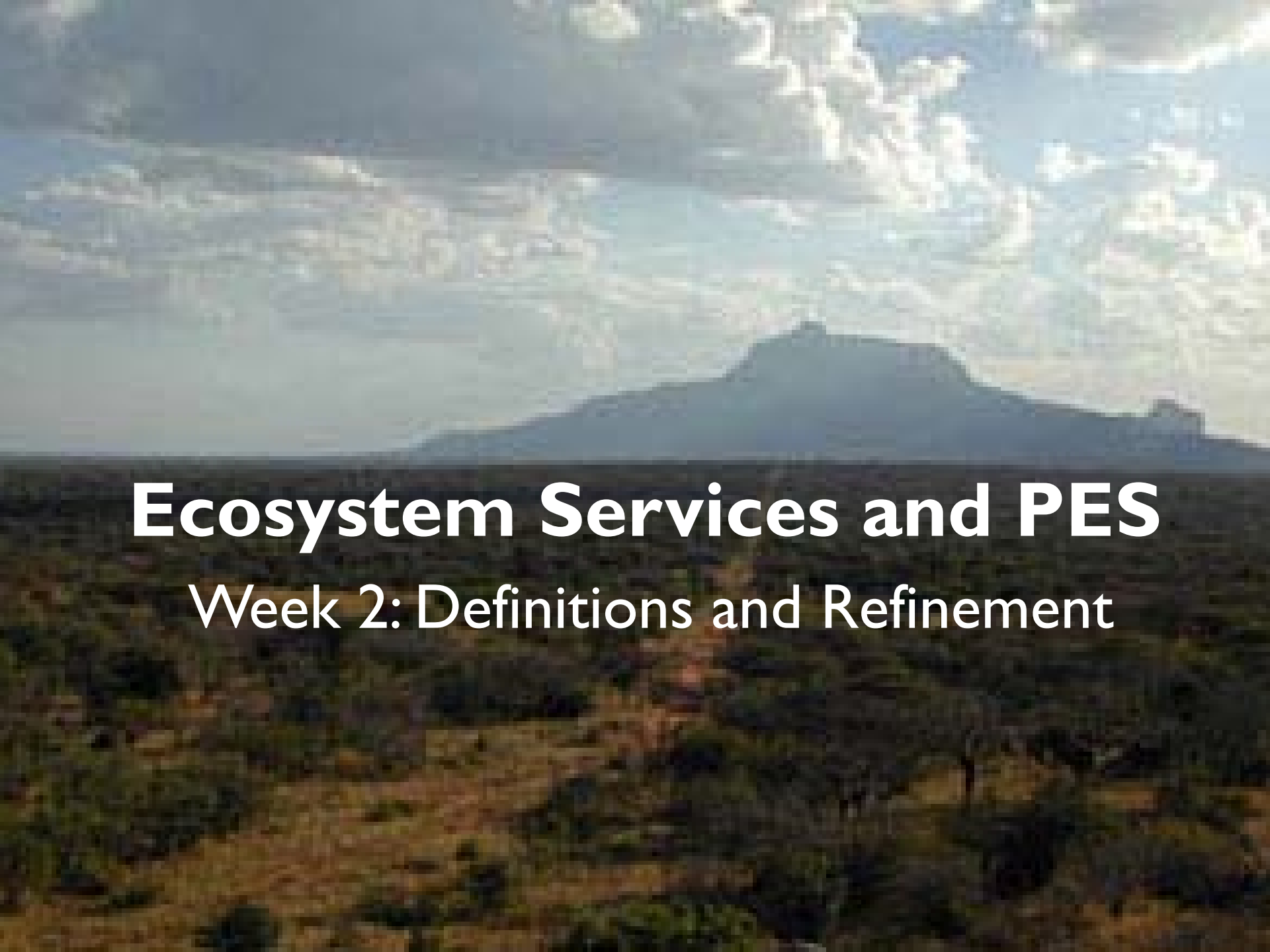

Ecosystem Services and PES

Week 2: Definitions and Refinement

Defining the importance of context and purpose

- Definitions and Classifications of Ecosystem Services influence their utility for decision making

- What should the purpose of our classification be?
  - Education, Cost-Benefit Analysis, Landscape Management/Conservation, Poverty Reduction/Human Welfare, Multiple Objectives, Others?

Definitions of Ecosystem Services

- Conditions and processes through which natural ecosystems and the species that make them up, sustain and fulfill human life (Daily 1997)
- The benefits people obtain from ecosystems (MA, 2005)
- The benefits that people derive directly or indirectly from ecosystem functions (Costanza et al.,1997)
- The aspects of ecosystems utilized (actively or passively) to produce human well being (Fisher et al. 2009)
- The ecological components directly consumed or enjoyed to produce human well-being (Boyd and Banzhaf, 2007)

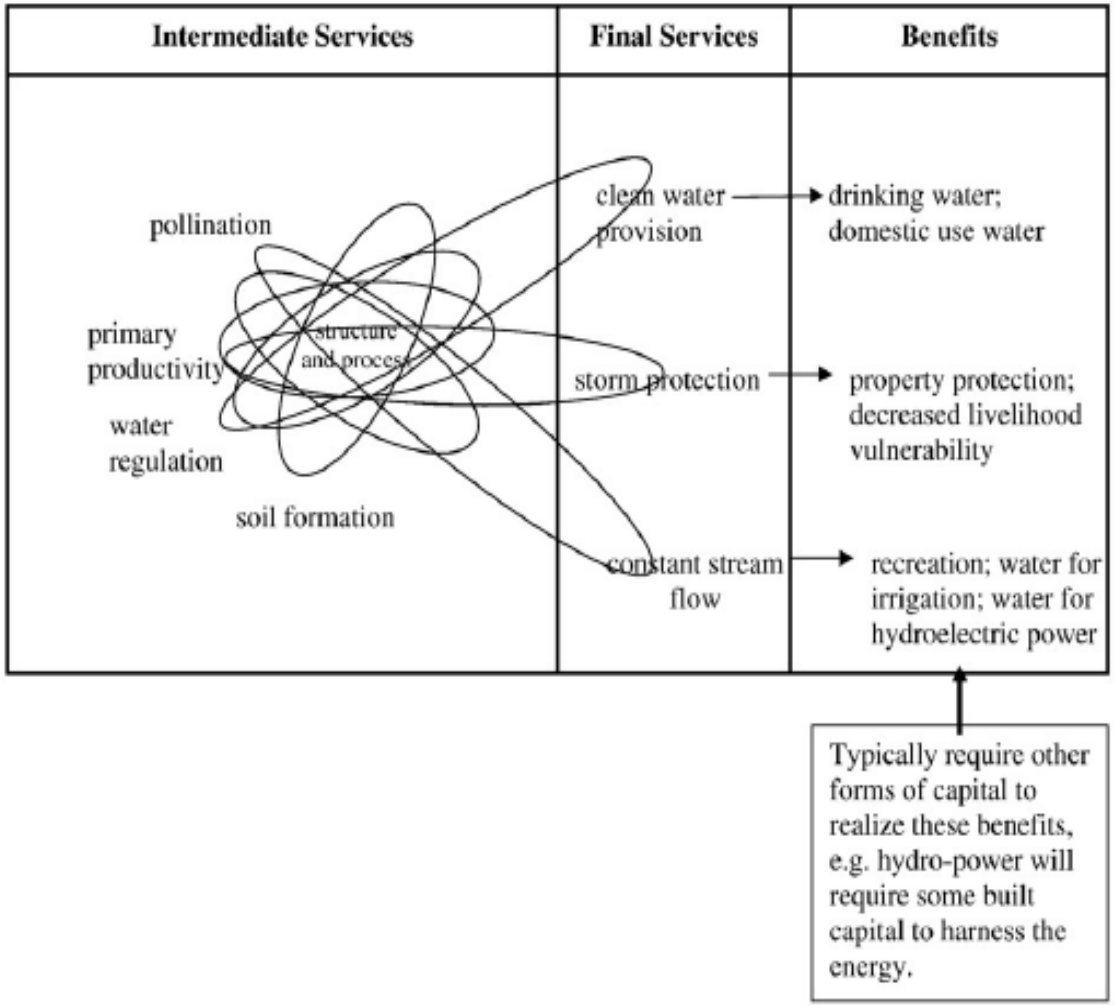

Fig. 3 – Conceptual relationship between intermediate and final services, also showing how joint products (benefits) can stem from individual services. Intermediate services can stem from complex interactions between ecosystem structure and processes and lead to final services, which in combination with other forms of capital provide human welfare benefits.

- From Fisher et al. 2009

Classification Guidelines Recommended by Fisher et al. 2009

- Classification should be informed by:
  - Clear and robust definition of ecosystem services
  - Characteristics of the ecosystem or ES under investigation
  - "decision context" for which ES are being considered

Characteristics of ES (drawing from Fisher et al. 2009 and Costanza 2008)

- Public-Private Good aspect (Excludability and Rivalness)
- Spatial and temporal aspects
- Joint production
- Complexity
- Benefit Dependence

(All of these may interact in complex ways)

***Note Costanza refers to two of these as classification schemes*

Classification by Excludability and Rivalness

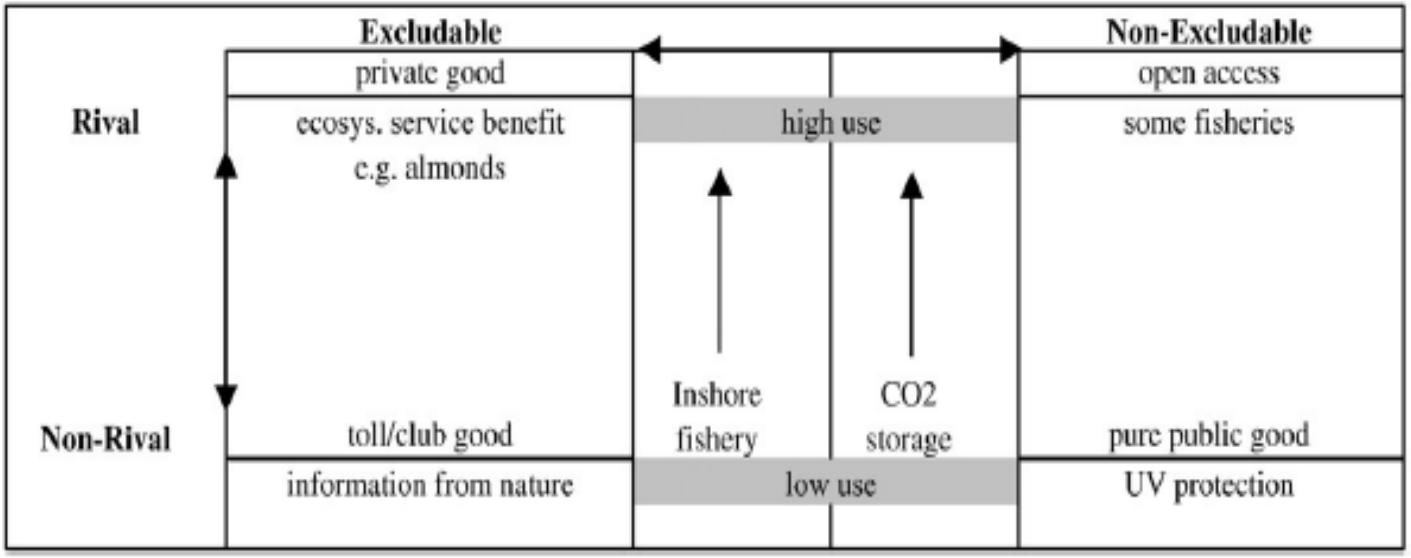

Fig. 4 – Goods and services can be characterized along a continuum from rival to non-rival and from excludable to non-excludable. Some goods that are non-rival at low use levels (fisheries and CO_2 storage) can move towards becoming rival goods with high use.

- Presented in Fisher et al. 2009; Similar idea presented in Costanza 2008

Spatial Aspects of Ecosystem Services

Table 1 – EcoServices classified according to their spatial characteristics

1. *Global non-proximal (does not depend on proximity)*
1&2. Climate regulation
Carbon sequestration (NEP)
Carbon storage
17. Cultural/existence value

2. *Local proximal (depends on proximity)*
3. Disturbance regulation/ storm protection
9. Waste treatment
10. Pollination
11. Biological control
12. Habitat/refugia

3. *Directional flow related: flow from point of production to point of use*
4. Water regulation/flood protection
5. Water supply
6. Sediment regulation/erosion control
8. Nutrient regulation

4. *In situ (point of use)*
7. Soil formation
13. Food production/non-timber forest products
14. Raw materials

5. *User movement related: flow of people to unique natural features*
15. Genetic resources
16. Recreation potential
17. Cultural/aesthetic

- From Costanza 2008

Typology Guidelines (Wallace, 2007)

1. A minimum set of sharply defined terms that effectively encompass the topic.

2. Clarity concerning the terms used to characterize services.

3. Specification of the point at which linked processes deliver a service.

Classification Proposed by Wallace (2007)

Table 3 – Proposed classification of ecosystem services and links to human values, ecosystem processes, and natural assets

Category of human values	Ecosystem services – experienced at the individual human level	Examples of processes and assets that need to be managed to deliver ecosystem services
Adequate resources	• Food (for organism energy, structure, key chemical reactions) • Oxygen • Water (potable) • Energy (eg, for cooking – warming component under physical and chemical environment) • Dispersal aids (transport)	*Ecosystem processes* • Biological regulation • Climate regulation • Disturbance regimes, including wildfires, cyclones, flooding • Gas regulation • Management of "beauty" at landscape and local scales. • Management of land for recreation • Nutrient regulation • Pollination • Production of raw materials for clothing, food, construction, etc. • Production of raw materials for energy, such as firewood • Production of medicines • Socio-cultural interactions • Soil formation • Soil retention • Waste regulation and supply • Economic processes
Protection from predators/disease/parasites	• Protection from predation • Protection from disease and parasites	
Benign physical and chemical environment	Benign environmental regimes of: • Temperature (energy, includes use of fire for warming) • Moisture • Light (eg, to establish circadian rhythms) • Chemical	
Socio-cultural fulfilment	Access to resources for: • Spiritual/philosophical contentment • A benign social group, including access to mates and being loved • Recreation/leisure • Meaningful occupation • Aesthetics • Opportunity values, capacity for cultural and biological evolution – Knowledge/education resources – Genetic resources	*Biotic and abiotic elements* Processes are managed to provide a particular composition and structure of ecosystem elements. Elements may be described as natural resource assets, eg: • Biodiversity assets • Land (soil/geomorphology) assets • Water assets • Air assets • Energy assets

Ecosystem services consistently relate to specific human values, but processes and assets do not. Most processes and assets contribute to a wide range of services.

SPUs proposed by Luck et al (2009)

Table 2. Key examples from the literature of explicit or implicit links with ecosystem services.

Service	Ecosystem [level of organization]	Service provider [level of organization]	Service-provider characteristics	Supporting element	Response measure	Relationship	Reference
Biological control	Agroecosystem [apple orchards]	Great tit [population]	Density of breeding pairs[a]	Density of nest boxes[b]	Caterpillar damage to apples	Control vs. treatment	Mols and Visser 2007
Biological control	Agroecosystem [coffee plantation]	Azteca ant	Green scale [population]	Activity level[c]	Shade trees[d] Number of scale[e]	Time to removal[f] Linear[g]	Perfecto and Vendermeer 2006
Biological control	Agroecosystem [rice fields]	Egg parasitoids [functional group]	Abundance of predators and parasitoids[h]	Presence of parasitoid and absence of predator	Leaf and plant-hopper abundance	Control under negative impact of predators on parasitoids[i]	Drechsler and Settele 2001
Pollination	Agroecosystem [watermelon crops]	Native bees[j] [functional group]	Functional group, species-specific visitation rates and efficiencies[k]	Upland habitat[l]	Pollen deposition[m]	Saturating, exponential increasing[n]	Kremen et al. 2002 (also see Kremen et al. 2004), Larsen et al. 2005
Pollination	Agroecosystem [coffee plantation]	Native and exotic bees [functional group]	Functional group dynamics[o]	Tropical forest[p]	Seed mass, fruit set, peaberry frequency, pollen deposition (number of visits per flower), bee species richness	Comparative[q]	Ricketts et al. 2004
Pollination	Agroecosystem [atemoya crops]	Nitidulid beetles[r] [functional group]	Functional group dynamics[s]	Rainforest	Beetle species richness[t]	Exponential decay[u]	Blanche and Cunningham 2005
Pollination	Agroecosystem [canola fields]	Wild bees [functional group]	Functional group dynamics[v]	Uncultivated land[w]	Bee abundance, seed set	Linear[x] Saturating[y]	Morandin and Winston 2006
Waste decomposition	Agroecosystem [rice fields]	Mallard [population]	Population density[z]		Residual surface straw[aa], structure of surface straw[ab], chemical composition[ac]	Control vs. treatment Control vs. treatment Control vs. treatment	Bird et al. 2000
Water regulation	Forest/terrestrial	Terrestrial vegetation [community]	Soil-slope-vegetation complex	Water regulation, hydroelectricity generation		Comparative[ad]	Guo et al. 2000
Water filtration	Freshwater	Forest [community]	Forest cover[ae]		Water and sediment nutrients	Various	Houlahan and Findlay 2004
Seed dispersal	Oak forest	Eurasian jay [population]	Population abundance[af]	Oak and coniferous forest[ag]	Oak saplings	n/a	Hougner et al. 2006
Seed dispersal	Tropical forest	Insular flying fox [population]	Flying fox abundance index[ah] = 0.77 to 0.81		Chewed diaspores[ai]	Threshold	McConkey and Drake 2006

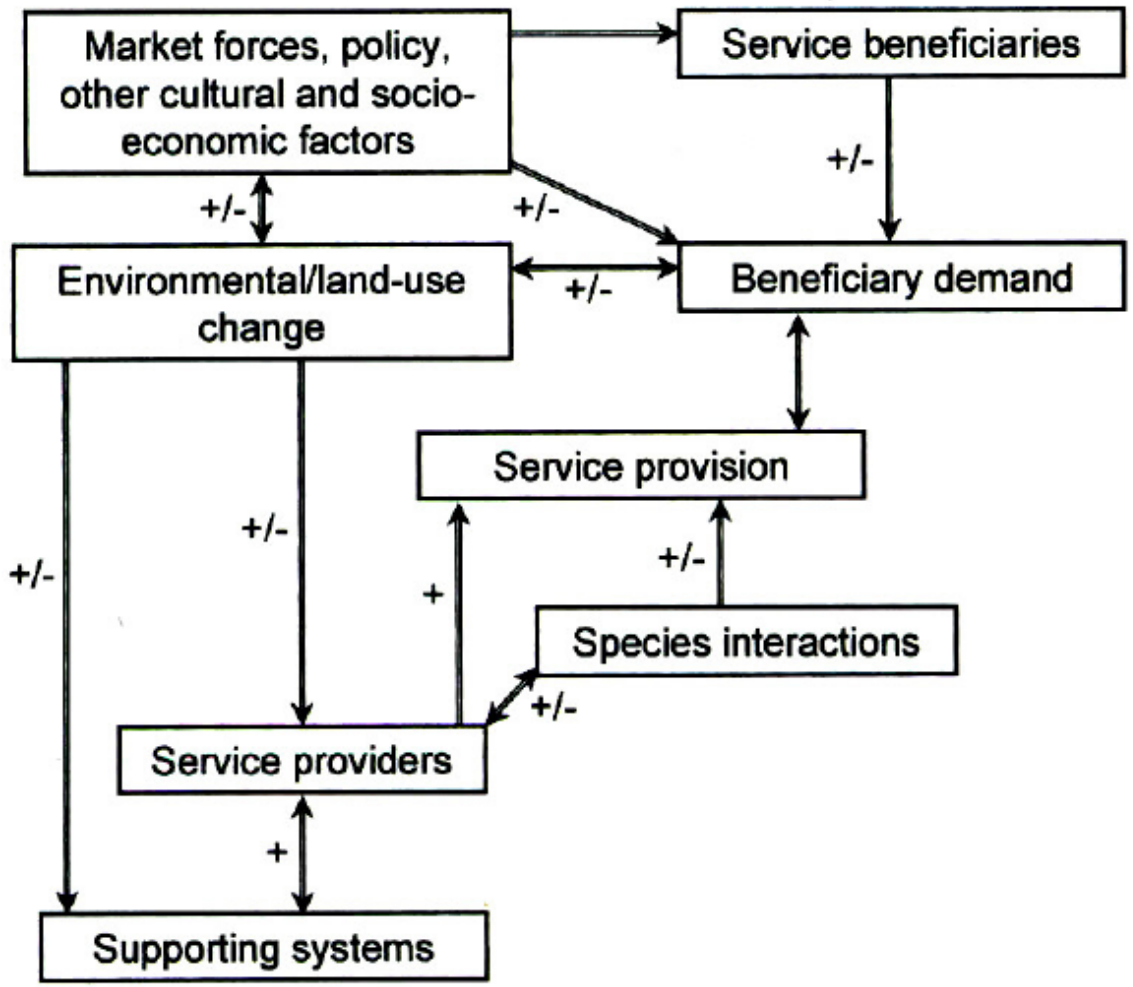

Figure 2. A conceptual model showing the links and positive or negative interactions among the socioeconomic and ecological factors of service provision. Cultural, social, and economic factors frame the needs of service beneficiaries and influence the demand for services. This demand is met through service provision, which is a result of service-provider characteristics, species interactions, and supporting systems. Environmental change, which is driven by but can also alter

Type of Market and Spatial location

	Individual	Regulatory	Government run
Global non-proximal			
Local proximal			
Directional Flow related			
In situ			
User movement related			

Discussion Questions

- How well integrated is ecology in these typologies/classification schemes?
- Which, if any, typologies/classification frameworks might be a useful starting point for analyzing the role of ecology in PES effectiveness?
- How should we break into groups to address overall questions of the class? (Regionally? Type of service group?)