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Letter to the Editor

# Ecosystem services: Multiple classification systems are needed

In a recent paper in *Biological Conservation*, Wallace (2007) argues that the classification systems currently used for ecosystem services are inadequate because they mix ends and means. He then proposes a system to rectify this perceived problem. While there is much interesting material in Wallace's paper, his basic premise is flawed and much of the paper suffers from a gross oversimplification of a complex reality. Wallace's solutions to the classification problem might work if the world had consistently crisp boundaries, static linear processes with no feedbacks, clear distinctions between means and ends, little uncertainty, only one use for the classification system, and people who always knew both everything about the world and how it all affects their welfare – in other words some very different planet from the one we inhabit. In the messy world we do inhabit, we need multiple classification systems for different purposes, and this is an opportunity to enrich our thinking about ecosystem services rather than a problem to be defined away.

Let us start with definitions. Ecosystem services are defined as "the benefits people obtain from ecosystems" (Millennium Ecosystem Assessment, 2005). I think this is a good, appropriately broad and appropriately vague definition. This definition includes both the benefits people perceive, and those they do not. The conventional economic approach to "benefits" is far too narrow in this regard, and tends to limit benefits only to those that people both perceive and are "willing to pay" for in some real or contingent sense. But the general population's information about the world, especially when it comes to ecosystem services, is extremely limited. We can expect many ecosystem services to go almost unnoticed by the vast majority of people, especially when they are public, non-excludable services that never enter the private, excludable market. Think of the storm regulation value of wetlands. How can we expect the average citizen to understand the complex linkages between landscape patterns, precipitation patterns, wetlands and flood attenuation, when even the best landscape scientists find this an extremely challenging task? We have to remain focused on the benefits provided by ecosystems, remembering that the degree to which the public perceives and understands them is a separate (and very important) question.

A second problem is that ecosystem services are not *ends*, while ecosystem processes are *means*, as Wallace suggests. The end or goal is sustainable human well-being. Ecosystem services are, *by definition*, means to that end. This does not imply that ecosystems are not also valuable for other reasons, but that ecosystem *services* are *defined* as the instrumental values of ecosystems as means to end of human well-being. The distinction Wallace (and also Boyd and Banzhaf, 2007) are really trying to make, i believe, is one between *intermediate* services and *final* services, not between means and ends. It is true that for the purposes of certain aggregation exercises adding intermediate and final services would be double counting. But that does not imply that intermediate services are not services. Think of the production of tires in an economy. Some tires are sold directly to consumers and are part of final demand, while others are sold to car companies and are intermediate products, sold to consumers as parts of cars. The tires themselves are indistinguishable from each other, the only difference being who buys them. When calculating GNP (which is the aggregate of sales to final demand) it would not be appropriate to count both the tires sold to final demand and the tires sold to car companies, since those tires are already counted as parts of the cars sold to final demand. But tires in both cases, whether intermediate or final products, are means to the end of human well-being and are not ends in themselves. Likewise, ecosystem goods and services, whether intermediate (or "supporting" in the Millennium Assessment typology) services or final services are all contributors to the end of human well-being. Also, ecosystem processes and services are not mutually exclusive categories, as Wallace seems to imply. Some processes are also services, others are not. Some services are intermediate, some are final, and some are partly both.

In addition, there are other important and useful ways to classify ecosystem services that are not captured in Wallace's typology. I'll mention just two: classification according to spatial characteristics and classification according to "excludability/rivalness" status.

Table 1 groups the 17 ecosystem services listed in Costanza et al. (1997) into five categories according to their spatial characteristics. For example, services like carbon sequestra-

**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

tion (an intermediate input to climate regulation) is classified as "global: non-proximal" since the spatial location of carbon sequestration does not matter. The atmosphere is well-mixed and removing carbon dioxide (or other greenhouse gases) at any location is equivalent to removing it anywhere else. "Local proximal" services, on the other hand, are dependent on the spatial proximity of the ecosystem to the human beneficiaries. For example, "storm protection" requires that the ecosystem doing the protecting be proximal to the human settlements being protected. "Directional flow related" services are dependent on the flow from upstream to downstream as is the case for water supply and water regulation. And so on for the other categories listed in Table 1.

Another way to classify ecosystem services is according to their "excludability and rivalness" status. Table 2 arrays these two characteristics against each other in a matrix which leads to four categories of goods and services. Goods and services are "excludable" to the degree that individuals can be excluded from benefiting from them. Most privately owned, marketed goods and services are relatively easily excludable. I can prevent others from eating the tomatoes i have grown, or the timber i have harvested or the fish i have caught unless they pay me. But it is difficult or impossible to exclude others from benefiting from many public goods, like a well-regulated climate, fish in the open ocean, or the aesthetic benefits of a forest. Goods and services are "rival" to the degree that one person's benefiting from them interferes with or is rival with other's benefiting from them. If I eat the tomato or the fish, you cannot also eat it. But if I benefit from a well-regulated climate, you can also do the same. Excludability is largely a function of supply (to what extent can producers exclude users) and is related to the cultural and institutional mechanisms available to enforce exclusion, while rivalness is a function of demand (how do benefits depend on other users) and is more a characteristic of the good or service itself. Table 2 places ecosystem services into the four categories that this two by two matrix creates.

These two examples should be enough to indicate that there are many useful ways to classify ecosystem goods and services and our goal is not a single, consistent system as Wallace implies, but rather a pluralism of typologies that will each be useful for different purposes.

Finally, ecosystems are complex, dynamic, adaptive systems with non-linear feedbacks, thresholds, hysteresis effects, etc. Wallace's Fig. 1 ignores this complexity and conceives of the system as a linear chain from production (means) to direct benefits by people (ends) with no feedbacks or any of the other complexities of the real world. As I have said, all ecosystem services are in fact means to the end of human well-being, ecosystem processes can also be services (they are not mutually exclusive categories), and the same services can be both intermediate and final, The real world is complex and messy and our systems of classification and definition of ecosystem services should recognize that and

**Table 2 – Ecosystem services classified according to their excludability and rivalness**

| | Excludable | Non-excludable |
|---|---|---|
| Rival | Market goods and services (most provisioning services) | Open access resources (some provisioning services) |
| Non-rival | Club goods (some recreation services) | Public goods and services (most regulatory and cultural services) |

work with it, not ignore it in a misguided attempt to impose unrealistic order and consistency.

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