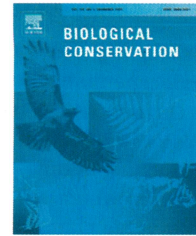
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## Letter to the editor

# Ecosystem services: Classification for valuation

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### ABSTRACT

This letter is in response to an article by Ken Wallace titled “Classifications of ecosystem services: problems and solutions” (Biological Conservation 139, 2007). This letter discusses the points we see as problematic with Wallace's framework and sets out our conceptualization of linking ecosystem services with human welfare. In this letter we suggest that utilizing the terms intermediate services, final services and benefits should go a long way to clearing up much of the ambiguity in ecosystem services typologies, especially for economic valuation purposes. As Wallace points out, clearly defining and organizing the concept of ecosystem services is not just a semantic decision, but it is integral to operationalizing something that can clearly illuminate tradeoffs in natural resource management.

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In his article “Classifications of ecosystem services: problems and solutions” (Biological Conservation 139, 2007), Ken Wallace makes several important points. The most critical being the motivation for the paper that in order for the concept of ecosystem services to make a large and meaningful contribution to conservation and human welfare, it needs to be clearly defined and put into a framework so that it is operational for societal management decisions. Other key points that Wallace elucidates include the need to integrate many fields of study from biology and philosophy to economics, and the need to delineate between ‘ends’ and ‘means’ in order to operationalize ecosystem service research.

As Wallace points out, clearly defining and organizing the concept of ecosystem services is not just a semantic decision, but it is integral to any process seeking to clearly illuminate tradeoffs in natural resource management and policy decisions. Defining and classifying ecosystem services has been the goal of several enlightening publications (Daily, 1997; MA, 2005; Boyd and Banzhaf, 2007; Wallace, 2007). However, there are conflicts between the discussion and classifications used in these works, as pointed out by Wallace (2007) and Boyd and Banzhaf (2007). The purpose of this letter is to suggest that the differences that exist stem from the fact that ecosystem services classification schemes are founded upon the specific context in which they are being used as well as the definition used. In line with this we present a classification which we are using in the context of ecosystem service

valuation in the Eastern Arc Mountains of Tanzania ([www.valuingthearc.org](http://www.valuingthearc.org)).

## 1. Classifications: fit for purpose, but different

Gretchen Daily's (1997) Nature's Services, really put ecosystem services on the map, and the field has been growing exponentially since then. The Millennium Ecosystem Assessment (MA) was based on making the link between human welfare and services provided by ecosystems explicit, and their classification system, delineating supporting services, regulating services, provisioning services and cultural services, was fit for this purpose. The MA's classification diagram stands as a strong heuristic. However, as pointed out by Boyd and Banzhaf (2007) and Wallace (2007), the classification does not work well for guiding practical accounting exercises or landscape management, respectively. They note that the main problem with the MA is that it mixes ‘ends’ and ‘means.’

This problem led Boyd and Banzhaf (2007) to develop a framework for the purpose of devising an accounting system for ecosystem services, which they define as the directly consumed ecological components of ecosystems. In this way they can ‘count’ things like lakes, forests, and bass populations. Wallace (2007) on the other hand is interested in managing landscapes and ecological processes to deliver ecosystem services. Wallace uses the MA definition that ecosystem services are the “benefits people obtain from ecosystems,” and by

backcasting these services Wallace looks to processes that landscape managers can manage to provide these benefits.

On a practical level there is a problem with all three of these classification schemes – they do not work for us. We are looking at how ecosystem services deliver human welfare benefits; where are the benefits realized; by whom; and how their value changes across the landscape in regard to different future scenarios. Our classification scheme is driven by the purpose of our research and how we define ecosystem services. So while there are some similarities with Wallace (2007), Boyd and Banzhaf (2007) and the MA (2005), there are important differences as well.

Drawing largely on Boyd and Banzhaf (2007) we propose that ecosystem services are the aspects of ecosystems utilized (actively or passively) to produce human well-being. There are three important characteristics of this definition.

- (1) *Services are not benefits.* As deftly pointed out by Boyd and Banzhaf (2007) services and benefits are different. They argue that recreation is not a service provided by ecosystems, but rather a benefit of which ecosystems provide important inputs. A benefit is something that has an explicit impact on changes in human welfare, like more food, better hiking, less flooding. Wallace (2007) and the MA (2005) consider services and benefits to be the same. For valuation, this is a problem and could lead to a problem of double counting. For example, adding values for primary production to values for recreational hiking would “double count” the value that say forests add to the hikers experience.
- (2) *Ecosystem services are ecological in nature.* Again, similar to Boyd and Banzhaf in that aesthetic values, cultural contentment and recreation are not ecosystem services. They are benefits, and are not just a function of ecosystems, but include of other inputs like human capital, built capital, etc. They are benefits also because they directly relate to changes in human welfare. For Wallace (2007) and the MA (2005) these things are services. We differ here with Boyd and Banzhaf (2007) in that they see services as ecological components, i.e. things you can count like lakes, forests, fish populations. We think that functions and/or processes are ecosystem services as long as there are human beneficiaries. This is important because it connects human welfare to nature throughout an ecosystem, not just the endpoint. This is in line with Daily (1997) and the MA (2005) which both make this connection explicit through the word service, not obscure

*we agree* →

it in ecological lexicon (i.e. processes, functions). For example, flood regulation is an ecosystem service here, as in Daily (1997) and the MA (2005), but is considered a process in Boyd and Banzhaf (2007) and Wallace (2007).

- (3) *Ecosystem services do not have to be utilized directly.* Here we take the opposite view of Boyd and Banzhaf (2007) and Wallace (2007) who argue that only the direct end-points are ecosystem services. We argue that as long as human welfare is affected by ecological processes or functions (somewhere down the line) they are services. Carbon sequestration is an ecosystem service because there are net human benefits derived for this process in a world of changing climate. This is in line with much of Daily's original text (1997). Another example, pollination is an ecosystem service since it is an ecological phenomenon that we utilize (indirectly) to enjoy certain food benefits. For us it makes more sense to call pollination an ecosystem service than say the almonds that we benefit from. In both Boyd and Banzhaf (2007) and Wallace (2007) it would be almonds that are the ecosystem service. *FINAL*

From these definitional points and our goal of valuation (see Chee, 2004 for ecosystem service valuation overview) we conceptualize that the benefits humans gain from ecosystems are derived from intermediate and final services. This is different to Boyd and Banzhaf (2007) because what we mean by services is different. For our purpose, it does not make sense to consider things like a bass population, a forest (as in Boyd and Banzhaf) or philosophical contentment (as in Wallace) as services because they do not lead us to benefits we can value. What we can value is water used for irrigation, bushmeat, timber products, and carbon stored. We suggest that these benefits relate to ecosystem services through intermediate and final services. For example pollination is one intermediate service that belies a final service of food provision. The benefit here is food for consumption, say almonds. In this way, we keep the link between human welfare and ecosystems throughout, but delineate a set of goods – benefits that we can place an economic value on.

Table 1 shows some of the services and benefits we are investigating in the Eastern Arc Mountains. The list of services and benefits is not exhaustive, but shown to highlight the relationships. For our purpose it makes several things clear for our fieldwork: (1) the multiple relationships between ecosystem processes and human benefits, i.e. services are complex and ubiquitous, (2) there is little danger of double

**Table 1 – Illustrative example of relationships between some intermediate services, final services and benefits**

Abiotic inputs	Intermediate services	Final services	Benefits
Sunlight rainfall nutrients, etc.	Soil formation primary productivity nutrient cycling  Photosynthesis pollination pest regulation	Water regulation  Primary productivity	Water for irrigation drinking water electricity from hydro-power  Food timber nontimber products

counting in valuation exercises, as we only value the distinct benefits and (3) clear understanding (and reminder) that as long as there are beneficiaries, most parts and processes of ecosystems provide services to supply benefits.

Due to the complexity of ecosystems and their processes a range of relationships are present. There may be several ways to understand final and intermediate services. If interested in the benefit of food, we can call the final service, i.e. the one providing the benefit, primary productivity, or we can call it food provision, or something else. The important thing for ecosystem service research is that project scientists and stakeholders can agree on the line between final services and benefits, so that we can manage, monitor and make policy to protect services that help maintain (and/or value) that benefit.

Our definition and approach are also flexible to several other important points about ecosystem services. First, as well argued by [Boyd and Banzhaf \(2007\)](#) the delineation between intermediate services, final services and benefits is not strict. Services are often a function of beneficiary's perspective. For example (from [Table 1](#)), if we are interested in the benefit of timber, then primary productivity is a final service, but it can be defined as an intermediate service when we are interested in drinking water as the benefit. It is also important to note that simple linear relationships do not often exist in ecosystems and therefore the same service can generate multiple benefits, e.g. for example water regulation provides flood prevention, drinking water, and recreation potential. As these are distinct benefits, it is acceptable to add the value of these benefits together. Finally, characteristics like resilience and functional diversity would also fit in this framework as services, as they are ecological phenomena that humans derive benefits from. However, defining the benefit would require modeling and scenarios to understand just what the benefit is of such a service, and it would still be difficult to attach meaningful economic valuation.

Finally, Wallace notes that the concept of ecosystem services is still ambiguous and in his appendices he points out

that an additional term “such as ecosystem benefit” might be useful. We agree with the importance of using the word benefit, and suggest further that also utilizing the terms intermediate services and final services should go a long way to clearing up this ambiguity and help to operationalize the concept of ecosystem services for valuation, but possibly for other contexts as well. [Boyd and Banzhaf \(2007\)](#) and [Wallace \(2007\)](#) have taken us forward, hopefully the ecosystem service research community can continue on this path.

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