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discussion synthesis from SER 2015, Workshop #5, *Restoration of ecosystem services: What data do we need?*

1. The premise of tradeoffs

There seemed to be general agreement with the premise that restoration approaches that target certain aspects of biodiversity or habitat function might produce higher levels of some ecosystem services than others, and that tradeoffs between services might result. (Perhaps if every single biotic component of a restored ecosystem returned to its original population size and level of functioning, the ecosystem services would necessarily be an emergent property of such a system, but this is rarely, if ever, possible in restoration.)

Discussants mentioned the example of Working for Water in South Africa, which has been very successful at a cultural ecosystem service (jobs creation), and has had some success (though less well documented) at improving water supply, also contributes to the loss of pollination services (because bees like eucalypt flowers) and to a loss of carbon sequestration (because eucalypts store lots of C).

The tradeoffs graphic I showed was from Chan, K. M., Shaw, M. R., Cameron, D. R., Underwood, E. C., & Daily, G. C. (2006). Conservation planning for ecosystem services. *PLoS Biol*, *4*(11), e379.

2. The principle that "there is no magic"

Restored ecosystems may be expected to increase ecosystem services, but they might not, or they might not achieve the level characteristic of intact ecosystems. (For a nice quantification of this at the global scale, see Benayas, J. M. R., Newton, A. C., Diaz, A., & Bullock, J. M. (2009). Enhancement of biodiversity and ecosystem services by ecological restoration: a meta-analysis. *science*, *325*(5944), 1121-1124.)

We often hear claims or expectations about increased ES, but these are rarely paired with hard data. The data on cultural services is particularly lacking compared to biophysical measures. We can't know what we don't measure; no one should assume that ecosystems "magically" produce higher levels of service as degradation is reversed. We need metrics, not magic.

3. What are the best metrics to quantify ecosystem service provision?

The best metric is the one that's "easy to do and repeatable," as Andrew put it. It should be both simple to perform and meaningful as a proxy. If it is to be widely measured, it needs to fall within the budgetary and technical capacities of managers in both the developing and developed world.

Each service, as well as biodiversity, should have its own simple metric (or metrics), rather than trying to sum up all the services in the aggregate with a single measure. If we

wanted to do this, the metric would have to be money. The advantage would be that all the services could be compared to each other, and summed. But the disadvantages are that many services are difficult to monetize, and that monetary worth changes according to shifts in market economies. So, the more durable measure is the hard metric that is specific to the service. (We should, however, remember that money is a major decision tool. Many people would like to use ES to justify the cost of restoration, or argue for restoration as an alternative to other hard-engineered solutions such as reforesting a floodplain rather than increasing levee height. Money is probably the only metric that matters for such arguments.)

Some of the non-monetary metrics proposed during the meeting were:

- soil depth
- seed set
- water infiltration rate
- soil cover by vegetation
- biomass accumulation (e.g. tree diameter increment)
- native:invasive ratio for key fauna (birds, worms) or plants
- sediment load
- species-area curve

However, it generally doesn't make sense to compare these metrics across ecosystems. The change in the metric (e.g., response ratio compared to baseline, or to the reference ecosystem) due to restoration is what matters.

4. What obstacles lie in the path of this effort?

They are the same obstacles that already plague restoration practice, and ecology more generally.

There are issues of scale: it is likely that larger restorations will provide different (additional) services than smaller ones. Beneficiaries might be at great distance from the locus of the services. Some services may take many years to be realized after the initial investment in restoration.

We already suffer from a widespread lack of monitoring of restoration success. Simply defining metrics does not give managers more time or money to perform monitoring. Many restoration projects are already underway and therefore might lack appropriate baseline data for comparison.

Reference (intact) ecosystems may be difficult to locate or may also be somewhat degraded with respect to services.

Some services (e.g. pollination) are really difficult to measure, and we might not be happy with proxy measures that are overly simplistic.

Seasonality and year-to-year variation may make it difficult to understand changes in ES provision without long-term efforts.

5. Given the obstacles, why is this worthwhile?

Because ES is becoming more and more important as a "selling point" for restoration in an era when people feel less and less connected to local biodiversity. And these justifications should be based on hard data, not wishful thinking.

Because collecting a lot of data will fuel meta-analyses that will help us understand tradeoffs and synergies in ES/biodiversity around the planet.

Because it's necessary for good conservation and restoration planning, to optimize resource use. There may be “hotspots” of ES that are more readily restored or more concentrated.

There are precedents in other fields for using simple, common metrics to create large global databases that yield new insights or enable appropriate environmental responses. Plant functional traits is one that we mentioned several times. Conservation International's "vital signs" initiative for sustainable agriculture is another. Landscape function analysis and a variety of other rapid field assessment methods (e.g. CRAM, AUSRIVAS, %EPT, Pollution Tolerance Index, etc) are widely used in ecological monitoring and are not only precedents but could also serve as a source of possible metrics for ES.

6. What's next?

Ultimately I intend to turn this into a review paper that proposes a set of adoptable metrics. I think the paper will need a lot of consultation with people in the ecosystem services realm as well as on-the-ground practitioners to come up with metrics that are both meaningful and feasible on the large scale.

Accordingly, I will set up an online forum for continued discussion by those who mentioned they would like to be part of a working group on this topic. I welcome anyone else to send suggestions for references or other resources, and also to spread the word to colleagues who might want to contribute to the discussion.