A USER'S GUIDE TO ECOSYSTEM SERVICES

Moving from Understanding to Action

Key-Log Economics for the Model Forest Policy Program

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Version 1.0

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ABSTRACT

The concept of ecosystem services provides a scientifically sound and practical way of understanding the complex ways in which conditions and changes in the natural world affect human well-being. Based on that understanding, ecosystem services users – and that includes all of us – can identify and prioritize actions that strengthen positive connections between natural and human communities. Developed for the Model Forest Policy Project's "Climate Solutions University," this Guide introduces ecosystem services as part of an overall assessment of the effects of climate change on those conditions and connections. The goal is to find solutions that head off or dampen the impacts of climate change on economic and other human conditions when information is limited. Because the connections between climate change and those conditions (and back again) are so numerous and complex, we will never have sufficient information to tell us what is THE PERFECT THING to do. Meanwhile, we don't have unlimited time and money to try EVERYTING just to see what works. What's needed is a scientifically sound way of getting started – of finding the SOMETHING (or a small number of things) that we can do that might be most important. This Guide, with its accompanying Checklist are a way of getting a handle on that complexity, organizing a conversation about how changes in the climate connect to changes in and between human communities, and drawing a roadmap to the "something" that makes the most sense in the users' own communities.

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On the Cover: The Copper River delta, Alaska, photo by Spencer Phillips

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Author's Note: Please do use that email address and contact me with any comments and suggestions, including errors and omissions you have found in this Guide and the spreadsheet tool it accompanies. This is truly Version 1.0, and I anticipate that future versions will be much improved as a result of feedback from experts in ecosystem services, community engagement, natural resource planning and, most of all, from citizen scientists looking for solid and useable way of making sense of our influence on the ecosystems on which we so completely depend.

Acknowledgements: Many thanks to the entire Model Forest Policy Project team, especially Nancy Gilliam, Julie Kintsch and Gwen Griffith who provided guidance, feedback and co-labor throughout the development of this guide and the ecosystem assessment tool. Thanks also to Leslie Bryan of the Western Shasta Resource Conservation District. Through her engagement, we were able to use Shasta County, California as an invaluable beta test site for the approach and the assessment tool.

A User's Guide to Ecosystem Services

MOVING FROM UNDERSTANDING TO ACTION

WHAT ARE ECOSYSTEM SERVICES?

The idea that people receive benefits from nature is not at all new, but "ecosystem services" as a term of art describing the phenomenon is more recent, having emerged in the 1960s (Millennium Ecosystem Assessment, 2003). Even today, the term is unfamiliar to most people, so let's begin with a sample of definitions.

"Benefits people obtain from ecosystems (Millennium Ecosystem Assessment, 2005)" is perhaps the simplest and most commonly heard. It has also been adopted as part of the new regulations governing planning for U.S. national forests (USDA Forest Service, 2012), so will be important for people living near or otherwise enjoying the ecosystem services originating on national forest lands.

Boyd and Banzhaf (2007) argue that this simple definition is too "ad hoc to be of practical use" in evaluation of impacts on human well-being and offer an alternative that makes ecosystems (goods and) services more directly comparable to other goods and services that people consume. *Final* ecosystem services, they offer, are "components of nature, directly enjoyed, consumed or used to yield human well-being (p. 619)." This definition is particularly helpful when one wants to value ecosystem services in monetary terms. Its focus on final ecosystem services is intended to avoid double counting the value of underlying processes along with the resulting good or service directly enjoyed, consumed or used.[1] Just as one does not buy steel, rubber, upholstery and wiring and THEN a car (one just buys a car), people should think of themselves as buying "drinking water" rather than some volume of water, plus purification services AND THEN purified water. The point is not that the underlying processes are not valuable; rather it is that their value is already included in the value of the final service.

Gary Johnson of the University of Vermont provides a definition that emphasizes that ecosystem services are not necessarily things – tangible bits of nature – but rather, they are the effects on people of those bits of nature. And, most importantly, he emphasizes that it is not just WHAT those effects are that matters – it is also WHEN and WHERE they occur. To wit:

> Ecosystem services are the effects on human well-being of the flow of benefits from an ecosystem endpoint to a human end point at a given extent of space and time (Johnson, 2010).

There's not a wasted word in there, those underlined some that I think are perhaps more equal than others. It is indeed benefits to people we're talking about. It is a flow we're talking about (which of course begs the question of the condition of various stocks from which those flows issue). And it is the spatial and temporal context of the flow that's important.[2] Flood control on the other side of the continent is only so interesting when you are stacking sandbags around your own home. And it would be best to have cleaner air before yet another child has developed asthma.

[1] Elsewhere, the same authors refer to ecosystem services as the "end products of nature that yield human well-being [emphasis added] (Boyd & Banzhaf, 2006)."

[2] See Maes et al. (2012), summarized in the "Key Resources" section, and Kareiva et al. (2011) for an in-depth look at tools and techniques for mapping ecosystem services and otherwise putting them in a spatial context.

What about Intrinsic Value?

To some readers, the exclusive focus of the ecosystem services approach on the instrumental values of nature – that is, the myriad ways in which nature benefits people – will leave a big gap in the rationale for caring about or conserving nature. Many, including this author, believe that nature and its components also have intrinsic value – literally the value of nature to itself – that can and should be considered in actions affecting ecosystems.

But because we humans lack the points of view of nature, we cannot measure or assess the intrinsic value of ecosystems, let alone make an apples-to-apples comparison of their intrinsic to their (humanly accessible) instrumental values.

That said, human regard for the intrinsic value of nature may enhance the instrumental value we obtain from nature. If, for example, I harbor a belief that nature values itself, I may derive greater enjoyment (benefit) from my experiences in and of nature, or I may hold greater passive use value (see footnote 3) for those components of nature that I do not use directly.

The bottom line is that ecosystem services add a different dimension to the value of nature: they do not diminish its value in other dimensions.

Note also that this definition allows for the full consideration of cultural and other services for which the flow of benefits may occur over vast extents of space and time. Cultural heritage values, for example, may be particularly enduring, and passive use values[3] propagate instantaneously and constantly to all who hold them.

Finally, Balmford, et al. (2011) present a framework for thinking about ecosystem services that echoes these definitions but, to add clarity, "disaggregate[s] ecosystem services into three interlinking sets, which differ in their proximity to human wellbeing: core ecosystem processes, beneficial ecosystem processes, and ecosystem benefits (p. 164)." This chain of relationships, from core processes to beneficial processes to human benefits, is implicit in the previous definitions. By separating them, the authors provide terms to clarify when we are talking about ecological endpoints (or components of nature) versus economic endpoints (human enjoyment/consumption/use). In the latter linkage especially (from beneficial processes to benefits themselves) they also provide the core basis for the comprehensive – but still manageable – ecosystem service assessment tool presented below.

We include these definitions to help frame, but not to bound, thinking and discussion about specific flows of benefits most important in particular communities. Nor should they limit the actions people, communities and institutions might take to ensure those flows even in the face of underlying stress, including that imposed by climate change.

FROM PROCESSES TO BENEFITS

To complement the verbal definitions of ecosystem services above, it will be helpful to consider a more visual depiction. We'll start with a very simple picture, following Balmford et al. (2011), of a cascading relationship in which "core ecosystem processes" result in "beneficial ecosystem processes" that produce "ecosystem benefits" (See Figure 1.)

This picture – especially the bottom two thirds of it – is the basis for the ecosystem services assessment tool introduced in the next section. There, as in this diagram, the emphasis is on the nexus between ecosystem conditions and functions (embodied in the core and beneficial processes) and the benefits themselves. It is in that second (lower) yellow arrow that the delivery of "an ecosystem

[3] These include "option, bequest and existence" value, which are, respectively, the value of preserving a component of nature for possibly future use by oneself, the value of preserving something for future use by others (heirs or unspecified members of a future generation), and the value of simply knowing that something exists and endures in a healthy state absent any expectation of future direct use.

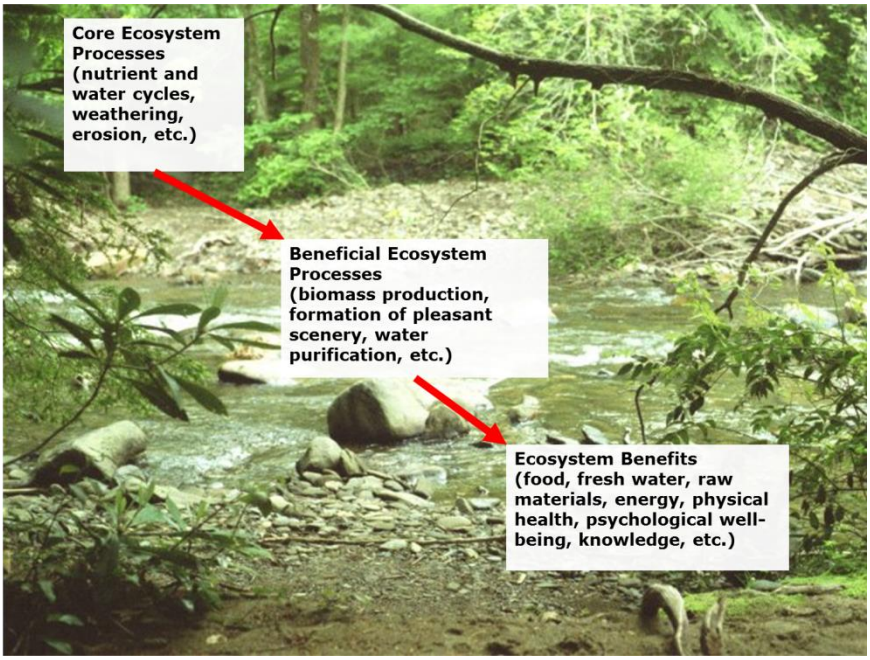

FIGURE 1 THE ECOSYSTEM SERVICES CASCADE
(Photo: Cohutta Wilderness, Chatahoochee National Forest, Georgia, Spencer Phillips)

endpoint to a human endpoint" occurs. And it is in transformations of that type that the impacts of climate change and other ecosystem stressors will "show up" in human well-being. So keep this simple picture in mind as we proceed.

Before getting there, however, it is worth putting a bit more complexity into our mental picture of ecosystem services. Figure 2 shows the same cascade in the form of a "concept map" comprised of propositions, such as "Core Ecosystem Processes produce Beneficial Ecosystem Processes," and "Beneficial Ecosystem Processes combine (with human Appreciation of natural systems) to define Ecosystem Benefits." (Follow the arrows to read other propositions.[4] In this concept map, solid lines represent tangible or biophysical connections, and dashed lines represent information flows.)

In addition the relationships depicted in Figure 1above, the concept map illustrates what happens next, including that the consumption or realization of ecosystem services both enhances human well-being on the one hand, and affects core and beneficial ecosystem processes on the other. The latter effect can occur directly or by adding to ecosystem stressors, including climate change (Esposito, Phillips, Boumans, Moulaert, & Boggs, 2011).

In addition, human well-being informs both our appreciation of natural systems (drinking water makes us appreciate clean water, for example) and our actions to conserve or enhance the underlying conditions (dubbed critical natural capital) that keep ecosystem processes going (Farley, 2012). Those actions, as we'll see below, may include the creation of market incentives or other initiatives to support ecosystem processes (core and beneficial) directly or to address stressors.

It is worth adding this complexity to our mental map of ecosystem services for two reasons. One is that Figure 1, which is typical of most diagrams intended to illustrate the ecosystems services concept, leaves out important feedback loops from the consumption of ecosystem services back to the condition of ecosystems that make further consumption possible. Without the feedbacks, one could be forgiven for thinking of ecosystem services as a never ending fountain of human happiness, rather than as another part of a complex system on which we have a profound influence.

[4] You can find CmapTools, the software for creating such concept maps as well as further background at the Florida Institute for Human and Machine Cognition, http://www.ihmc.us/.

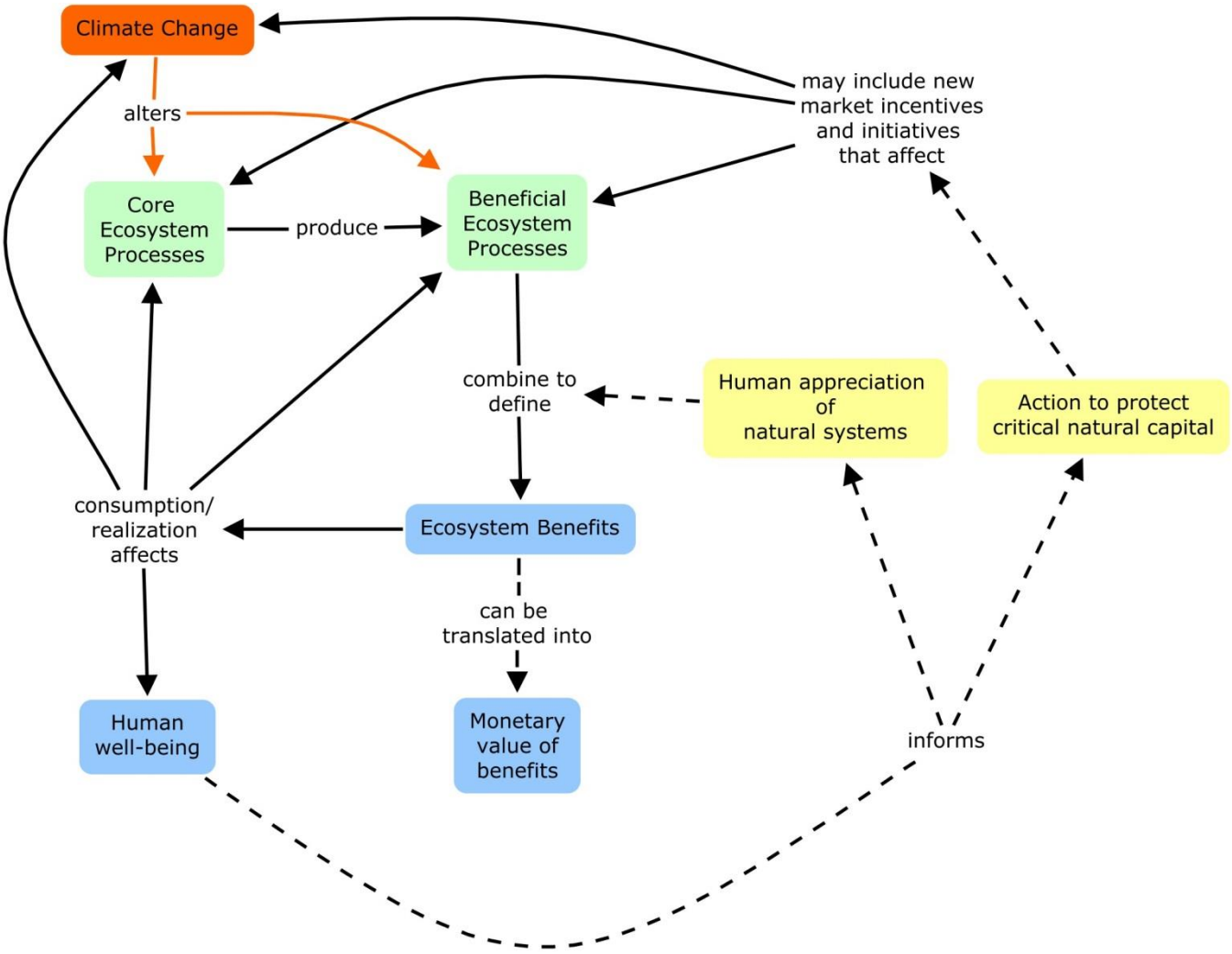

FIGURE 2 ECOSYSTEM SERVICES CASCADE, WITH FEEDBACKS

The second reason is to place your work to understand and take measures to address climate change squarely within that system. As you work with the ecosystem service assessment tool described below and more importantly, when you do something about the impact of climate change on regional ecological and economic conditions, you'll see that work as part of the positive feedback loop from ecosystem benefits through your actions all the way back to a better chance of their future availability.

AN ECOSYSTEM SERVICES ASSESSMENT TOOL

There are many tools and approaches to ecosystem services assessment, and many of those are quite powerful and worthwhile. They range in complexity from little more than making a list, to creating dynamic, spatially-enabled models of large landscapes and the relationships among human and natural communities within them. What is provided here is somewhere in between, and probably more toward the "make a list" end of the spectrum. The most it requires is a spreadsheet program and your thinking and engagement. You can certainly enhance that engagement with the use of additional tools, of more sophisticated assessments of ecological and economic conditions in your area, or even advanced computer modeling. But those are not necessary to get started with or even to complete the use of this tool. (Indeed, one thing you might do with this tool is prioritize the further, more detailed assessment and analysis that might be useful as follow-up.)

Keeping in mind that this is just *an* (not *the*) ecosystem services assessment tool, it does embody a good bit of more detailed thinking from researchers and practitioners who have gone before. The organization and some of the mechanics of the spreadsheet tool have are based, in large part, on a combination of two previous efforts. One is the beneficial processes-by-ecosystem benefits concept and matrix laid out in Balmford et al. (2008 and 2011), by which much of the complexity of Figure 2 can be set aside without losing essential elements. The second is Smith and Caligiuri's (2012) approach to evaluating the impact of land management actions on ecosystem services in a particular landscape. Our hope is that the combination provides an even more powerful understanding of ecosystem services and a foundation for a plan of action to ensure their provision in the future.

Two more preliminary notes are first, that there are detailed instrucations on *how* to use the workbook itself in its "Instructions" tab. Those are not repeated here. Instead, this section provides a higher-level guide to what using the workbook should entail and accomplish. Second, some of the terms used in the spreadsheet and in this section may be unfamiliar. The workbook does include brief definitions in the comments in several of the cells (those contining the names of beneficial ecosystem processes, for example). In addtiion the Glossary section below includes a full list of the beneficial ecosystem processes as well as the less obvious ecosystem benefits included in the workbook.

Using the Assessment Tool

A. Open the Ecosystem Services Checklist template Microsoft Excel[5] and immediately save a copy as a workbook. [There are just a few more tips on mechanics in Guide – set in square brackets like this sentence. Please see the Instructions tab and other hints embedded in the workbook for the rest.]

B. Review all of the instructions in the Instructions tab, and then select the Impact Assessment tab.

C. Your first task is to rate the current condition or level of function of as many of the beneficial ecosystem services as you can – or at least as many as you feel will be critically important as part of the ecosystem benefit delivery system depicted in Figures 1 and 2, above.[6] For each beneficial process, you'll select whether the process is in excellent, good, fair, or poor shape (Figure 3). This is obviously a qualitative assessment and a judgment call. Use what data and assessments you have on hand, not least of which will the judgment of others working with you on the project.

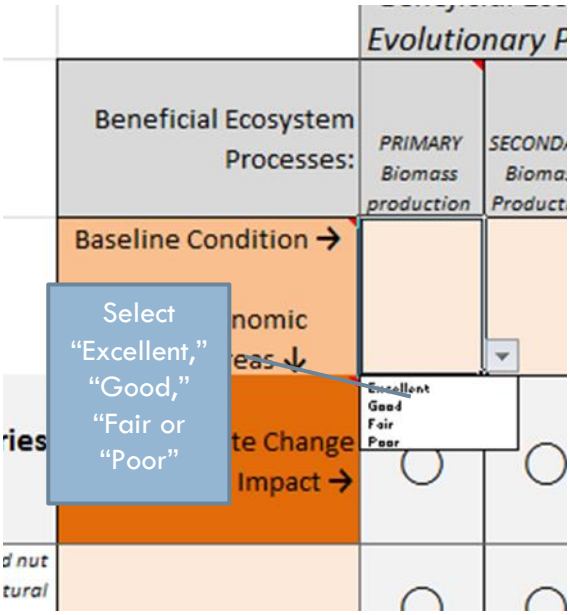

FIGURE 3 RATING BASELINE CONDITION OF BENEFICIAL ECOSYSTEM PROCESSES

The reason for this rating is that it, in combination with the results of the next step, will help you prioritize the beneficial ecosystem processes on which to concentrate your assessment of impacts on benefits and, ultimately, your investments in action

[5] The workbook might work in other programs such as OpenOffice.org Calc, but has not yet been tested.
[6] It is perfectly fine to start with benefits (rows) and work your way across the beneficial processes (columns), but for the purposes here, we'll start with the processes and then consider the benefits later.

steps. Processes with excellent or good performance or condition might be more resilient to climate change and, therefore, may need less immediate attention, for example.

D. Next, for those beneficial processes for which you've just rated the condition, consider whether climate change will affect the level of function (productivity), in what direction, and by a lot or a little (Figure 4). You are again making a qualitative judgment about this impact, but it is important to keep in mind that you are not making a judgment about whether the impact is "good" or "bad" relative to human benefits or preferences. There may be beneficial ecosystem processes, such as primary biomass production, that could *increase* as a result of climate change, even though such an increase might not *improve* the delivery of some (or even any) ecosystem benefits.

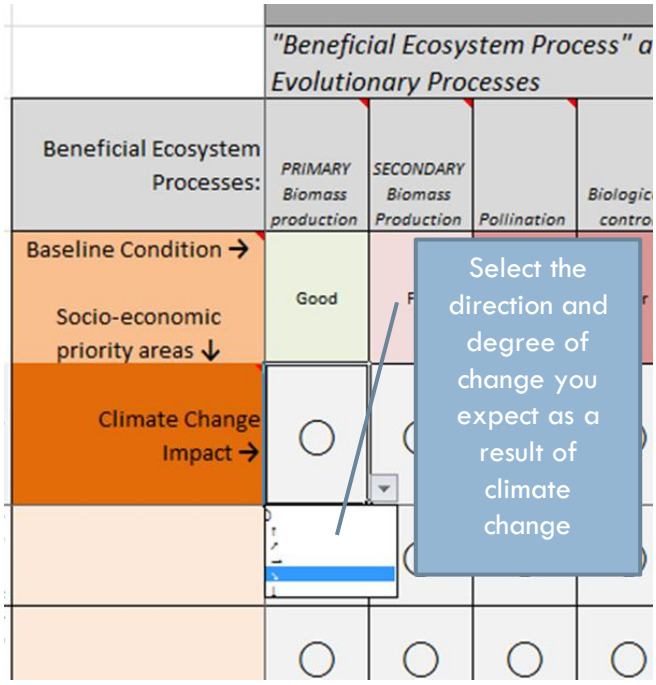

FIGURE 4 RATING IMPACT OF CLIMATE CHANGE ON ECOSYSTEM PROCESSES

[Scroll to the right of the Beneficial Processes columns to see a brief description of what the ratings mean.]

[As you make these and other selections in the workbook, it is a great idea to keep a log of your thinking behind the selection, and the easiest way to do that is to right-click the cell and insert a comment.]

E. Turning to the Ecosystem Benefits rows, you have two tasks, both of which will help you identify top priority interactions or process-benefit linkages to consider in the next step.

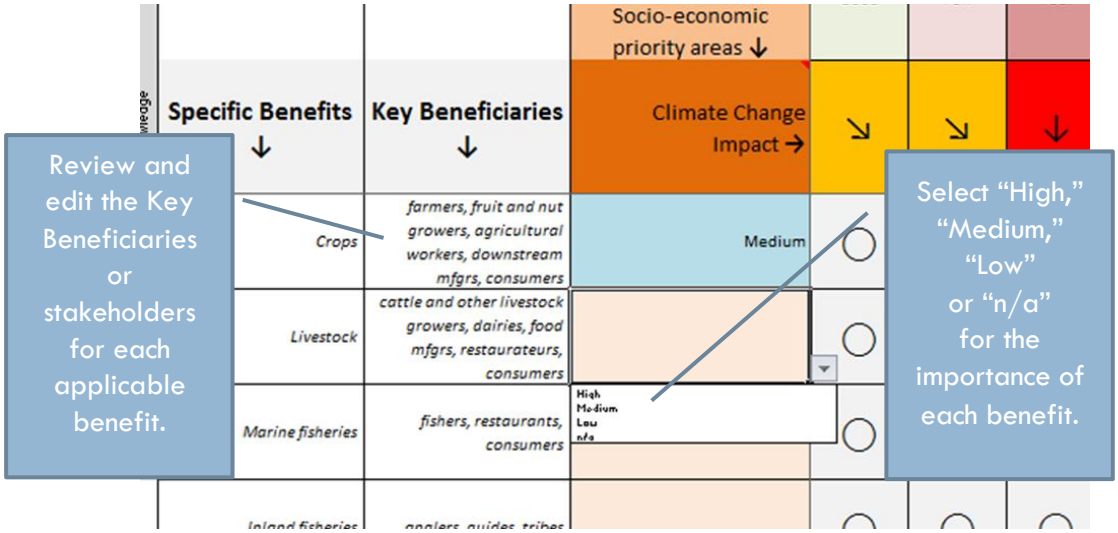

FIGURE 5 EVALUATING BENEFITS AND BENEFICIARIES

a. For each "Specific Benefit" select "High," "Medium," "Low," or "n/a" as your judgment regarding the priority of the benefit in your region (Figure 5). [As with the baseline condition of ecosystem processes, scroll to the right to review what those "benefit importance" categories mean.]

b. Review the sample list of "Key Beneficiaries" and add, subtract or annotate as you see fit. [You might need to click in the cell to see all of the sample entry (in the formula bar).]

F. Now we get to the links or intersections of beneficial processes and specific benefits. You may want to start on the rows of benefits that are of "High" or "Medium" importance to your region and/or the columns for those beneficial processes where you anticipate "Some Decrease" or a "Strong Decrease" in their health or productivity as a result of climate change. For each intersection of interest, select one of the arrows indicating the direction and magnitude of change. As with the other selections, this indicator is qualitative, but you will find that your prioritization is richer if there is some variation in your choices – that is, if not all of the intersections are expected to see a strong decrease, for example.

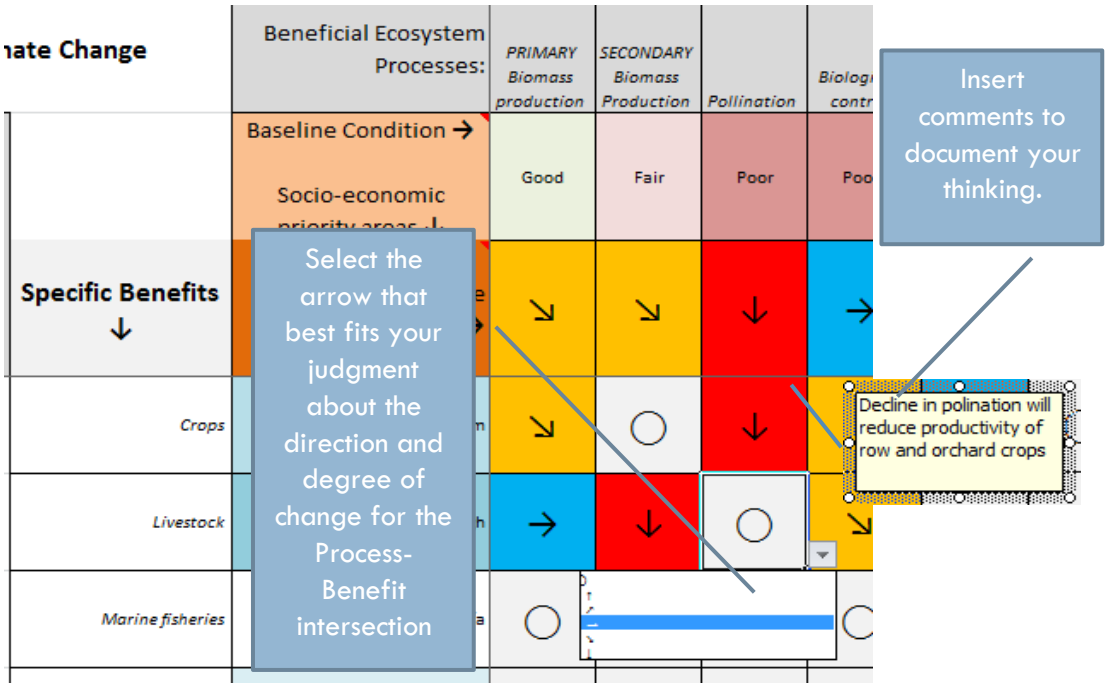

FIGURE 6 RATING THE EFFECT OF CHANGES IN PARTICULAR PROCESSES ON PARTICULAR BENEFITS

[Remember that you can temporarily rows or columns that you don't want to consider right away.]

G. Once you have recorded your judgments for all relevant process-benefit intersections (or at any time), you can view the Process and Benefits Charts, which show the simple count of the number of intersections for which a strong decrease, some decrease, neutral, some increase, or strong increase are expected. The "Process Chart" shows the number of benefits in each change category for each process. Similarly, the "Benefits Chart" shows the number of processes in each change category for each benefit.

These may provide a quick way to spot some top priorities for which to develop solutions and action

plans. A column with a lot of orange and red, for example, indicates a process that my require more rapid intervention, and a bar with those colors could flag the benefits at greatest risk of decline.

Finally, use the the "Strategies" and "Strategy Map" tabs to record your thoughts on what actions you might take to forge positive connections between the ecosystem processes and ecosystem benefits of greatest concern or interest in your community. The "Strategies" tab is simply a list and brief definition of such strategies as payments for ecosystem services, marketing partnerships and certification and labeling. The list is not exhaustive, and users should add any others they choose. The "Strategy Map" mirrors the Impact Assessment, including its color coding (to make it easy to zero in on the connections of greatest concern). Use the cells as the intersection of process columns and benefit rows to briefly describe the strategies for further consideration as well as the specific stakeholders who can work with you to implement those strategies.

(Note that this section of the assessment workbook is still very much in development, so don't be shy about filling in your own ideas where none yet exist or editing or adding to the suggestions already entered. We intend, in version 1.1 or later, to link these suggestions to case studies of places where each idea or type of idea has been tried. In the meantime, please see the Key Resources (below) from Forest Trends and the Ktoomba Group (2008) and from Tallis, Goldman, Uhl and Brosi (2009) summarized in key resources.)

Beyond the workbook itself, users will naturally want to bring the thinking that it stimulated and captured (in your various ratings, comments and notes) to action agendas, project proposals, monitoring plans and other efforts. Whatever form your next steps take, it is our greatest hope that they will be more strategic, effective and successful as a result of your assessment of the health and outlook for ecosystem processes and benefits in your region.

GLOSSARY

Beneficial Ecosystem Processes:

Ecosystem processes that directly underpin benefits to people (all based on Balmford (2008, pp. 30-32), unless noted).

Primary Biomass production: Production of plant biomass (Balmford), or the accumulation of biomass by organisms that use inorganic sources of energy (i.e., plants) (Mr. G's Environmental Systems)

Secondary Biomass production: Production of animal biomass (Balmford) or Accumulation of biomass by animals and other organisms from organic energy sources (Mr. G's Environmental Systems)

Pollination: Contribution of insects, birds, bats and other organisms to pollen transport resulting in the production of fruit and seeds. May also include seed and fruit dispersal.

Biological control: Inter- and intra-specific interactions resulting in reduced abundance of species that are pests, vectors of disease, or invasives in a particular ecosystem.

Other ecological interactions: Other inter- and intra-specific interactions, for example competition and predation.

Formation of species habitat: Formation of the physical properties of the habitats necessary for the survival of species (canopy structure in forests, coral reefs).

Species diversification: The production of genetic diversity ACROSS species.

Genetic diversification: The production of genetic diversity WITHIN species.

Waste assimilation: Removal of contaminants from the soil in an ecosystem, including through biological processes such as decomposition or assimilation.

Soil formation: Process by which soil is created, including changes in soil depth, structure and fertility.

Erosion regulation: Control of the processes leading to erosion, for example, by controlling the effects of water flow, wind or gravity.

Formation of physical barriers: Formation of structures that attenuate the energy of (or block) water or wind flow (mangroves, dunes, forests).

Formation of pleasant scenery: Formation of landscapes that are attractive to people.

Air quality regulation: Removal of contaminants from air flowing through an ecosystem, including through physical processes (filtration) or biological processes (decomposition or assimilation).

Regional/local climate regulation: Modulation of regional/local climate (temperature, humidity, wind events).

Water regulation (timing): Regulation of the timing of water flow through an ecosystem (attenuation of floods/droughts).

Water purification (quality): Removal of contaminants from water flowing through an ecosystem, including through physical processes (filtration) or biological processes (decomposition or assimilation).

Water provisioning (quantity): Changes in the quantity of water flowing through an ecosystem.

Global climate regulation: Modulation of global climate and ocean acidity through changes in the concentration of greenhouse gases in the atmosphere.

Currently unknown beneficial processes: The possibility that wild nature contributes to our current and/or future welfare in ways we do not yet realize. For example, the contribution of forests to the regulation of global climate has only very recently been realized as a beneficial process.

Ecosystem Benefits:

The products of ecosystem processes that directly impact human wellbeing (following Balmford (2008, pp. 32-33), unless noted. Some Benefits appear in more than one category.

Food:

- Crops, including orchard fruit and nuts, mushrooms, cultivated algae, etc.
- Livestock, including poultry
- Marine fisheries, both wild/capture fisheries and aquaculture
- Inland/Freshwater fisheries, both wild/capture fisheries and aquaculture
- Wild animal products, including bush meat, invertebrates, etc.
- Wild plants for food, including mushrooms, ramps, etc.

Freshwater (for direct consumption; excludes irrigation water, covered in crops):

- Drinking water
- Industrial process water

Raw materials:

- Crops, such as cotton and flax

- Livestock, such as wool and other fiber
- Wild plants or animals for fiber, including rattan, hides
- Timber bot from natural forests and from plantations

Energy:

- Biofuels from domestic plants
- Charcoal/firewood from wild plants
- Dung from livestock
- Working animals (oxen, llama)
- Hydroelectric energy

Property:

- Preventing loss of property value or condition
- Transportation and other infrastructure condition (roads, hospitals, factories)

Physical health (excluding nutrition, covered under Food):

- From One-time use benefits (synthesis of medicines copied from/inspired by natural products)
- Wild medicinal plants
- Nature-related outdoor activities that maintaining health and fitness
- Avoiding injury and illness from natural hazards, biological agents, pollution, etc.

Psychological wellbeing:

- Crops and Livestock (gardening and interactions with pets, maintenance of rural/farming lifestyle)
- Nature-related outdoor activities (hiking, diving, viewing attractive scenery)
- From Marine and Inland fisheries and Wild animal products (i.e. watching fish, birds, animals)

Knowledge:

- Nature-related outdoor activities
- One-time use benefits (new scientific discoveries, artistic inspiration)
- Through education about the natural world.

Unknown benefits: the possibility that wild nature provides/will provide benefits currently unknown (e.g., algae now considered a promising biofuel).

KEY RESOURCES

While any of the works cited in this user guide would be valuable reading, the following five represent those most likely to help you go deeper on various aspects of ecosystem services, from the conceptual basis, to means of assessing and mapping ecosystem service value, to the design of market-based and other programs to ensure future ecosystem service productivity. Each of these is available on-line to the general public (links current as of June 7, 2013) and, for the Climate Solutions University community, a copy is included on the CSU resource site.

Boyd, J. W. (2011). The risk of ecosystem service losses. *Resources*(Summer), 33-37.

This short article nicely covers physical and financial risk and uncertainty associated with ecosystem stress. Using the well-established notion of "option value," Boyd explains the importance of avoiding, or at a minimum delyaing, actions that could have irreversible consequences. He also outlines strategies to provide a hedge against ecological risk, including building resilience in ecosystems and investing in a diverse portfolio of conservation measures.

http://rff.org/Publications/Resources/Pages/178-The-Risk-of-Ecosystem-Service-Losses-Ecological-Hedging-Strategies.aspx

Collins, S., & Larry, E. (2007). *Caring for Our Natural Assets*. Washington, DC: USDA Forest Service, Pacific Northwest Research Station.

In this excerpt form a longer USDA Forest Service technical report, Collins and Larry outline some of the major stressors affecting ecosystems, especially forests. These include conversion to non-forested uses, the spread of invasive species, and especially climate change. The paper also includes a sketch of the ecosystem services concept (based on the Millenium Ecosystem Assessment) and a list of market-based approaches for conserving ecosystems.

http://www.fs.fed.us/ecosystemservices/pdf/collins_larry.pdf

Forest Trends, The Katoomba Group, and UNEP. (2008). *Payments for Ecosystem Services: A Primer*. Washington, DC: Forest Trends and The Katoomba Group.

As the title states, this monograph provides an excellent guide for groups considering a payments for ecosystem services (PES) program as part of their overall ecosystem conservation strategy. After reviewing underlying ecosystem services concepts and conditions, the Primer walks through the assessments and other steps toward implementation of a successful PES program. Geared toward operations in rural areas and developing countries, the Primer also devotes significant attention to the extent to which PES can interact positively and negatively with anti-poverty programs.

http://www.forest-trends.org/publication_details.php?publicationID=2347

Maes, J., Egoh, B., Willemen, L., Liquete, C., Vihervaara, P., Schagner, P. J., . . . Bidoglio, G. (2012). Mapping ecosystem services for policy support and decision making in the European Union. *Ecosystem Services, 1*(1), 31-39.

As noted in the section titled What are Ecosystem Services?, above, the location and spatial extent of ecosystem services is crucially important. This scholarly paper includes an excellent presentation of the ecosystem services cascade framework reflected above (Figure 1) (and in (Balmford, et al., 2008 and 2011)), and applies that framework to an example in which water quality and water purification

services are mapped for southwest France. The authors conclude that both the cascade model and mapping techinques promote better understanding of ecosytesm services and, therefore, better opportuntiies for effective policies to improve the health and productivity of natural systems.

http://www.sciencedirect.com/science/article/pii/S2212041612000058

Tallis, H., Boldman, R., Uhl, M., & Brosi, B. (2009, February). Integrating conservation and development in the field: implementing ecosystem services projects. *Frontiers in Ecology and the Environment, 7*(1), 12-20.

In this review of ecosystem services projects undertaken by two conservation organizations (The Nature Conservancy and the World Wildlife Fund), the authors analyze more than one hundred such projects, classifying the approaches taken, tools used and conditions under which the projects were implemented. While the analysis is preliminary and no prediction of success is offered, the research does suggest that evaluating the applicability of different types of ecosystem service projects to a particular context could increase program effectiveness.

http://www.esajournals.org/doi/pdf/10.1890/080012

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