Eliciting Demand for Ecosystem Services: Results and User Guidance from the OPERAs Demand Synthesis Working Group

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Summary

Here we share what we have learned from working with stakeholders to elicit demand for ecosystem services, drawn from experience in seven of the OPERAs Exemplar case studies. We have developed an eight-step framework for identifying and working with stakeholders, identifying and eliciting ecosystem services that stakeholders value, and analyzing and communicating these services. Here we show how we applied this framework in our own research in seven cases in diverse European ecosystems, including rural and urban areas, coastal and mountain systems, and local and regional scales. By doing so, we have two goals: (1) to provide guidance to a wide audience of researchers and practitioners interested in capturing demand for ecosystem services for their own studies in a rigorous way, and (2) to present specific results of interest to the OPERAs community using this framework to compare between cases. Ultimately, understanding the ecosystem services that stakeholders value can illustrate conservation and education priorities, raise awareness of the importance of ecosystem services, and inform better policy and practice.

Purpose

This document is intended to help researchers apply an ecosystem services approach to identify the ecosystem services that stakeholders value. Although it is aimed at researchers, it could also be used by practitioners interested in eliciting demand for ecosystem services. A “quick guide” summary version of this document is available at http://www.oppla.eu/product/17540.

Motivation

- A major goal of OPERAs is to improve ecosystem services in policy and practice. The test cases for doing this are found in the twelve Exemplar case studies, designed to span a range of geographies, scales, ecosystems, stakeholders, and sectors.
- A great deal of ecosystem services research focuses on describing and mapping the supply of individual ecosystem services – what nature provides.
- Studying only ecosystem service supply risks focusing on those services that are easy to measure or viewed as ecologically important by researchers, but may be not well understood or highly valued by stakeholders.
- One way to motivate conservation and using ecosystem services in practice is for researchers to connect ecosystem services to things that people care about.
- Much OPERAs research aimed to understand what people demand and value from ecosystems.
- Better understanding and linking the supply and demand perspectives can help more fully achieve the potential for ecosystem services to improve policy and practice.

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Eight Steps to Eliciting Ecosystem Service Demand

Through synthesizing our experiences of developing and carrying out research within diverse OPERAs Exemplars, the Demand Synthesis Working Group has developed the following framework for assessing stakeholder demand for ecosystem services:

1. Determine study objectives
2. Identify and engage key stakeholders
3. Identify all potential ecosystem services for your case
4. Develop indicators for ecosystem services
5. Select method to elicit demand
6. Elicit stakeholder demand for ecosystem services
7. Analyze and compare demand
8. Assess implications of results

It is important to note that studying ecosystem services demand requires a focus on both the ecosystem services that are (potentially) provided by the study area, as well as the value that stakeholders place on these services. The traditional ecosystem services cascade model (Haines-Young and Potschin, 2013) begins with the natural ecosystem structure and function that provide the service (these first three steps constitute the supply of ecosystem services), and then continues to the human system where people benefit from and value those services (the latter two steps can be interpreted as demand for ecosystem services). The focus on demand starts at the end of this chain (Figure 1), and requires engaging stakeholders to elicit their values, since these cannot be directly observed in the environment.

An alternative to elicit demand in large-scale or desk-based research is to use proxy values. Proxies can be observation-based, such as visitor counts to national parks, and social media data (e.g. Van Zanten et al., 2016) as indicators of environmental appreciation. Demand values can also be modelled through a quantitative approach, where a conceptual model for the demand for the ecosystem service is constructed by experts or stakeholders, and subsequently mapped over larger areas. For example, air quality regulation service is provided by vegetation, but it is only in populated areas and in areas where there is air pollution that the service relevant, and therefore the demand can be assumed to exist only in those areas.

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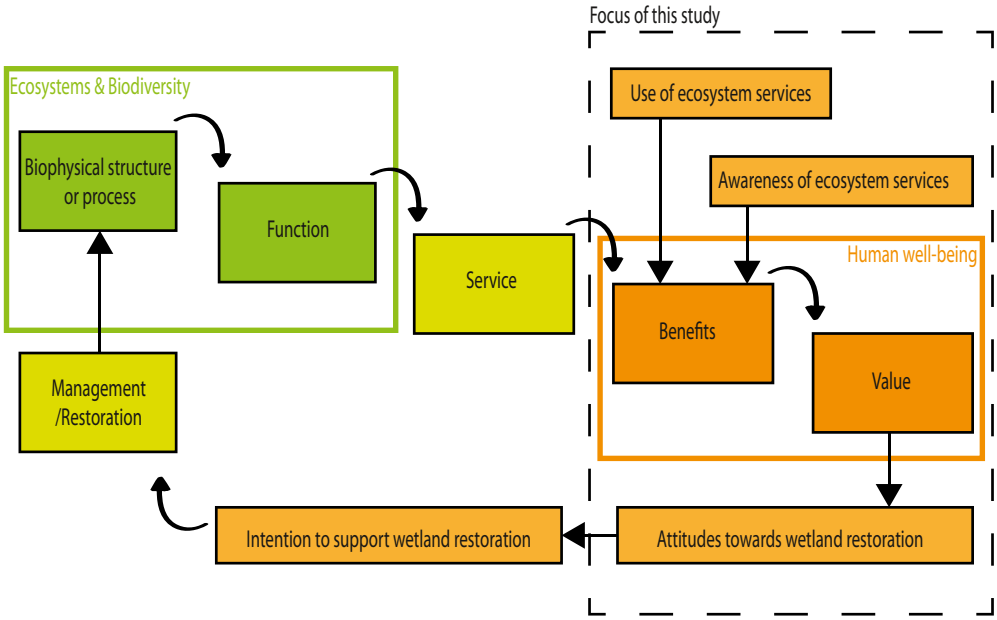

Figure 1. The ecosystem services cascade represents ecosystem service supply flowing from nature (green boxes), resulting in benefits and values for people, representing ecosystem service demand (orange boxes). Figure reprinted from Scholte et al., 2016, adapted from de Groot et al., 2010, and Haines-Young and Potschin, 2010.

1. Determine study objectives

An obvious starting point that will guide data collection and the entire research design is of course the goal of your work. In a research project, this will mean specifying the research questions. In an applied management project, this will involve specifying management objectives and targets.

At the beginning of the OPERAs project, each of the twelve Exemplars produced a study design, specifying the Exemplar rationale and motivation, how and why the case study boundaries were chosen, research questions, Exemplar goals, and links between stakeholders, instruments, and ecosystem services (Nicholas et al., 2014). Seven Exemplars that considered demand for ecosystem services were included in the demand synthesis (Table 1).

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Table 1. The OPERAs Exemplars and their respective studies included in this demand synthesis. Although many of the OPERAs Exemplars are extensive and include multiple studies, for this synthesis we focused on the specific studies within each Exemplar that had measured stakeholder demand for ecosystem services.

Exemplar Name	Demand Study Focus	Demand Study Location and Scale
Swiss Alps	Valuing mountain cultural ecosystem services	Regional – Visp/Saastal, Switzerland
Wine	Several, including local residents' value for cultural ecosystem services from vineyards, and literature review mapping vineyard ecosystem services in over 4,000 papers	Local surveys (England and California); Global literature review
Scotland Inner Forth	Local residents' value for coastal areas	Local – Inner Forth, Scotland
Barcelona	Coastal restoration and construction with the local authority	Municipal – Barcelona, Spain
Danube	Support for wetland restoration	Regional – Persina, Bulgaria
Europe	Regional-scale ecosystem services mapping	Across the European continent
Montado	Local and regional ecosystem services delivery	Local and regional – Montado, Portugal

2. Identify and engage key stakeholders

2.1. Identify and analyze your stakeholders

A wide range of techniques exists to identify and analyse your stakeholders, ranging from stakeholder mapping tools, to working with professional facilitators, to using online research including social media. It is important to identify both stakeholders' individual characteristics and how stakeholders interact with each other, as ecosystem services management and governance include interactions between both human and natural systems. We have developed a separate guidance document that explains some stakeholder identification and analysis approaches in more detail (Lascurain, 2017).

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2.2. Approach and engage stakeholders

Once your key stakeholders are identified, you need to engage and build relationships with the stakeholders. From earlier interviews with the Exemplar leads regarding their stakeholder experiences, we found that three key elements were necessary for successful stakeholder engagement: shared motivation, trust, and space (Schoonover et al., 2016). In turn, each of these three elements comprised three to five different components. See Schoonover et al. (2016) for more information.

2.3. Examples from OPERAs

From analyzing the results of an email survey with researchers in each of the seven Exemplars participating in the Demand Synthesis Working Group, we found four methods were used to initially identify stakeholders, including: asking existing stakeholder contacts to connect with new stakeholders; publicizing the opportunity for stakeholders to participate in workshops in local media; web analysis; and directly approaching individuals in person. As an example of the first method, researchers in the Montado Exemplar asked local land managers to provide a list of stakeholders. The publicizing method was used by the Swiss Alps Exemplar through an article published in a local newspaper and a radio interview, while web analysis was carried out by researchers in the Wine Exemplar to identify global carbon leaders for their online survey. Finally, students working on the Scotland Inner Forth Exemplar approached local residents on the high street of Alloa, Scotland, to talk about research and invite participants to a workshop in a local town hall.

Exemplar researchers found several key points that helped to facilitate the initial contact with potential stakeholders and set a good foundation for a positive working relationship (Table 2). The factors are related to three aspects of the research: the researcher, the stakeholder, and the research process itself. The researcher could improve relationships by taking care in introducing themselves properly, explaining their research goals, and sharing results from previous work. Important aspects to address about the stakeholder included discussing and linking their stake to the research, recognizing their knowledge and values, and getting a testimony from another stakeholder. Finally, regarding the project, it was important to be clear about how the stakeholder could help and what they could expect, to consider conflicts, and to be transparent.

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Table 2. Foundations of a positive relationship with stakeholders in research, identified from an email survey with the seven OPERAs Exemplars in the Demand Synthesis Working Group.

Research aspect	**Situation**	**Explanation**
Researcher	Explaining research goals	Researchers in the Wine Exemplar presented their project to stakeholders via both email and phone before asking the stakeholders to participate in the research.
	Sharing results from previous work	The Swiss Alps Exemplar researchers presented research from previous project in their first stakeholder workshop with local experts. This helped the research team set the context for launching a new project.
Stakeholder	Linking their stake to the research	When convincing the visitors and hunters of Companhia das Lezírias to take part in the choice experiment, researchers in the Montado Exemplar explained how the results would help in choosing the best land management practices for the area.
	Recognising their knowledge and values	Researchers in the Montado Exemplar sent individual invitations to their workshop that specifically mentioned how the stakeholders' knowledge would make an important contribution to the research.
	Getting a testimony from another stakeholder	Researchers working on the Streamline tool in the Scottish Exemplar asked participants for feedback on the interview experience after it is finished. Testimonials of the research were then added to the research website to help convince others to take part in an interview.
Research process	Being clear about expectations and ways to help	Researchers in the Scotland Inner Forth Exemplar told the residents that they were researching the coastal areas and were organising workshops to find out what local residents thought about their local landscape, future plans and any concerns.
	Conflicts	Researchers in the Scotland Inner Forth Exemplar brought in neutral and trained facilitators to help in moderating the conversation and allow different sides of the discussion topics to be heard. Facilitators set good ground rules that helped the researchers to achieve their research goals by directing the conversation further, so that it did not only center around conflicting views.
	Transparency	Researchers in the Scotland Inner Forth exemplar attempted to address any key concerns before asking participants to commit to a workshop, e.g., their ability to contribute to conversation, anonymity, and how the researchers would use their input.

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3. Identify all potential ecosystem services for your case

3.1. Select an ecosystem services framework

To identify which ecosystem services are important to stakeholders, you must first identify the possible range of ecosystem services that the study system can or does provide. The ecosystem services approach aims to provide one structured way to understand the benefits that people derive from nature, out of a huge range of alternative possible approaches to the same topic (for example, literature or economics). Major benefits of the ecosystem services approach include taking a holistic view across methods and disciplines (Hermelingemier and Nicholas, 2017), avoiding a narrow focus on only one service and considering possible tradeoffs, and serving as a "platform for bringing people and their different views and interests together" (Schröter et al., 2014, pp. 518).

To take advantage of the ecosystem services approach, it is important to make use of the extensive learning that has already taken place from international assessment and synthesis efforts, aimed at standardizing the approach, and follow an existing framework. Some of the major ecosystem services frameworks include the Millennium Ecosystem Assessment (2005), TEEB (2010), CICES (2013), and IPBES (Díaz et al., 2015), among many others. Some efforts have been made to harmonize between frameworks (e.g., Liquete, 2013), but the most important aspect is to select an established framework and avoid "reinventing the wheel" by defining case-specific services that may be hard to translate to a broader audience.

3.2. Use the framework to enumerate ecosystem services for your case

Starting with the chosen ecosystem services framework, enumerate each generic service (e.g., "harvest of crops") to your particular case ("winegrape harvest"). Consider both importance and the feasibility of collecting or obtaining data in selecting which services are relevant to your case.

When enumerating services, be sure to include at least one example from each of the highest levels (e.g., Sections in CICES) of the framework – in other words, at least one provisioning, one regulating, and one cultural service – to identify trade-offs between domains. If you are studying more than three services, consider selecting services at the next-highest level (e.g., Division in CICES, such as nutrition, materials, and energy from the provisioning section) as your organizing principle.

3.3. Involve experts and stakeholders in enumerating ecosystem services

To ensure you capture all the possible ecosystem services for your case, make sure you involve people with local knowledge of your study system, especially if you are new to the area. Consider experts from both research (e.g., researchers who have published papers on the ecosystem, or who

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work at local universities and research agencies), and practice (e.g., local NGOs and conservation and management organizations). Be sure the perspectives of your chosen stakeholder groups are represented by the selection of ecosystem services. You may even conduct research with stakeholders (e.g., focus groups, pilot interviews) to help refine the list of ecosystem services you plan to study in your system.

3.4. Examples from OPERAS

All of the OPERAs exemplars followed the CICES framework because it is the European standard for assessing policy goals, such as progress towards the European Biodiversity Targets of 2020. Starting with this framework, the Wine Exemplar determined which ecosystem services were most relevant to their case, ultimately including two provisioning, ten regulating and maintenance, and eight cultural services. They then translated the CICES terminology into terms more recognizable to wine industry stakeholders (Table 3). Both the selection of services and the chosen terminology were informed by wine researchers.

Table 3. A selection of ecosystem services enumerated for the OPERAs Wine Exemplar (last column), using the CICES framework (first four columns).

Section	Division	Group	Class	**Enumerated for Wine**
Provisioning	Nutrition	Biomass	Cultivated crops	**Direct harvest of grapes and leaves for consumption**
	Materials	Biomass	Fibers and other materials from plants, algae and animals for direct use or processing	**Fibers and other materials from grapevine (e.g., prunings, grape skins, grape seeds)**
Regulation & Maintenance	Maintenance of physical, chemical, biological conditions	Water conditions	Chemical condition of freshwaters	**Water is of sufficient quality for growing grapes**
		Atmospheric composition and climate regulation	Micro and regional climate regulation	**Micro and regional climate are suitable for growing grapes**
Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Physical and experiential interactions	Physical use of land-/seascapes in different environmental settings	**Physical use of vineyard landscapes (e.g., hiking, biking, horseback riding)**
		Intellectual and representative interactions	Aesthetic	**Beauty and inspiration of vineyard landscapes**

As another example, to ensure they included all the possible ecosystem services for their case, researchers in the Scotland Inner Forth Exemplar first interviewed local residents to find out which ecosystem services participants knew of and cared about. These ecosystem services were then included in a choice experiment in the main phase of the research project.

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4. Develop indicators for ecosystem services

4.1. Find an indicator for each ecosystem service

Each ecosystem service selected for your study will require an indicator to measure it. Indicators convey information about the characteristics and trends of the service of interest (Brown et al. 2014). Indicators should be appropriate to your study system, and reasonable to measure or observe with the time and resources available. Useful guidelines or reviews on developing indicators are available (e.g., Brown et al. 2014; Egoh et al. 2012; Maes et al. 2016), however they often focus on ecosystem service supply indicators. Finding appropriate demand indicators is especially challenging since demand values – in contrast to more biophysically-grounded ecosystem service supply values – are often not directly observable entities (Wolff et al. 2015).

Figure 2 provides an overview of the key steps of ecosystem service indicator development. Experiences from our research show that to determine demand indicators it is particularly important to find indicators that relate to the actual benefits people derive from ecosystem services. This requires that stakeholders are engaged in deriving or at least reviewing indicators for ecosystem services. As illustrated in Figure 2, progressing from services to indicators is often an iterative, rather than linear, process.

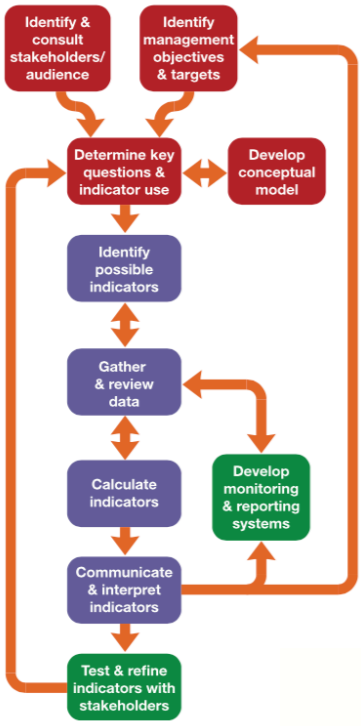

Figure 2. Ecosystem Service Indicator Development Framework developed by OPERAs partners to work with stakeholders in developing indicators. Figure reprinted from Brown et al., 2014.

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4.2. Consider the types of indicators

When choosing indicators, consider their relative strengths and weaknesses for the research you want to conduct. Indicators may be either **quantitative or qualitative** (Table 4). Quantitative indicators can be biophysical, monetary, or non-monetary. **Biophysical** indicators are usually applied to measure the supply of ecosystem services. If used as a proxy for demand, they equate the demand with the actual use or consumption of a service and thus measure the demand that is met by supply (Burkhard et al., 2012; Wolff et al., 2015). **Monetary** indicators can be derived from direct use and consumption information or from willingness-to-pay studies. If cost and price information is used to define indicators, they are similar to biophysical indicators. Since willingness-to-pay studies are hypothetical, it is possible that demand may exceed the current supply, and to infer demand for ecosystem services for which no direct consumption information exists. **Non-monetary** quantitative indicators include rankings or scores and are useful to compare services of different categories. In general, quantitative research is likely easier to administer (e.g., via an online survey) and can be more widely distributed than qualitative research, allowing larger sample sizes.

Qualitative indicators are often derived from open-ended text responses in questionnaires or structured face-to-face interviews. Commonly used questions used to derive qualitative indicators across the Exemplars included asking stakeholders for their wish-list of services, their concerns or opinions given different management scenarios, their preferences of the spatial use of different places, their perception of landscape quality, or their awareness of the impacts of the use of natural resources.

In general, quantitative indicators are often more easily observed and comparable than qualitative indicators. However, qualitative indicators can better reveal different types of value dimensions and why services matter to people (Martín-López et al., 2014). The type of indicator chosen also relates to the method for eliciting demand (Section 5 of this document). Indicators and methods should be selected together in an iterative process if possible. If you first chose an indicator, you will be restricted in the method suitable to measure it. On the other hand, if you first chose a method, it will restrict the type of indicator you can use. You might start with an indicator and look at the methods you could use and then go back to the indicator and adapt it to better suit the method.

Table 4. Characteristics of different indicator types for measuring ecosystem services.

Type	Category	Focus of Analysis
Quantitative	Biophysical	Ecosystem
Quantitative	Monetary	People
Quantitative	Ranking, score	People
Qualitative	Open	People

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4.3. Represent indicators clearly in words

Phrase your indicators in simple, clear, familiar language for your audience, not necessarily using the term “ecosystem services” or the specialist terminology from your particular ecosystem services framework. Since you have used a framework to develop your indicators, it will still be possible to “back translate” your work to a shared standard. In this stage, the words you select become your indicator. Informally discussing ecosystem services with several stakeholders can reveal common understanding and words for different services. It is best to pilot test indicators with members of your intended participant groups to make sure the descriptions selected are clear for them, and get feedback to improve before launching.

4.4. Examples from OPERAs

The use of indicators across the Exemplars in the Demand Synthesis Working Group is illustrated in Figure 3. Demand for ecosystem services in all three CICES ecosystem services categories was most often elicited with a method that assigns relative importance or a score to different ecosystem services. Indicators were derived by methods such as counting numbers of published papers, asking stakeholders to rank ecosystem services, or asking stakeholders to assign a value between 1 and 5 for the importance of different services. Monetary studies used indicators such as market prices for provisioning services (e.g., market price of fish), avoided costs for regulation services (e.g., avoided costs of repairing after storm or flood impacts) or willingness-to-pay for cultural services (e.g., willingness to pay for maintaining a cultural landscape). Biophysical indicators were either biophysical entities (e.g., NO_2 concentrations in air) or entities that resulted from processes in ecosystems and social-ecological systems (e.g., population density in urban areas).

Qualitative studies in the OPERAs Exemplars included in this synthesis relied on stated concerns or appreciations of stakeholders (e.g., concerns about impact of severe weather on crops). Overall, as Figure 3 illustrates, many of our studies investigated cultural ecosystem services, which is in contrast to more supply-side oriented studies and highlights the importance of cultural ecosystem services to stakeholders. Furthermore, our results do not support the common assumption that quantitative ecosystem services demand assessments are restricted to larger scales where corresponding consumption data are available (Busch et al., 2012), as the majority of the regional case studies used quantitative indicators.

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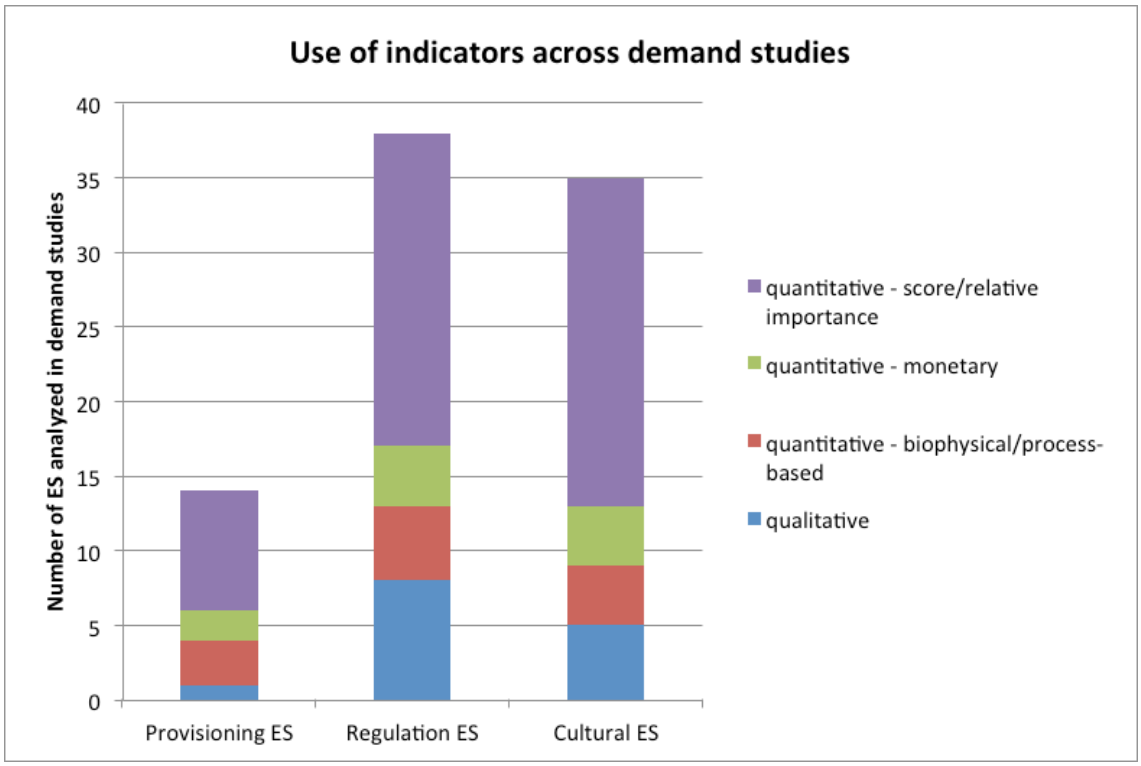

Figure 3. Use of ecosystem services indicators to analyze ecosystem service demand across the seven Exemplars in the Demand Synthesis Working Group. A total of different 87 ecosystem services were explored in these studies, spanning all three ecosystem services categories and using a range of different indicator types to elicit demand for these services.

Table 5 gives some examples of how ecosystem services were translated into indicators in our Exemplars. Starting with the CICES class, we determined whether the indicators should be quantitative or qualitative and then phrased them in clear, simple language. Further indicators for ecosystem service demand are reviewed by Wolff et al. (2015).

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Table 5. Examples of indicators translated into clear and simple language in the OPERAs Exemplars.

CICES Class	Indicator	Exemplar
Maintaining nursery population and habitats	Area of dry meadows in the region (hectares)	Swiss Alps
Heritage, cultural	Number of farms in the region	Swiss Alps
Mass stabilization and control of erosion rates	Quantity of natural hazard (avalanche) incidents within last 10 years	Swiss Alps
Experiential use of plants, animals and landscapes	Frequency of visits to special sites	Scotland Inner Forth
Cultivated crops	Grape yields (tons per hectare)	Wine
Aesthetic	Number of prizes granted for innovation in maritime promenade landscape architecture	Barcelona

5. Select method to elicit demand

5.1. Select an appropriate method to answer your questions for your case

Once you have selected your indicators, you must then choose the method(s) you will use to collect your data. There are many different methods that can be used to elicit demand for ecosystem services. The choice of method will depend on several of factors, including which ecosystem services you want to assess, what type of information you want to collect, what indicators you plan to use, how large a sample you want to engage, and how much time and resources you have to devote to your study. Some potential methods include choice experiments, surveys, focus groups, participatory GIS, interviews, and quantitative indicator analysis from existing databases, maps, and photos for desk-based research. Table 6 describes a number of these methods.

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Table 6. Illustrative methods used to elicit demand for ecosystem services for studies in this synthesis. See Appendix for study references.

Method	Description	Indicator type(s)	Ecosystem Services
Choice experiment	Participants choose between hypothetical options that differ in ecosystem services provision. Researchers analyze participants' preferences for ecosystem services based on the trade-offs in ecosystem services they were willing to make.	Quantitative	Any
Q-method	Participants sort statements from literature or popular discourse. Researchers analyze sorting to derive a handful of main perspectives on a topic.	Qualitative	Any
Participatory GIS	Participants mark places of importance on a map using an online tool or on paper. Researchers aggregate results and analyze patterns across space.	Spatially explicit; use-based or appreciation-based	Spatially explicit (not cultural intangible)
Quantitative indicator analysis	Existing data sources are used to map or quantify the distribution of ecosystem services that may be used as proxies for demand, e.g., photos uploaded to social media sites indicate aesthetic landscape enjoyment.	Quantitative	Any
Workshops	Participants interact with others and researchers during a range of exercises which may include discussion, mapping, listing, drawing, writing and playing games.	Quantitative or qualitative; spatially explicit or implicit; use-based or appreciation-based	Any, but especially cultural services that are best expressed in narrative methods; socially important services that require group deliberation; or situations where learning is required before participants feel comfortable to express their views
Focus groups	A discussion amongst a representative group of participants, moderated by facilitators.	Qualitative; spatially explicit or implicit; use-based or appreciation-based	Similar ecosystem services as in workshops
Surveys	Participants respond to a pre-defined set of questions without the presence of a researcher	Quantitative or qualitative; use-based or appreciation-based	Ecosystem services that are well known and understood by participants
Interviews	Participants interact with the researcher in person or over the phone.	Quantitative or qualitative; use-based or appreciation-based	Same as for surveys

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5.2. Consider the most appropriate format for conducting your method

In addition to selecting your method, it is also important to select the format in which you plan to carry out the method. This includes determining whether to meet in person or carry out your method online, as well as whether to engage stakeholders in groups or individually. As with the method, this depends on what type of information you want to collect, how large a sample you want to engage, and how much time, resources and effort you have to devote to your study. For example, carrying out a survey online might allow you to reach a greater number of stakeholders but likely would not achieve the depth of information that you might be able to collect by meeting in person. Similarly, a group workshop might reach a greater number of people and encourage more exchange than interviewing stakeholders individually, but might also limit the amount of information an individual stakeholder is able or willing to share.

5.3. Examples from OPERAs

Examples of the methods employed by each of the OPERAs demand studies and their rationale can be seen in Table 7. As seen from the table, the methods varied widely.

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Table 7. Examples of the methods used in OPERAs demand studies included in this synthesis. See Appendix 1 for study references.

Exemplar Study	Stakeholders	Method	Unit of Indicator	Why Chosen
Swiss Alps: Valuing mountain cultural ecosystem services	265 + 311 local residents in 2 villages	Choice experiment	Utility coefficient (willingness to pay)	Use of feasible alternatives in the elicitation process; based on the same theoretical background as method for simulating supply of ecosystem services; allows estimation of value in marginal changes in services; applicable to non-marketable services
Wine: Cultural values for vineyards	45 residents and wine producers	Q-method	Ranking of qualitative statements	Insight into various perspectives; allows comparison between people; interactive format
Wine: Low-carbon vineyard leaders & practices	10 global + 6 English wine producers	Online survey / semi-structured face-to-face interviews	Ranking of most important ecosystem services	Survey allowed contacting stakeholders around the world in a short time; interviews allowed for follow-up questions
Wine: Quantitative lit review of vineyard ecosystem services	Academic researchers (4000 papers)	Quantitative lit review	Number of peer-reviewed publications	To provide an overview of existing knowledge and knowledge gaps
Wine: Motives for organic winegrowing in Germany	12 German winegrowers	In-depth interviews	Qualitative statements	Allowed time for participants to consider their responses, as the topic was unfamiliar or not frequently discussed
Scotland Inner Forth: Local residents' value for coastal areas	109 local citizens	Workshops, choice experiments, participatory GIS	Spatial distribution & frequency of visits, votes for most important services, qualitative statements	Wide range of methods was included to allow participants to articulate values in different ways, which was particularly important for cultural services
Barcelona: Coastal restoration and construction with the local authority	Approximately 4800 photos + 220 beach visitors	Quantitative indicator analysis (photos), interviews, surveys	Observations and mapping (e.g., number of beach visits)	To reveal patterns in use and awareness in the local community
Danube: Support for wetland restoration	105 farmers, fishermen, local residents	Structured face-to-face interviews	Qualitative statements on use values	To reveal differences in awareness and value for ecosystem services
Europe: Regional-scale ecosystem services mapping	Regional datasets	Matching supply and demand indicators	Spatial analysis of European-wide datasets	To capture large-scale patterns revealed by existing data
Montado: Local & regional ecosystem services delivery	13 regional + 31 local (NGOs, municipalities, land managers, others)	Participatory workshops	Local: ranking ecosystem services, Regional: choosing the top 5 services	Ranking revealed differences in value between services, underlying motivations could be discussed in the workshops

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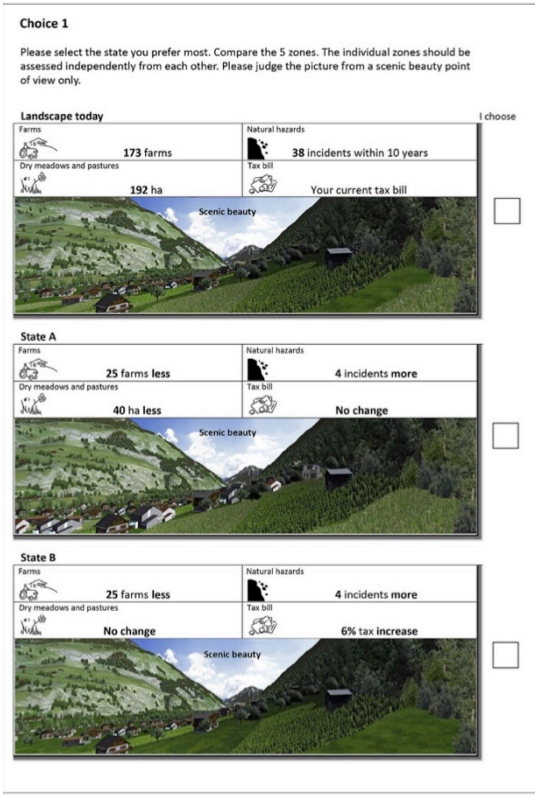
A specific example of a method used to assess stakeholder demand came from the Swiss Alps Exemplar, where the ecosystem service scenic beauty was represented in pictures for a choice experiment (Figure 4). Three landscape elements were represented by simple icons: farms (as an indicator for cultural heritage), natural hazards (mass flow regulation) and dry meadows and pastures (habitat service). In the choice tasks, stakeholders had to choose between the landscape today and hypothetical future states A or B. The icons and pictures were developed with a graphic designer and pilot tested with different people to reveal their intuitive associations with the symbols.

Figure 4. Visualizations used in the choice experiment in the Swiss Alps Exemplar (Brunner et al., 2016).



6. Elicit stakeholder demand for ecosystem services

6.1. Conduct research

Once you have selected an appropriate method to collect data that will achieve your study objective related to ecosystem service demand, you have to actually collect the data, that is, implement your research design and carry out the chosen method. Here a range of fundamental research design and subject-specific resources can be helpful, such as the Research Methods Knowledge Base

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(Trochim, 2006), or guides to specific research styles such as case studies (Yin, 2014) or methods such as surveys (Kelley et al., 2003).

6.2. Give space for stakeholders to express views in their own words

One important aspect of studying stakeholder demand is that participants will likely hold views that even the best study design cannot anticipate. And of course, no framework is entirely complete, or best for every application, so the ecosystem services framework may not capture some values important to your stakeholders. Therefore, it's important to include at least some open-ended questions to capture participant responses in their own words. For example, at the end of a structured survey, you might ask, "What is your most formative experience in [the study landscape], and why?" These questions, if linked with your research objectives, can be powerful in revealing and understanding participant motivations important to understand demand for ecosystem services.

6.3. Examples from OPERAs

As noted above, studies in the Demand Synthesis Working Group included a wide range of goals, methods, and approaches. More detail on how these studies were carried out can be found in Appendix 1.

7. Analyze and compare demand

7.1. Identify the most highly valued services within your study

Based the data you have collected, you should now be able to analyze your data to determine the ecosystem services most demanded by your stakeholders. These data can be analyzed in terms of both highest demand overall, and demand preferences between different groups of stakeholders (e.g., residents vs. tourists, farmers vs. birdwatchers). Understanding which stakeholders value which services and why can help identify management options to achieve shared objectives, or highlight areas of conflict to try to address.

7.2. Explore questions of scale

Scale is an important factor when assessing the importance of ecosystem services because services can be generated at a range of scales and supplied to stakeholders at many other different scales (Castro et al., 2014). This can sometimes create potential conflicts in environmental management, in particular between local stakeholders and stakeholders at larger scales (Hein, van Koppen, de Groot, & van Ierland, 2006). Comparisons across scales are seldom done (Dick, Maes,

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Smith, Paracchini, & Zulian, 2014) but can reveal important information about potential conflicts and trade-offs.

7.3. Compare stakeholder demand with ecosystem supply, and with ecological assessments of priority for conservation

It is also important to consider the relationships between ecosystem service demand and ecosystem service supply. There are often spatial differences between areas that have the capacity to supply ecosystem services, and those in which ecosystem services are demanded. Ensuring that areas prioritized for conservation and management are those that will benefit society requires identifying where demand and supply coincide (Verhagen et al., 2016). For example, ecosystem service maps that depict the capacity of the landscape to provide services can be weighted so that only the areas where the service is potentially demanded remain as relevant for the service. Multiple studies have demonstrated that policy appraisal and planning outcomes can be markedly different depending on whether or not demand is considered in the assessment (e.g. Luck et al., 2012; Cimon-Morin, et al,, 2014; Verhagen et al., 2016).

7.4. Compare between cases

One benefit of using a standard ecosystem services framework is that it supports comparisons between your study and other cases. Depending on your research question, you may be interested to know results for ecosystem services demand or supply in similar geographic regions (e.g., Mediterranean) or similar ecosystems (e.g., mountains). You may also be interested to compare how different systems facing similar problems (e.g., climate change, urbanization) have fared. For collaborative projects, the framework allows comparison between different cases to learn about unexpected synergies and deduce common patterns more easily, promoting deeper fundamental understanding. Even if your study does not focus on comparison, the use of a shared framework will facilitate others learning from your study in designing future research and in conducting future synthesis or meta-analysis efforts (e.g., IPBES (Díaz et al, 2015)).

7.5. Examples from OPERAs

The Montado Exemplar wanted to get an overall idea of the value of ecosystem services. The Exemplar started with the group level of the CICES framework and adapted it to their case, resulting in 12 groups of ecosystem services. Participatory workshops with different stakeholders of the Montado (e.g., landowners, land managers, beekeepers, hunters, researchers, etc.) were then conducted at both at the local and regional scales. Regional stakeholders chose the five most important ecosystem services and valued them on a scale of 1 to 5. A classification of 0.5 was further given to other services considered important but not in the top five, while services that were

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not considered important received a score of zero. At the local scale, stakeholders valued each of the 12 ecosystem services on a scale of 1 to 5. In the end all values were averaged by service for each scale.

Looking at demand for ecosystem services on at one scale (regional) in the Montado Exemplar revealed that regulating and maintenance services were most valued by the stakeholders, followed by provisioning services, while cultural services were seldom selected as important. Within the first category, soil formation and composition and maintenance of water quality were the most important services. Wild or cultivated products for food was the second most important for stakeholders in this agro-silvo-pastoral system (Figure 5).

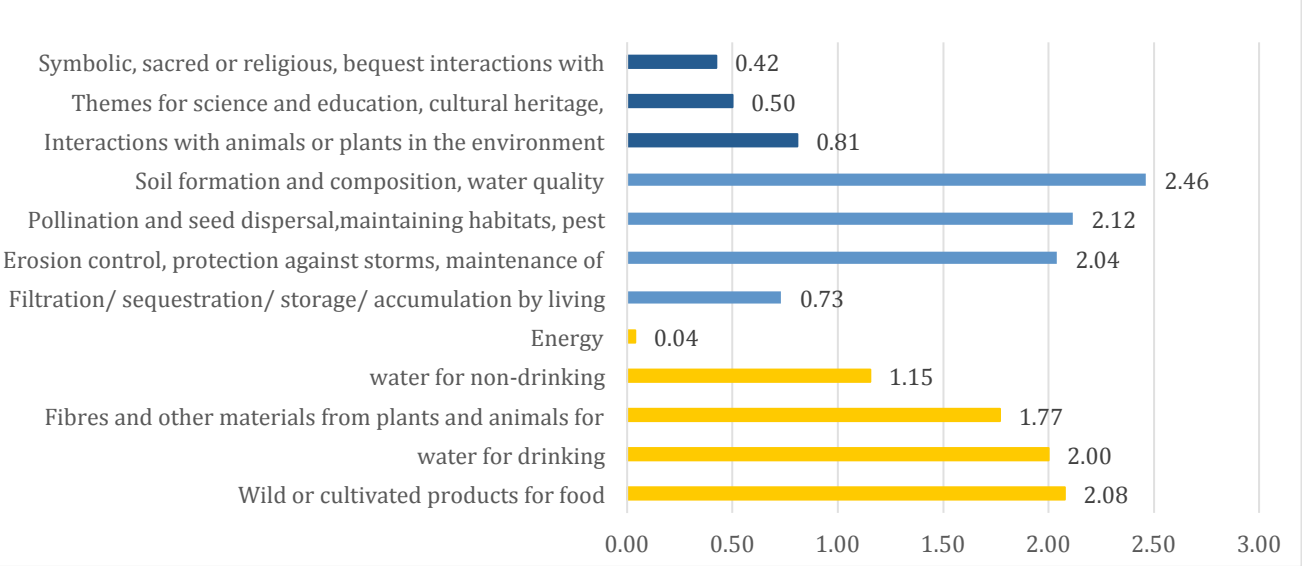

Figure 5. Bar plot showing workshop results for ecosystem services valuation by the Montado stakeholders at a regional scale. Plot axis represents the classification given by the stakeholders to each of the 12 ecosystem services on a scale of 1 to 5 for the five services considered as most important. Other ecosystem services considered as important (but not in the top five) were given the classification of 0.5. Services considered not important received a value of zero. All values were averaged for each ecosystem service. Dark blue: cultural ecosystem services; blue: regulation and maintenance services; yellow: provisioning services.

Comparing the Montado Exemplar's demand for ecosystem services at the regional scale with that at the local scale reveals different levels of demand (Figure 6). For example, although stakeholders rated soil formation and composition as the most important service at both scales, demand for cultural ecosystem services such as science and education was quite a bit higher at the local scale than at the regional scale.

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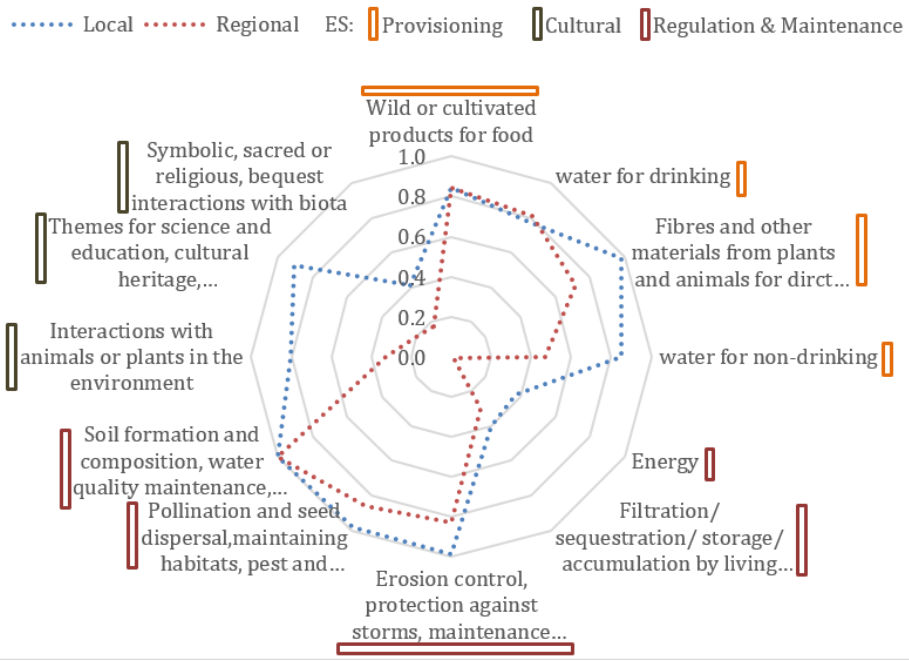

Figure 6. Radar plot showing workshop results for ecosystem services valuation by the Montado stakeholders at both local (N=31 stakeholders) and regional (N=13 stakeholders) scales. Plot axis represents the classification given by the stakeholders to each of the 12 ecosystem services on a scale of 1 to 5 for local scale and on a scale of 1 to 5 or the five considered as most important at the regional scale. At the regional scale, other services considered as important (but not in the top five) were given the classification of 0.5, while services considered not important received a value of zero. All values were standardized by dividing the values by the maximum of each scale.

In the Demand Synthesis Working Group as a whole, our use of CICES allowed us to compare demand across quite different OPERAs exemplars. To do so we selected six services that were the most commonly measured and/or the most highly valued in one or more of our studies. We chose two provisioning services (nutrition and materials), two regulating and maintenance (flow mediation and “maintenance of physical, chemical, biological conditions”, renamed Habitat for labeling below), and two cultural services (scientific and aesthetic). We represented the results in a flower diagram (Figure 7).

The indicators used varied between studies, so each petal in the flower diagram represents the same CICES class but may have measured different things. For example, for the orange “flow mediation” petal in Figure 7, the Swiss Exemplar used willingness to pay for one less natural hazard (avalanche), the Wine Exemplar used soil conservation and erosion protection (among other things), the Scotland Inner Forth Exemplar used “coastal safety”, the Barcelona Exemplar used “beaches as

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a buffer system against storm and flood events", and the Montado Exemplar used erosion control and storm protection (among other things).

Drawing on a method developed by Malinga (2016), we normalized the maximum value for a given service (e.g., nutrition) within one study by calculating the ratio between the demand for that service, and the highest demand expressed for any service in the same study. Therefore, the petal length in the flower diagrams represents relative demand within each study, relative to the maximum demand observed. Since each study is assessed relative to its own maximum, we can use these flowers to compare relative demand between studies, but not to compare absolute values of service delivery between studies.

Overall this figure shows that all five studies valued flow mediation (this could vary widely, from carbon sequestration to avalanche protection). Scientific services were also valued in four of the studies. Aesthetic services were valued for the Swiss Alps, Wine, and Montado Exemplars.

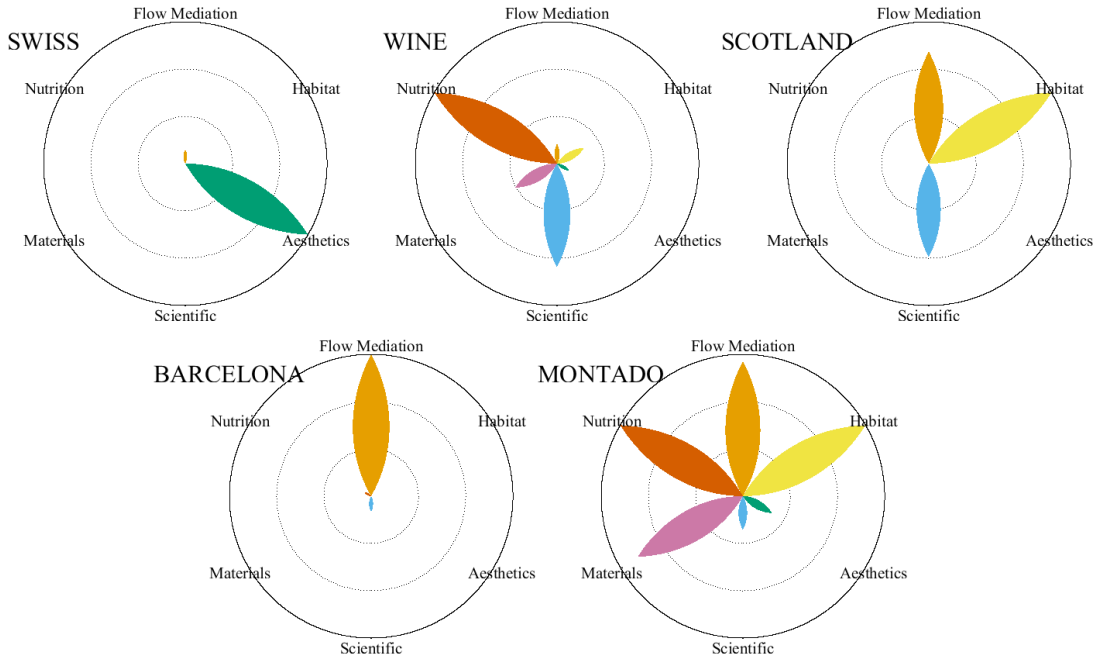

Figure 7. Relative demand for the six most valued ecosystem services across five OPERAs exemplars. Petal length depicts relative demand within one study, from 0% in the middle to 100% (the most highly valued service within that study) at the outer ring. For example, in the Wine Exemplar, nutrition was the most highly demanded service, and thus it is counted as 100%. Other petal lengths are relative to this baseline, e.g., demand for materials was about one third as high as for nutrition in the Wine Exemplar. Services that were not measured are not shown.

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8. Assess implications of results

8.1. Draw conclusions from your analysis

For an applied study, the ultimate goal of assessing demand for ecosystem services is to use this information to help improve policy and practice. It is thus important to consider both what your results mean for stakeholders and how they could be actionable and for whom.

8.2. Communicate demand

As with eliciting demand, it is important to communicate the results and implications of your study in a way that resonates with your various stakeholders. This includes tailoring your message and communications vehicle to your audience. For example, while a policy brief might be the most effective vehicle to reach a local government official, it is likely not an appropriate communications tool for an audience of local citizens. It is also important to keep in mind that different stakeholders may be positively or negatively affected by any actions you propose.

8.3. Determine action plans to use your results to improve policy or practice

Understanding demand for ecosystem services can help you determine potential strategies and actions to improve policy or practice. For example, given an ecologically important ecosystem service, if demand for that service exceeds supply – i.e., stakeholders already value the ecosystem service but more needs to be done to increase provision of the service – you could harness this interest to involve the community in management of the ecosystem. On the other hand, if supply of the service exceeds demand – i.e., there is sufficient delivery of the service but stakeholders don't value it highly – you could educate stakeholders on why the service is important and link it to something they already care about to ensure they do value and thus protect it (Figure 8).

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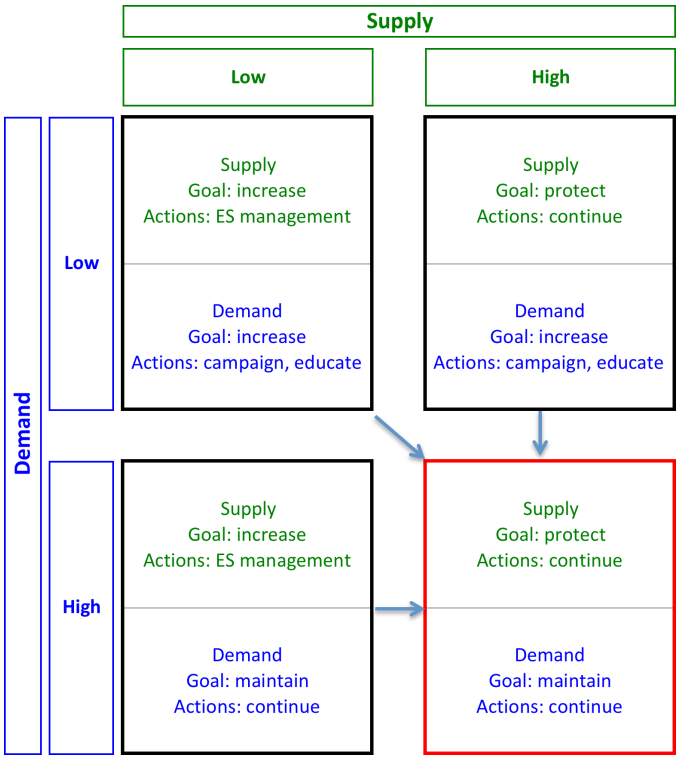

Figure 8. Assessing both supply and demand for an ecologically important ecosystem service can help determine potential actions to improve or maintain that service. For example, if the supply (green) of a particular service is low but demand (blue) is high, one strategy could be to harness this demand and involve stakeholders in managing the ecosystem to help increase the provision of the service. Ultimately, the goal is to get to place where both supply and are sufficiently high (red box).

8.4. Example from OPERAs

The Danube Exemplar conducted a demonstration with stakeholders of one of the tools used in their study to support management planning and wetland restoration decisions in the Persina Nature Park. The park management and regional environmental inspectorate reviewed the results. The Exemplar also shared results with the Bulgarian Executive Forestry Agency, as the agency is currently selecting a methodology for estimating demand of forest ecosystem services, to support a nation-wide forest owner compensation scheme to be launched in 2018-2020.

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Discussion

Through collaborating across OPERAs Exemplars, we were able to identify common threads in our approaches from very different studies that aimed to elicit stakeholder values for ecosystems. This affirmed the importance of eliciting stakeholder values and helped us to reflect on our approach to doing so, resulting in the creation of this eight-step framework, which we hope will be of use to researchers in the future.

There are a number of points to reflect upon from our experience with applying this framework for eliciting demand for ecosystem services, especially regarding methodological challenges and the potential for conflicts of interest in dealing with an inherently normative issue like ecosystem services demand.

Methodologically, we found that even following similar approaches between the OPERAs Exemplars, it could still be quite a challenge to pull together and compare data. Each study had its own goals and therefore assessed different things, and did so via different indicators and methods. This could make it difficult to compare results between studies. Using the eight-step framework presented here, however, could make it easier for researchers in the future to share a common approach that would facilitate comparisons. We also realized the importance of consistent data curation and management for transparency in research, and to facilitate participation in future comparisons and meta-studies.

In terms of conflicts of interest, we found examples of conflicts both between researchers and stakeholders, and between different groups of stakeholders. In the first case, there may be a mismatch between ecosystem services demand by researchers and by stakeholders. For example, stakeholders may highly value a service that is ecologically trivial, while not being aware of or interested in a service deemed ecologically critical. This may be particularly true for regulating services, which are often more abstract and hard to see. Cultural ecosystem services have until recently been less well studied by researchers, but for stakeholders they might be a crucial part of their relationship with the ecosystem (Chan et al., 2012; Daniel et al., 2012).

Conflicts between stakeholders can also be revealed (or even created!) by assessing ecosystem service demand, especially if recommendations for policy and practice are made. This is because there are likely divergent interests, where certain groups of stakeholders will experience different costs and benefits from proposed conservation or management policies. For example, in the Inner Forth, the proposal for managed realignment of the estuary via wetland restoration was supported by bird conservation organizations and town planners as a flood control measure, but opposed by the landowners who would have to give up farming on their land to convert cropland to wetland. The researchers in the Inner Forth have been working with local residents in the area to gauge citizen

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perspectives on the proposal for wetland restoration. Inclusion of a wider range of stakeholder perspectives, such as citizens, is an important step towards dealing with conflicts that arise from trade-offs related to ecosystem service demand.

Our analyses also revealed several opportunities for future research. One such opportunity would be addressing the complexity and diversity of ecosystem services demand. Different stakeholder groups often exhibit conflicting demands, which necessitates trade-offs in policy and management decisions. Research on demand for ecosystem services can help illustrate and contribute to solving potential conflicts of interest and supporting negotiation processes (Geijzendorffer et al., 2015).

Another area of potential research includes further explorations of both spatial and temporal scales. Demand for services is generated at different spatial and temporal scales. The notion of different spatial scales has been already developed and used for ecosystem service supply, but similar considerations are underdeveloped for ecosystem service demand. While certain demands are focused on local services (e.g., air purification), demand for other services can be more diffuse (e.g., carbon sequestration) or be linked at higher spatial scales (e.g., water purification). At the same time, the temporal dynamics of ecosystem service demand require further investigation. Longitudinal studies of demand could help understand the ability of stakeholders to adapt to changes in ecosystem supply over time (Wolff et al. 2015).

Finally, to support the development of sustainable and equitable management strategies, access of stakeholders to demanded ecosystem services needs to be explored. Often, issues of ownership, social status, education, or gender hinder the accessibility of ecosystem services and result in unsatisfied demand. Science can contribute to unravelling such obstacles and developing fair solutions (Geijzendorffer and Roche 2014).

Conclusion

Researchers often focus at the beginning of the ecosystem services cascade with the supply of services that their study system can or does provide. They may be guided in their choice of key services by their disciplinary background (seeing what is perceived as important to their discipline), or focus on services of high ecological interest or important conservation status, identified through expert analysis. They often seek to quantify the services they research. Stakeholders, on the other hand, often experience ecosystem services through their demand for them, based on their own personal, direct, daily, tangible, visible experience of the benefits from these services. Better understanding and linking these two perspectives can help more fully achieve the potential for ecosystem services to improve policy and practice.

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Appendix 1. List of OPERAs Exemplar studies referenced in this document

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Swiss Alps	1. Brunner, S, R Huber & A Gret-Regamey. 2016. A backcasting approach for matching regional ecosystem services supply and demand. Environmental Modelling & Software 75: 439-458. 2. Ryffel, A, R Huber, R Seidl, and A Gret-Regamey. In review. Regional differences in preferences for ecosystem services: a choice experiment approach in two Swiss mountain regions.
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Appendix 2. The Demand Synthesis Working Group

Over an eight-month period, seven of the OPERAs exemplars formed a working group to synthesize our experiences in researching the demand for ecosystem services. These cases were diverse, ranging from global literature reviews (Wine Exemplar) to expert interviews and distributed questionnaires among many local residents (Swiss Alps Exemplar). Many of the OPERAs exemplars are extensive and include multiple studies. However, for this synthesis, we focused on the specific studies within each Exemplar that had measured stakeholder demand for ecosystem services (see Appendix 1).

The group members collaborated to design the synthesis process and share information on their studies, in a process developed through regular Skype calls and email exchanges. We developed electronic templates and questionnaires to harmonize very different kinds of qualitative and quantitative data across studies, and also shared a repository of papers, presentations, and other materials across Exemplars in order to learn more about what each Exemplar had done. Based on this iterative process, we propose the above eight-step framework for eliciting ecosystem service demand.

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