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Published in:
Ecosystem Services

DOI:
10.1016/j.ecoser.2015.11.012

Print publication: 01/01/2016

Document Version
Peer reviewed version

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Highlights

- We completed a SWOT analysis of the ecosystem services (ES) framework
- The ES approach is a useful interdisciplinary communication tool
- Implementation is hampered by incomplete science and inconsistent application
- The ES approach could benefit from more alignment with existing policies and tools
- Threats include insufficient funding and a loss of political will
- We discuss strategies in light of the SWOT for furthering the approach

Strengths, Weaknesses, Opportunities and Threats: a SWOT analysis of the ecosystem services framework

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Article type: *Original Research Article*

Keywords: *Environmental policy; expert survey; Young Ecosystem Services Specialists*

Word count: *Abstract = 200; manuscript = 7,227. Number of figures = 6, number of tables = 5.*

Abstract

The ecosystem services concept (ES) is becoming a cornerstone of contemporary sustainability thought. Challenges with this concept and its applications are well documented, but have not yet been systematically assessed alongside strengths and external factors that influence uptake. Such an assessment could form the basis for improving ES thinking, further embedding it into environmental decisions and management.

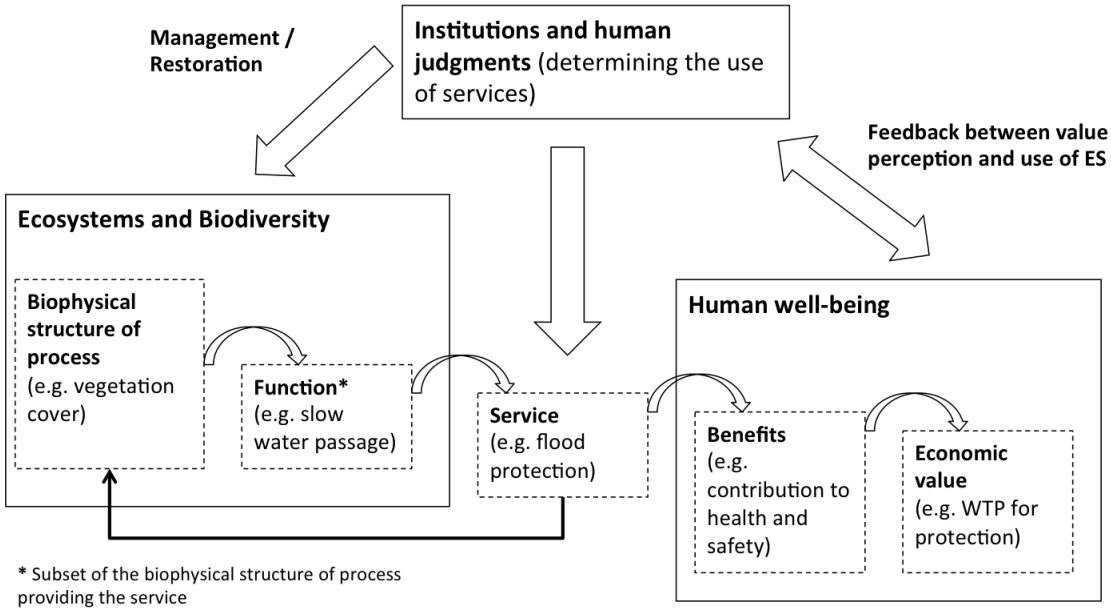
The Young Ecosystem Services Specialists (YESS) completed a Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis of ES through YESS member surveys. Strengths include the approach being interdisciplinary, and a useful communication tool. Weaknesses include an incomplete scientific basis, frameworks being inconsistently applied, and accounting for nature's intrinsic value. Opportunities include alignment with existing policies and established methodologies, and increasing environmental awareness. Threats include resistance to change, and difficulty with interdisciplinary collaboration. Consideration of SWOT themes suggested five strategic areas for developing and implementing ES.

The ES concept could improve decision-making related to natural resource use, and interpretation of the complexities of human-nature interactions. It is contradictory – valued as a simple means of communicating the importance of conservation, whilst also considered an oversimplification characterised by ambiguous language. Nonetheless, given sufficient funding and political will, the ES framework could facilitate interdisciplinary research, ensuring decision-making that supports sustainable development.

1. Introduction

The term ‘ecosystem services’ (ES) was first introduced in the 1980s as an advocacy tool for biodiversity conservation, and has since been subjected to a variety of definitions and classifications (Ehrlich & Ehrlich, 1981; Ehrlich & Mooney, 1983; Chan et al., 2007; Peterson et al., 2010). Since the 1990s, the continued evolution of ecosystem service definitions and classifications has been well documented (e.g. Costanza et al., 1997; Daily, 1997; MEA, 2005; Boyd & Banzhaf, 2007; Wallace, 2007; Chapman, 2008; Costanza, 2008; Fisher et al., 2009; TEEB, 2010; Böhnke-Henrichs et al., 2013). Whilst there is no one universal ecosystem services definition or framework, a recent and widely cited definition considers ES to be “the direct and indirect contributions of ecosystems to human well-being” (Braat & de Groot, 2012; TEEB, 2012; Fig. 1). Whilst critical voices have considered this a reflection of a utilitarian and anthropocentric view of nature, others emphasise that the concept of ES implies a worldview that humanity must be treated as part of nature rather than separate from it, and that we fundamentally rely upon functioning ecosystems – a view that has become increasingly recognised in recent decades (Mace, 2014). For the purposes of this paper, we define an ES framework to be “a framework by which ecosystem services are integrated into public and private decision making” (Ranganathan et al., 2008). Such an approach can include valuation of the goods and services provided by nature to society, thus enabling them to be incorporated into decisions regarding the governance of natural resources (Daily et al., 2000; Yousefpour et al., 2012). An ES framework is not restricted to economic valuation, and also allows the integration of multiple value domains (ecological, social, cultural and economic values), thus acknowledging the complexity of social-ecological systems in decision making (Martín-López et al., 2014) and the plurality of human values (Kenter et al., 2015).

***Figure 1**: Schematic representation of the conceptual thinking behind the ecosystem services framework (modified from: Braat & de Groot, 2012).*



Although the academic literature continues to debate the definition of ES, decision makers have increasingly implemented ES as part of environmental and natural resource policies and management frameworks. However, the viability of the ES framework has been challenged both conceptually and practically (McCauley, 2006; Redford & Adams, 2009; Norgaard, 2010; Peterson et al., 2010; Barbier, 2012; Beaudoin & Pendleton, 2012; Ressurreição et al., 2012; Sitas et al., 2013). A recent review by Schröter et al. (2014) highlights that the conceptual basis for ES may conflict with: biodiversity conservation; a fear of 'selling out' on nature; the commodification of nature; the vagueness of the concept; and, the power dynamics involved in ES research and management (see also Bowles, 2008; Naidoo et al., 2008; Bullock et al., 2011; Sommerville et al., 2011; Büscher, 2012; Luck et al., 2013). Knowledge gaps, specific to the connectivity between sustainability and human well-being, have also been highlighted as a challenge for the successful implementation of the ES concept (Nicholson et al., 2009; Chan et al., 2012), as have problems with existing tools, datasets and frameworks (Naidoo et al., 2008; Keeler et al., 2012).

In light of these concerns and challenges, significant research investment continues to seek the 'best' implementation pathways for the ES concept (Kremen & Ostfeld, 2005; Carpenter et al., 2009; Petz et al., 2012). As part of a collective endeavour to better understand how to operationalize the ES concept, an increasingly wide variety of implementation frameworks (Cowling et al., 2008; Nahlik et al., 2012; Petz & van Oudenhoven, 2012), payment structures (Gibbons et al., 2011; Sommerville et al., 2011; Bryan,

2013), ES tools (Nelson & Daily, 2010), and datasets (Schulp et al., 2012; Baral et al., 2013) have been developed and trialled globally.

Paralleling the proliferation of these disparate approaches, and despite concerns from some regarding the extent to which the ES concept can realistically deliver upon its objectives (e.g. Norgaard, 2010), the concept has begun to inform an increasingly wide range of national and international legislation and agreements (Perrings et al., 2010). Examples include the ecosystem-based management on which the European Marine Strategy Framework Directive is built (Long, 2011; Jobstvogt et al., 2014), the 14 Aichi Targets developed by the Convention on Biological Diversity (Strategic Goal D; CBD, 2010) and incorporation of ES in the CBD Ecosystem Approach, as well as the relatively new Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES; Larigauderie et al., 2010).

Given the landscape of conceptual and intellectual debates, practical concerns, and increasing legislative consideration, it is important to continually and critically appraise the ES concept – searching for gaps, suggesting how any gaps might be filled, and considering to what extent the approach remains fit for purpose in a wider context. Here, we look critically at the ES concept through a Strengths-Weaknesses-Opportunities-Threats (SWOT) type analysis. Existing reviews have explored challenges to the successful implementation of the ES concept (Wallace, 2007; de Groot et al., 2010). Our SWOT assessment presents these challenges in a broader context – by providing an integrated, structured analysis of perceived strengths and weaknesses within the ES concept and its applications, as well as of the external opportunities and threats that may benefit or impede further development. Additionally, we use such analyses to begin developing strategies that might overcome existing or future challenges to the ES concept.

For the purposes of this paper, the authors surveyed an interdisciplinary group of ES researchers and practitioners – the Young Ecosystem Services Specialists (Böhnke-Henrichs et al., 2014) – eliciting their perceptions on the Strengths, Weaknesses, Opportunities and Threats of applying the ES concept for natural resource policy, planning, governance and management. YESS members are diverse, working across a wide range of ecosystems and disciplines, applying a variety of different methods and approaches to study and implement the ES concept (Böhnke-Henrichs et al., 2014). The rationale for relying upon early career ES researchers was to capture the perspectives of those who have a substantial, up-to-date understanding of the topic, but joined the field of ES research and implementation after its inception rather than being amongst those who first established it. Such researchers and practitioners are likely to critically think about established concepts, have cutting-edge experience of research on and implementation of the ES framework, and be actively engaged in innovation.

2. Material and Methods

A mixed methods research strategy (Teddlie & Tashakkori, 2011) was employed, in the form of online surveys and face-to-face discussion groups, so as to elicit the perceptions from YESS members on the Strengths, Weaknesses, Opportunities and Threats of the ES framework. Applying a mixed methods approach allowed researchers to better capture the richness and complexities of the phenomena under study than by using a singularly qualitative or quantitative approach.

2.1 *Survey respondents*

Young Ecosystem Services Specialists (YESS) is an international network of early career doctoral and postdoctoral researchers, lecturers, and practitioners working on a variety of ES topics at a range of research, environmental and nature conservation organisations. At the time of the SWOT analysis, there were 67 active members of YESS. As members represent a range of expertise in the ES field, they were considered sufficiently well informed to complete a SWOT analysis of the ES framework. Respondents' backgrounds span the natural sciences and environmental and ecological economics, but other social sciences were under-represented and there was no participation from arts or humanities scholars. As such, the sample is not representative of the whole early career ES research community.

2.2 *SWOT analysis and development of strategies*

SWOT analyses derive their name from the assessment of the Strengths (S), Weaknesses (W), Opportunities (O), and Threats (T) faced by an industry, sector, company or any organisation (Gao & Peng, 2011). The idea of a SWOT analysis has its roots in strategic management research conducted in the 1960s and 1970s (Arslan & Er, 2008; Sevkli et al., 2012), and arises from the perspective that the performance of a given (typically economic) agent with respect to a particular objective depends upon the way in which the management of that agent interacts with both the *internal* characteristics of the agent, and the broader *external* context in which the agent must act (but over which the agent has no direct control in the short term) (Houben et al., 1999).

When applied to ES and its associated research fields, Strengths can be considered to be those features of the ES concept that underpin the ability of the concept and the field to achieve the implicit goals of:

a) increasing awareness of the extent to which human societies interact with and are dependent upon the environment;
b) better integrating the natural and social sciences and engaging and acknowledging stakeholder knowledge;
c) greater understanding of the impacts of environmental change and environmental policy on human wellbeing; and,
d) contributing towards achievement of sustainable relationships between human society and ecosystems.

By way of contrast, Weaknesses are attributes that can undermine the achievement of the goals (a-d) unless they are specifically addressed and improved. Here, Strengths and Weaknesses can be considered features of the ES concept itself, or 'internal' features. Conversely, Opportunities include the economic, technical, social, political, legal, and environmental features representing the context within which the ES concept is implemented, and that may facilitate or encourage the achievement of these goals. We thus consider Opportunities to be 'external' features. Threats are, similarly, external features that may prevent the accomplishment of the above goals (a-d).

The value of a SWOT analysis stems not only from its ability to highlight ways in which an agent's internal and external environments interact to affect its success (Houben et al., 1999), but also from its ability to be used in the development and implementation of long-term strategies to achieve particular objectives (Houben et al., 1999; Yuksel & Dagdeviren 2007; Arslan & Er, 2008; Gao & Peng, 2011; Mainali et al., 2011; Sevkli et al., 2012). There are various classes of strategies that can follow from a SWOT analysis: e.g. those that link Strengths and Opportunities ('SO Strategies'), those that link Weaknesses and Opportunities ('WO Strategies'), those that jointly focus on the Strengths and Threats ('ST strategies'), and those that arise from the joint assessment of Weaknesses and Threats ('WT Strategies'). For example, SO strategies utilise the fact that Strengths may help to capitalise upon external Opportunities, whereas WO strategies focus upon the pursuit of external Opportunities to lessen the severity of Weaknesses. Similarly, ST strategies focus on the potential for existing internal Strengths to mitigate the impact of external Threats, while WT strategies consist of actions intended to reduce both internal Weaknesses and external Threats simultaneously (Sevkli et al., 2012).

2.3 *Analytical procedure*

In conducting a SWOT analysis of the ES framework, an iterative approach was used. The first step of the process involved an online pilot survey (Survey 1) of 20 YESS network members, who were simply asked to share their perceptions about the Strengths, Weaknesses, Opportunities, and Threats (SWOT) of applying the ES framework in their work, as an open question. The pilot study was followed by two main surveys (i.e. Survey 2 and 3), where the framing of survey questions was refined based on pilot survey findings. The surveys took place in 2013: the pilot survey from January to March, Survey 2 from August to September, and Survey 3 from November to December.

A central research coordinator compiled the responses from the pilot survey, and attempted to identify themes for each SWOT characteristic, including the frequency with which the theme emerged.

Figure 2: *The development and delivery of the ES SWOT research process*

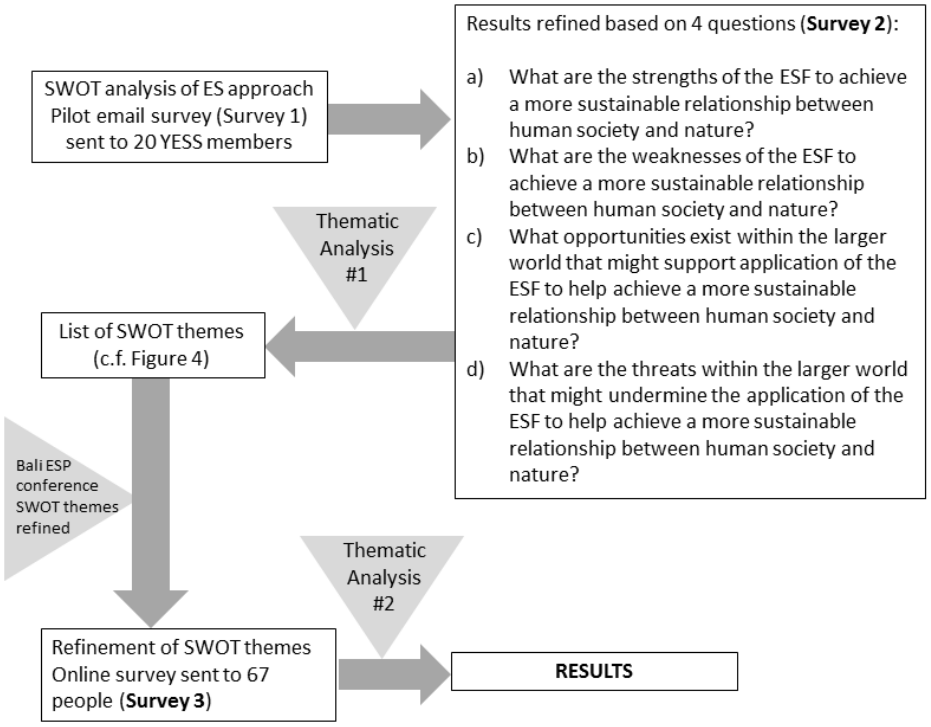
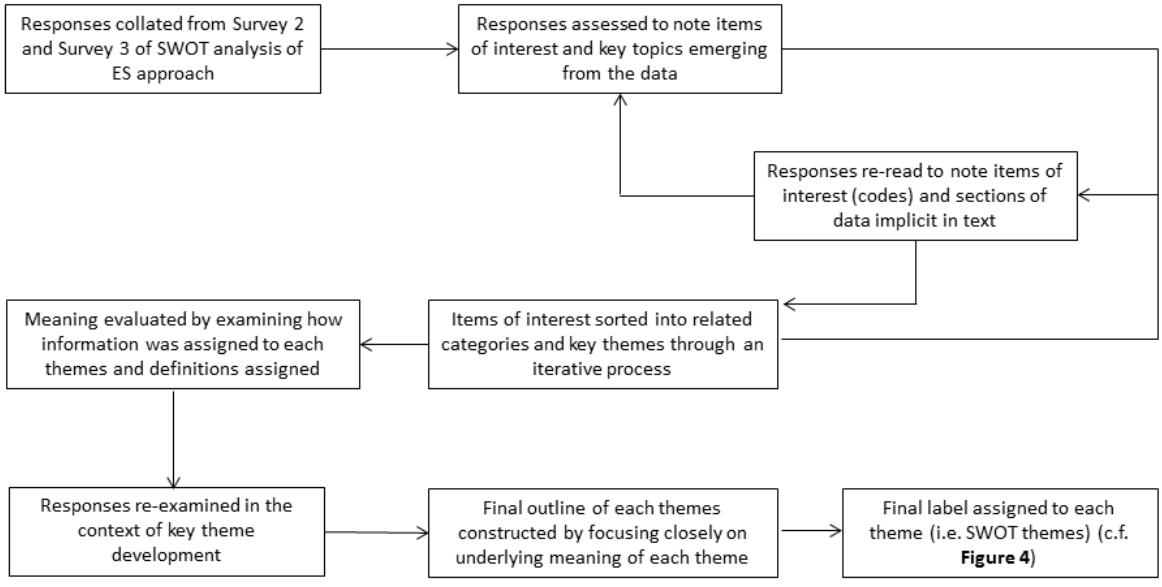


Figure 3: *The analytical process performed upon responses to Surveys 1 & 2, to develop SWOT themes*



The results of the pilot survey generated varied responses and fragmented agreement for each SWOT category – thus, the outcomes were sent back to YESS members, who were asked to refine their responses based on the following, more structured questions (Survey 2), and considering the goals (a-d) outlined in section 2.2:

a) What are the Strengths of the ES framework to achieve a more sustainable relationship between human society and nature?

b) What are the Weaknesses of the ES framework to achieve a more sustainable relationship between human society and nature?

c) What Opportunities exist within the larger world that might support application of the ES framework to help achieve a more sustainable relationship between human society and nature?

d) What are the Threats within the larger world that might undermine the application of the ES framework to help achieve a more sustainable relationship between human society and nature?

A thematic analysis was carried out on the results of Survey 2 by two independent YESS researchers (Fig. 3). 'Themes' were considered to arise if similar suggestions were made by more than one respondent (e.g. 'the ES framework is interdisciplinary', as a Strength). The researchers identified between 10-13 themes per SWOT category with the requirement that both researchers had to reach consensus on the existence and wording of each theme. The results of that stage were presented, discussed and refined at the Ecosystem Services Partnership (ESP) conference in Bali in 2013[1], during a facilitated YESS workshop. Themes in all four SWOT categories were presented and explored in open discussion. Note that themes were not removed or added at this stage, as the goal was not to change the outcomes of the original survey; rather, their meaning was clarified as far as possible for a wider audience.

Following this refinement, a third online survey (Survey 3, Appendix) was developed and a link sent to all YESS members. Survey 3 required respondents to share their level of agreement on a 9-point scale from -4 ("strongly disagree") to +4 ("strongly agree") for each theme identified in the previous stage by the research coordinators, and refined at the Bali conference. 'Level of agreement' was then measured between 0% and 100%, corresponding to the percentage of respondents that agreed with the theme (i.e. rating on the agreement scale between +1 to +4) or disagreed with the theme (i.e. rating between -4 to -1).

Respondents then ranked the themes' respective perceived importance by selecting the three most important themes within each of the four SWOT categories. We used a weighted sum procedure for this

[1] http://previous.espconference.org/previous_editions/81764/5/0/60

part of the analysis (i.e. scores per respondent: 3 = most important; 2 = second most important; 1= third most important) and presented the group result as the 'total importance score'. The maximum total importance score would have been 60, if all respondents chose the same theme as most important.

3. Results

3.1 *Final survey respondent demographics*

Following Surveys 1 (pilot) and 2, 20 YESS members participated in the final SWOT Survey 3 (~30% response rate). The average participant was 33 years old (min. 26 years, max. 45 years) with men and women equally represented. The sample covered researchers from 16 different countries. Participating YESS members were predominantly PhD students or postdoctoral researchers with an average of three years of ecosystem services research experience (min. one year and max. 9 years). The majority of participants stated that they had a background in environmental/conservation sciences (75%) or environmental/ecological economics (40%) (Table 1).

Table 1: *Stated group affiliations of YESS survey participants (Survey 3)*

Research/practice field	**Frequency***
Environmental/conservation sciences	15
Environmental/ecological economics	8
Agriculture/forestry	5
Ecology/ecosystem sciences	5
Geography	4
Biological sciences	4
Environmental policy/governance studies	4
Sustainability studies	4
Others	5

** Multiple selections and open responses were possible. The number of participants was 20*

3.2 *Breakdown of outcomes by SWOT category*

3.2.1 Strengths

Amongst the key themes identified across all four SWOT categories (Fig. 4), the interdisciplinary approach was highlighted as the most important Strength of the ES framework (in this case a total importance score of 28 as a weighted sum). This was followed closely by the chance to improve accounting for nature (*score*=24) and taking a holistic approach (*score*=16). Raising societal awareness of ES benefits (*score*=9), the ability of the ES framework to reconnect people to nature (*score*=7) and the

conceptual simplicity of the ES framework (*score*=5) were noted as key strengths, but were ranked lower in importance in comparison to the founding purpose of the ES concept (i.e. as a communication and advocacy tool; *score*=13). These findings indicate that survey respondents believe that fundamental Strengths of the ES framework lie in its interdisciplinary potential and in its ability to support improved decision-making. The respondent's agreement with the themes presented to them as Strengths ranged from 80%-100% (***Table***).

Figure 4: *SWOT themes ranked according to their total importance score. The score is expressed as weighted sums (scores per respondent: 3 = most important; 2 = second most important; 1 = third most important; 60 = maximum group score).* Symbols□(○ □ ◗+✶) and shading indicate the 5 different strategy topics that emerged from the SWOT themes. For details see section 3.3

Table 2: *Strengths of the ES framework identified. 'Importance score' and 'agreement with theme' measured during survey 3, as specified in the Material and Methods section.*

Survey themes	Total importance score	Agreement with theme (%)
Interdisciplinary approach: The diversity of disciplines involved in ES research strengthens the framework. The ES framework is methodologically flexible; it invites methods stemming from different disciplines to be applied and new methods to be developed.	28	95
Improved accounting for nature: Ecosystem services valuation might improve environmental decision making by accounting for the freely available and often intangible services provided by nature.	24	100
Holistic approach: The ES framework takes a holistic perspective that brings social, ecological and economic values together and highlights trade-offs between and within the three dimensions.	16	100
Advocacy and communication tool: The ES framework provides a tool to advocate and communicate nature conservation, by adding social and economic reasoning to ethical arguments.	13	100
Increased societal engagement: The simplicity and anthropocentric perspective of ecosystem services facilitates its uptake by a wide range of actors and sectors e.g. policy makers, media, businesses and the general public. This might lead to larger engagement of these groups in nature conservation processes.	9	85
Equity in natural resource allocation: The ES framework could lead to more equity in natural resource allocation through improved accounting for ES and more equitable distribution of natural resources amongst stakeholders.	9	80
Reconnecting people to nature: The link between the biophysical and human dimensions of ecosystems is made explicit by the ES concept. The ES framework makes nature conservation about what matters to people.	7	80
Conceptual simplicity: The ES framework outlines the multifaceted way in which society benefits from ES and addresses the cause-effect relationship between environmental impacts and human well-being in an easy understandable manner.	5	90
Knowledge base: The ES framework enables us to categorize and organise our knowledge about the interconnectedness of humans and nature. This is an important pre-requisite to improving our understanding of the complexity of these connections.	5	95
Works on different scales: The ES framework enables the use of different geographical and temporal scales to account for ES. It can account for ES that are provided to distant areas or future generations and allows cross-comparison of local and global impacts.	3	90

3.2.2 Weaknesses

Survey respondents agreed that the two main Weaknesses in the ES framework are an incomplete scientific basis (*score*=20) and inconsistencies in the application of a divergent range of available ES frameworks (*score*=16) (Table 3). Questionable measures of the intrinsic value of nature (*score*=14), the ambiguous language of the ES framework (*score*=13), and an overemphasis on monetary values (*score*=11), were also considered key weaknesses by survey respondents. The need for better tools (*score*=3) and the scale-dependence of outcomes (*score*=4) were the lowest ranked weaknesses of the ES framework. Overall, survey respondents highlighted the need for: greater methodological and terminological consistency; an overarching ES framework in the short term; further research; better understanding of ES supply; better understanding of the relationship of ES supply to maintaining or enhancing biodiversity in the long-term; and enhancing the influence of non-monetary methods to assess ES.

The respondents' agreement across themes ranged from 65% to 80%, i.e. lower than for the strengths (Table 3).

***Table 3**: Weaknesses of the ES framework identified. 'Importance score' and 'agreement with theme' measured during survey 3, as specified in the Material and Methods section.*

Survey themes	Total importance score	Agreement with theme (%)
Scientific basis incomplete: Our current understanding of the links between, biodiversity, ecosystem functioning and ecosystem services provision is poor.	20	70
Framework inconsistently applied: There are a range of ES frameworks in circulation, which do not entirely overlap. This might increase difficulties around data sharing and comparability of research results.	16	80
Disregarding intrinsic value of nature: The anthropocentric view of the ES framework and its application in decision making might cause an imbalance between biodiversity conservation targets and social and economic objectives, with dominance of the latter two.	14	70
Ambiguous language: The terminology used in the ES framework is open to interpretation.	13	70
Overemphasis on monetary values: An overemphasis of the monetary values of ecosystem services within ecosystem assessments might be contrary to the original objective of making ecosystems count.	11	80
Some ecosystem services poorly represented: The cultural, regulating and supporting services tend to be less well represented in ES research and assessments than provisioning services.	9	65
Large resources needed to apply framework: Implementing the ES framework in practice requires considerable resources (e.g. data, finance, expertise).	8	75
Inaccessible to non-specialists: Those who do not work in the ecosystem services field, or are not scientists, might find the ES framework terminology and methodology hard to understand.	6	65
Benefits poorly understood: It is non-trivial to aggregate, analyse and present the benefits received from ES. Many people might not necessarily acknowledge benefits of the ES identified by researchers.	6	75
Oversimplification: The ES framework is sometimes used in a way that oversimplifies ES to the extent that they are poorly represented and assessed. This might lead to misguided environmental decision making.	5	70
Difficult to apply: The ES framework is difficult to implement in practice. It is currently considered to be methodologically challenging to combine the large number of ES in one assessment.	5	75
Scale-dependence of outcomes: The ES framework is applied in different ways across different scales (local, regional, national etc.), with a range of possible outcomes at each scale.	4	70
Need for better tools: The ES assessment tools currently available to practitioners and researchers are inadequate and need to be improved.	3	75

3.2.3 Opportunities

A list of 11 themes within the Opportunities category reflects the positive outlook of survey respondents for future potential development in the ES framework. Alignment with policies and strategies (*score*=24) and existing tools and methods (*score*=18) were ranked as the top two opportunity themes. These were followed closely by increasing environmental awareness (*score*=17), and opportunity for better realising sustainability (*n*=16) (***Table***). Other themes within this quadrant have the potential to complement the top opportunities: for example, more funding (*score*=7) could align with policies and strategies, technological advancements (*score*=4) can advance existing tools and methods, and demand for ecosystem management (*score*=14) can align with increasing environmental awareness.

Table 4: *Opportunities identified for the ES framework. 'Importance score' and 'agreement with theme' measured during survey 3, as specified in the Material and Methods section.*

Survey themes	Total importance score	Agreement with theme (%)
Alignment with policies & strategies: Existing environmental policies and strategies already in place or currently under development are well suited to fit the ecosystem services concept, such as the CBD Strategic Plan for Biodiversity and the EU Biodiversity Strategy among others.	24	75
Alignment with existing tools & methods: ES framework can be easily integrated into existing tools and methods of environmental policy, such as environmental impact assessment and cost-benefit analysis.	18	95
Increasing environmental awareness: The ES framework fits into the growing global awareness of environmental issues, including climate change and its potential long-term impacts.	17	85
Operationalization of sustainability: There is a need to operationalize the term of 'sustainability' and reduce its vagueness. The ES framework with ecosystem services indicators and assessments could provide the framework to make sustainability more assessable and traceable.	16	95
Demand for ecosystem management: The demand to improve ecosystem based management, as well as the necessity to increase its acceptance might support the use of the ES framework.	14	85
Interest of societal actors: ES framework has received recognition and support from a wide range of actors within society, including public media, researchers, the business sector and stakeholders involved or affected by environmental management.	9	80
Policy awareness: Governments are aware of the ES framework as a result of the Millennium Ecosystem Assessment and The Economics of Ecosystems and Biodiversity initiative. Current demand for national assessments of natural resources is high.	8	75
More funding: Funding bodies are interested to support research with societal impact and interdisciplinary projects. There is also the opportunity to get more funding by highlighting the benefits that nature provides to humans.	7	85
Technological advancements: Fast increasing computing power allows us to use more complex system models to analyse data. Technological advancements also allow new ways of interacting with audiences through online media, video, games, and presentations.	4	85
Institutionalisation of nature's value: Establishment of legal requirements to protect the environment and the ES it provides. Incorporating the regulation of ES into laws and constitutions. Example set by Ecuador.	2	85
People's utility: People tend to value their self-regarding benefits higher than other-regarding values (including non-humans). The ES framework might benefit from this kind of thinking.	1	60

3.2.4 Threats

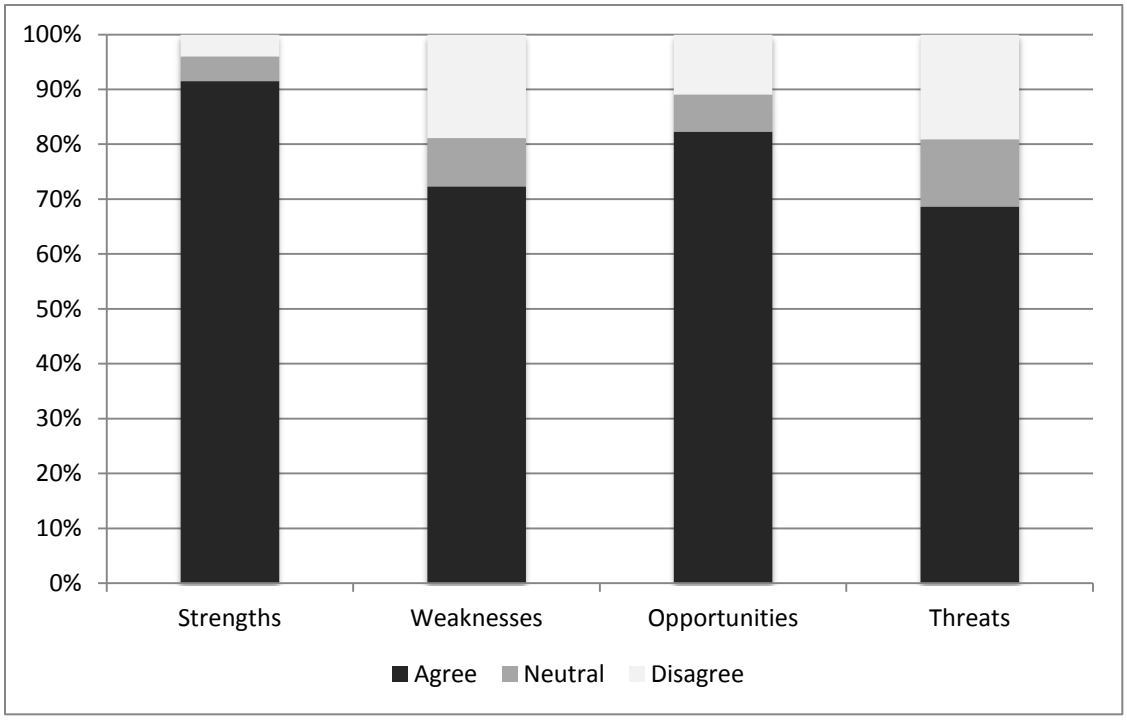
Resistance to change in environmental practices (*score*=32), difficulty of interdisciplinary work (*score*=19) and insufficient funding (*score*=14) were the top three Threats as selected by survey respondents. Interdisciplinarity of the ES framework (*score*=19) was highlighted as a potential Threat due to different technical terminology and applications. The lack of institutional capability (*score*=13) and loss of political interest (*score*=13) were equally perceived as Threats for the ES framework.

An overall assessment of SWOT themes across all categories revealed that at least half of survey respondents were in agreement for most SWOT themes (Fig. 5). Only the Threat theme ‘diversion from sustainability goals’ received less than 50% agreement from survey respondents. There was greater agreement across survey respondents within the Strengths quadrant (92%) as compared to Opportunities (82%), Weaknesses (72%) and Threats (69%) quadrants (Fig. 5). Broad agreement with themes was expected since they were derived from survey respondents’ contributions in Survey 2.

Table 5: *Threats identified for the ES framework. 'Importance score' and 'agreement with theme' measured during survey 3, as specified in the Material and Methods section.*

Survey themes	Total importance score	Agreement with theme (%)
Resistance to change environmental practices: Even if understanding of human impacts and nature conservation benefits is considerably improved, changing environmental practices might not follow automatically.	32	85
Difficulty of interdisciplinary work: ES framework requires inter-disciplinary collaborations, which are hard to truly achieve in practice.	19	75
Insufficient funding: Funding for research might suffer severe cuts.	14	75
Loss of political interest: In the mid- to long-term future, policymakers might lose interest in promoting or implementing ES framework, if expectations for practical solutions of environmental management cannot be met by the ES framework.	13	80
Lack of institutional capability: Insufficient institutional capacity and expertise to implement treaties, agreements, conventions etc.	13	55
Competing approaches: Different approaches to biodiversity conservation and sustainable resource management divert interest away from ES research and assessments.	8	55
Loss of interest from researchers: Due to pressure of working at the cutting-edge of science and publishing novel approaches, scientists might lose interest in researching ES framework and move on to new approaches.	7	60
Misuse of environmental tools: Environmental tools can be incompletely or incorrectly applied, and therefore become ineffective or worsen the situation.	6	70
Lack of awareness across general public: Overall low understanding of ecosystems among general public including stakeholders and policy makers. These groups might be disengaged, if their interests are not sufficiently taken into account by the ES framework, or if low ecological understanding prevents buy-in to the ES framework.	5	85
Environmental ethics viewpoint: Approaches such as the ES framework, which put human values before nature's intrinsic value, might face opposition by some factions within the nature conservation field and the general public.	2	80
Diversion from sustainability goals: Society at large may lose interest in nature conservation and sustainability goals, thus removing the demand for the ES framework.	0	35

***Figure 5**: Overall agreement with the themes developed for each SWOT category. Agree = rating between +1 and +4; neutral = rating 0; disagree = rating between -1 and -4.*



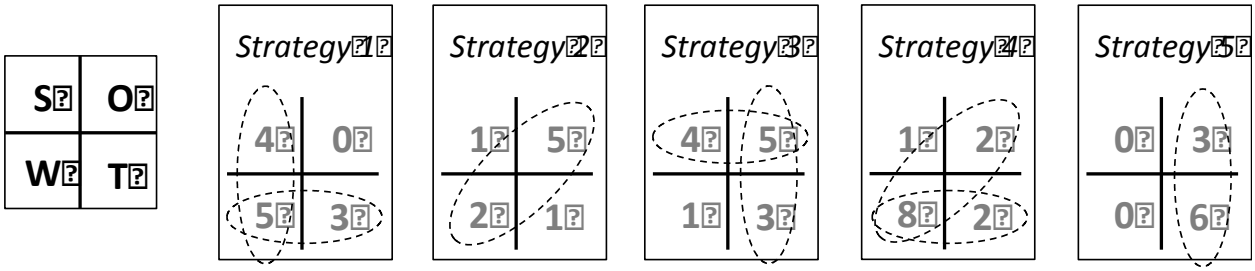
3.3 *Strategy development based upon the SWOT*

Following on from the SWOT, the authors grouped themes into 5 different strategic areas (Fig. 4):

1. **ES concept characteristics**
2. **Application of the ES concept**
3. **Effects of ES concept application**
4. **Demands of ES concept application**
5. **User interface of the ES concept**

Certain SWOT themes belong under more than one strategy. When counting the items per topic, it became clear that these are distributed irregularly in the different quadrants of the SWOT diagram (Fig 6). While, for instance, Strategy 1 themes are concentrated within quadrants S, W and T, Strategy 5 themes have been identified only in quadrants O and T – perhaps unsurprisingly, given that the 'user interface' strategy might only be expected to be represented in the 'external' quadrants.

***Figure 6**: Conceptual representation of strategy development and distribution of SWOT themes for each strategy topic. Far left: reminder of the four quadrants constituting the SWOT assessment. Dashed lines highlight the quadrants considered for each strategy 1 – 5. The number of SWOT themes identified within each quadrant is given for each strategy.*



This distribution of themes across the SWOT quadrants was used as a starting point for identifying topic related strategies. These were considered useful under the assumption that a single overarching strategy may not be suited to capture the complexity of the problem and may also not be sufficiently tailored for those working in their respective context within the ES framework. Further, depending upon their expertise, survey respondents may have been interested in certain topics only – thus, topic-specific strategies would likely be more easily adopted.

3.3.1 Strategy 1 – ES framework characteristics

In Strategy 1 we consider a **strength-weakness (SW)** combination, and how to use identified Strengths to overcome Weaknesses. By contrasting the four highest scoring strengths with the five highest scoring weaknesses (Fig. 6), this strategy would focus upon the characteristics that form the ES framework via:

- extending the interdisciplinarity of ES research, with an emphasis on further strengthening links with the social sciences and increasing involvement from the arts and humanities;
- creating holistic frameworks that contain clear and concise language so the approach can be consistently applied as communication and advocacy tools; and,
- increasing the representation and analysis of ES beyond utilitarian values to highlight broader shared and social values, and the intrinsic value of nature, including by highlighting synergies between intrinsic value and supporting and regulating services, and shared values and cultural services.

It is important to highlight that both the difficulty of interdisciplinary work and the variety of competing approaches within the Threat quadrant (Fig. 6) may not be reduced under the proposed **SW** strategy. Thus, a **strength-threat** strategy could be applied to reduce these threats. Pursuit of such a strategy should improve the ability of ES analyses to make progress on improving the sustainability of human-environment interactions.

3.3.2 Strategy 2 – Application of the ES framework

The second Strategy would concern the use of external Opportunities to overcome internal Weaknesses, with themes residing in the **weakness-opportunities (WO)** quadrants. Two of the highest scoring Opportunities acknowledge the potential alignment of the ES framework with existing agreements (e.g. the CBD Aichi targets, the UN Sustainable Development goals), and with existing tools (e.g. spatial conservation planning, environmental impact assessment, remote sensing). However, the Weaknesses suggest that this approach is inaccessible to non-specialists and difficult to apply. A **WO** strategy could focus on using the identified opportunities in two ways:

- Enhanced communication to elucidate how ES can be linked and add value to key performance indicators, and other measures that determine policy implementation success (e.g. measures of sustainable economic development). This broader picture could facilitate a better understanding of ES; and,
- ES specialists assisting and working with non-technical audiences in identifying and applying the most relevant and effective ES methods and tools for the required application. The result could be greater uptake and ownership of the ES framework.

3.3.3 Strategy 3 – Effects of an ES framework application

Thirdly, we consider the potential use of the ES framework to overcome Threats, given a combination of **strengths, opportunities and threats (SOT)**. Blending the existing Strengths of the ES framework (which includes improved accounting for nature, increased societal engagement, equity in natural resource allocation and reconnecting people with nature) with Opportunities (specifically an increase in environmental awareness and operationalization and institutionalisation of the ES framework) could offer scope for increasing environmental awareness and understanding (countering the identified threat of low awareness).

Equally, drawing upon these Strengths could ensure that implementation of the ES framework becomes or remains a political imperative (at the same time seeking to address any threat of a loss of political or researcher interest), and that the institutional application of the ES framework adds value.

A strategy containing these elements could also consider seeking to showcase the ES framework itself as a way of measuring the effects of resistance to change environmental practices (a third Threat theme).

3.3.4 Strategy 4 – Demands of an ES framework application

The fourth Strategy concerns dealing directly with barriers to the application of the ES, with a focus upon **weaknesses, threats** and some **opportunities (WTO)**. Overcoming Weaknesses and Threats is considered likely to be challenging. The strategic direction is heavily influenced by 8 Weaknesses, ranging from an incomplete scientific basis, to the fact that large resources are needed to apply frameworks, to the need for better tools. Insufficient funding is highlighted as a Threat, however, funding

is also an identified Opportunity – so understanding exactly where the funding gap lies, and what causes it, would be a key challenge to deal with under this strategy.

Many of the identified Weaknesses – disregard for intrinsic value, oversimplification, ambiguous language, inaccessibility – are perhaps at the root problems of conceptual convergence and communication. These Weaknesses are compounded by Threats such as loss of interest and lack of awareness. A strategy for resolving these challenges must involve collaboration between those researching and implementing the ES framework, as well as a focus on communication to non-specialists.

Although the Opportunity for technological advances through applying the ES framework was highlighted, it is endangered by the Threat of a lack of institutional capacity. The approach requires extensive support in terms of human and financial resources, to develop capacity, if it is to realise the opportunities it presents.

3.3.5 Strategy 5 – Wider interface with the ES framework

Finally, a strategy that focuses upon external issues, i.e. **opportunity-threat (OT)** quadrants, is necessary. This would concern the public face of the ES framework – specifically, how users (such as policy makers, researchers and the general public) engage with the approach.

Identified Opportunities highlight interest in and awareness of the ES framework on the part of a range of stakeholders. These are in contrast with a number of identified Threats such as: resistance to change in environmental practices, loss of political interest, lack of awareness across the general public and loss of interest by researchers. Building upon the topic of communication mentioned in Strategy 4, careful communication and dissemination measures would need to be designed that build upon existing interest and awareness – and, if the approach does prove successful in practice, ensuring that success is evaluated and publicised so as to avoid losing interest on the part of both researchers and policymakers. In turn, this latter requirement suggests the need for monitoring and detailed ex-post evaluation of the implementation of the ES framework.

A key Opportunity, as mentioned in Strategy 2, is alignment with existing policies. By seeking to support existing agreements and policies, and providing useful mechanisms for policy implementation rather than replacing them, it could perhaps be ensured that the ES framework circumvents the threat of resistance to change. The same reasoning could apply to the Threat of competing environmental approaches.

4. Discussion

The YESS group carried out a three-stage survey constituting a SWOT analysis of the ES framework. The aim of the assessment was to seek agreement on the perceived utility of an ES-based approach from

a set of early career researchers and practitioners, and to offer the beginnings of some potential strategies for taking the framework forward based upon findings. In this way, we have extended the existing literature on the ES framework, which, whilst highlighting challenges to the use of ES concepts, is usually not structured around a SWOT analysis, and contains limited discussion around such strategies. While strategies to address challenges related with the application of the ES concept have been discussed elsewhere (see de Groot et al., 2010; Baker et al., 2013; Schröter et al., 2014), the strategies we identify emerge from a systematic approach to address perceived weaknesses and threats of ES-based approaches. The identified strategies should not be seen as exclusive, rather, they arise from focusing upon different combinations of the SWOT quadrants, and therefore can be complementary.

Numerous YESS members including 20 participants in the final survey (Survey 3), plus attendees at an ESP conference in Bali, gave input at the various stages of the SWOT analysis. There was very strong agreement by participants in relation to the most highly ranked Strengths, Weaknesses, Opportunities and Threats. The outcomes suggest that key Strengths include that the ES framework is interdisciplinary, provides a means for improved accounting for nature, is holistic, and is a useful advocacy and communication tool. Current Weaknesses include that the scientific basis for the approach is incomplete, ES frameworks are inconsistently applied and do not necessarily account for nature's 'intrinsic' value, and that the language of ES can be ambiguous. External Opportunities for the ES framework include alignment with different existing and emerging policies and strategies, the implementation of the approach through existing tools and methods, and the possibility that environmental awareness is increasing more generally. Finally, identified external Threats include general inertia regarding change in environmental practices, the broader difficulties with successful interdisciplinary collaboration, and insufficient funding to fully realize the potential of the ES framework.

Subsequent consideration of the themes coming out of the SWOT suggested five key strategic areas for furthering the ES framework: (1) approach characteristics; (2) application of the framework; (3) effects of application; (4) demands of application; and, (5) interface with the framework. Whilst the development of full strategies for improving and (if appropriate) embedding the ES framework into practice is beyond the scope of this article, we make some suggestions based on SWOT outcomes, and our findings here could influence the development of strategies.

4.1 *Strategies*

Strategy 1 is based around how existing Strengths with the approach might be used to overcome Weaknesses. Options include using the interdisciplinary nature of the ES framework, and the associated broad network of researchers working in the space, to further develop the currently incomplete scientific basis (see Bennett et al., 2015). Equally, since the approach has the Strength that it requires practitioners and policymakers to take a holistic view, it should readily be able to incorporate additional considerations

that it currently lacks (e.g. inclusion of broader shared and social values; Kenter et al., 2015). Given the approach's potential Strength as an advocacy tool (Costanza et al., 2014), a focus upon this strength could result in the approach being used to leverage input from many more stakeholders than it currently does, to help ensure more equitable use of ES. However, there are also challenges: not least that interdisciplinary science is not easy, or that some stakeholders may remain unwilling to engage with the ES framework if they consider it to violate notions of intrinsic value of nature (Lang et al., 2012). The notion that the ES framework should go beyond utilitarianism to include broader values is now broadly recognised (Kenter et al., 2015), as reflected in explicit in the inclusion of shared or social values in major assessments (e.g. TEEB, 2010; UK National Ecosystem Assessment, 2011; 2014). The degree to which the ES framework is or may be able to incorporate non-anthropocentric values is more contentious. There has been debate around whether the concept of services to human-wellbeing is by definition anthropocentric, and not amenable to notions of intrinsic values (Gómez-Baggethun & Ruiz-Pérez, 2011; Braat and de Groot, 2012; Jax et al. 2013; Costanza et al., 2014; Schröter et al., 2014), and our survey suggests that most participants recognise the disregard of nature's intrinsic value as a weakness of the ES framework (Table 3). Nonetheless, notions such as habitat services (TEEB, 2010), and conceptualisations of cultural ecosystem services (e.g. Chan et al. 2012; Daniel et al., 2012) can provide a hook for bringing in biocentric values that go beyond the economic notion of existence value. Others have suggested a new ethical approach altogether that aims to transcend the intrinsic-instrumental, biocentrism-anthropocentrism divide (O'Neill et al., 2008). Although delving into this debate is beyond the scope of this article, it is useful to point out that survey participants also associated this issue with application of the ES framework in decision making, and thus broader institutional concerns around how the ES framework is applied. This runs parallel with two aspects of ES that, according to Gómez-Baggethun and Ruiz-Pérez (2011), are often neglected: (i) the role of the particular institutional setup in which environmental policy and governance is currently embedded; and (ii) the broader economic and socio-political processes that have governed the expansion of pricing into previously non-marketed areas of the environment.

Strategy 2 addresses the use of external Opportunities to overcome internal Weaknesses. Two key Opportunities involved the potential alignment of the ES framework with policies and strategies, and with existing tools and methods (e.g. spatial conservation planning, remote sensing, environmental and economic impact assessment). Meanwhile, one potential Weakness was that the approach can be inaccessible to non-specialists, and difficult to apply. Finding ways to align the ES framework more closely with existing policies, strategies and methods could facilitate a better understanding of ES for those not working directly in the field. This is a strategy that can be considered already in progress (e.g. incorporating ES into landscape planning; Albert et al., 2014), but it is nevertheless worth emphasizing that doing so is likely to be productive, developing guidelines and providing examples of applied research on how this can be done, highlighting the ongoing need to communicate the basic ideas behind the ES

framework (according to the Strengths identified, those ideas are essentially rather straightforward; Fig. 4), and developing knowledge exchange networks that bring together policy makers, research and practitioners (e.g. the UK Ecosystems Knowledge Network[2]). Focused efforts for ES specialists to work with non-technical audiences in identifying and applying the most relevant and effective ES methods and tools, for a given application, should result in greater uptake and ownership of the ES framework. Here transdisciplinary approaches, involving the co-production of knowledge offer much promise (Liu et al., 2010; Jahn et al., 2012; Reyers et al., 2015) Encouraging the use of existing familiar tools and methodologies to implement the ES framework could equally support uptake, and help address the ongoing challenges around how best to operationalize the approach.

Strategy 3 targets the effects of applying the ES framework given a combination of the relevant Strengths, Opportunities and Threats. Blending the existing Strengths of the ES framework (e.g. conceptual simplicity, increased societal engagement, reconnecting people to nature) with Opportunities could well support an expanding general awareness of and willingness to engage with environmental issues (e.g. within industry; Bull et al., 2015), increasingly politicising the value of implementing the ES framework. Yet it must be considered that a 'loss of political interest' was identified as one of the major Threats to the ES framework. So long as the ES research community builds firmly upon the Strengths and Opportunities identified here, and given recent developments in ES policy – such as the potential incorporation of mandatory ES assessment into European environmental impact assessment requirements, and the recent establishment of IPBES – it would seem unlikely that political interest for the framework will fade in the short term. However, it cannot be taken for granted that this will perpetuate in the longer term, and so any strategic approach must contain measures to keep ES on the political agenda, and importantly ensure that ecosystem management activities are implemented on the ground in order to bridge research-policy-implementation gaps. Another Threat to the ES framework is resistance to changing environmental practices – one can understand the potential for fatigue on the part of policymakers and the public, given how substantially concepts within conservation (and consequently policy development) have changed over recent decades (e.g. Mace, 2014). Arguments based on key Strengths with the ES framework, such as being characterised by conceptual simplicity and working on multiple scales, as well as explicit recognition and management of Weaknesses (e.g. perceived focus on monetary values) will continue to be required in order to overcome this overarching Threat. The fact that the ES framework provides a potentially strong advocacy and communication tool may be a useful asset in arguing for its wider implementation, especially with regards to engaging with the business sector (Reyers et al., 2015). Here working with bridging agents can be powerful (Braat & de Groot, 2012; Ruckelshaus et al., 2013). However, ultimately the ES framework is only a means to diffuse ends, and it is conceivable that at some

[2] http://ecosystemsknowledge.net

point the ES framework is superseded by other conceptualisations of sustainability and human-nature relations that prove more useful, persuasive or effective in terms of being embedded into practice.

Strategy 4 brings a focus upon Weaknesses, Threats and Opportunities. Research needs for the ES framework have been identified in the literature (e.g. Braat & de Groot, 2012; Bennett et al., 2015). Clearly, input of additional funding and resources to develop the ES framework would begin to address some of these challenges – and indeed insufficient funding has been highlighted as a Threat. But this does not constitute a strategy in itself, as the ES framework competes with many other fields for research funding. The strategy would be to use the identified Strengths and Opportunities to make the case for increased funding to develop and implement the ES framework: such as, e.g. on-going alignment with existing governmental or international policies and strategies. Equally, reducing the costs and efforts required for applying the ES framework will be important. Opportunities for reducing costs and efforts can include uptake of recent technological developments, utilizing synergies between research projects and strengthening the networking and exchange of involved scientists rather than 're-inventing the wheel', and striking a balance between application of existing knowledge and methods based on agreed frameworks and protocols and ongoing debate and innovation. The Opportunity provided by technological advancements in terms of applying the ES framework (e.g. ES models and algorithms, hardware for monitoring components of ES), must be considered in the context of a lack of institutional capacity (as a Threat) in some cases. This might perhaps be mitigated through the open exchange of tools and knowledge, as well as key datasets. Further Opportunities could include the development and testing of less data-heavy tools and methods, for instance, by using proxies and existing datasets (e.g. Helfenstein & Kienast, 2014; Jacobs et al., 2015).

Themes informing Strategy 5 are within the Opportunities and Threats quadrants. This strategy relates to the 'public face' of the ES framework – specifically, how to encourage users (such as policy makers, societal actors, researchers and the general public) to engage with the approach. The Opportunities highlight interest and awareness of the ES framework on the part of a range of stakeholders. This can be used to promote the approach, but must be balanced with recognition of the difficulty in maintaining a consistent conceptual framing (Lamarque et al., 2011). Equally, public acceptance of the ES framework must overcome any future potential loss of political interest, resistance to change in environmental processes, lack of awareness across the general public and loss of interest by researchers. The ES framework and concepts behind it require clear communication across a range of audiences if the approach is to be successfully implemented, and the concept of ecosystem services should be mainstreamed across sectors, outlining the potential benefits of doing so (Cowling et al., 2008; Sitas et al., 2014). Note, finally, that a potential Threat that was raised in the pilot survey was the chance of societal diversion from sustainability goals more generally. This was not retained as a Threat to the ES framework by the last survey, perhaps as the respondents trust society will continue to pursue

sustainability goals in some capacity (despite changing contextual conditions, e.g. austerity measures and economic crisis).

4.2 *Study limitations and further work*

The survey sample size (20 researchers in Survey 3) was small in absolute terms and thus cannot be assumed to represent the view of early career ES researchers generally. Nonetheless, there was a good degree of variety in the age, sex, nationality and experience with ES of those participating, which may have minimised potential biases in responses. As further research, it would be interesting to extend the survey more widely to other respondents and examine the extent to which the findings are in agreement with the broader ES community, especially of the opinions and perceptions of more long-established researchers in the field of ES.

The respondents to the survey were biased towards the natural sciences and environmental and ecological economics. Therefore, the outcomes may be different if the same survey approach was carried out using a more diverse academic sample (e.g. including more respondents with humanities and broader social science backgrounds), or decision makers. Similar future exercises could be undertaken to draw insights among and between different groups of ES users, stakeholders, researchers or practitioners. The strategies we have outlined should be seen as suggestive, rather than concrete guidelines for action. We offer them as a means for combining the findings of our surveys in a way that is practical and useful to future directions in the theory and practice of the ES framework.

Beyond potential biases associated with participants in the study, there are important linguistic uncertainties to consider. For a start, we consider a valuable component of the survey to be the variety in nationalities represented by respondents, but this same factor means that there is likely to be uncertainty introduced to the identification of themes resulting from subtleties in translation between different native languages. Such uncertainty extends to vaguely defined technical terms, and indeed, the definition of 'ecosystem services' itself. Here, we have used the TEEB definition, but others exist e.g. "the benefits people obtain from ecosystems" (Millennium Ecosystem Assessment, 2005); "the benefits provided by ecosystems that contribute to making human life both possible and worth living" (UK National Ecosystem Assessment, 2011), which are clearly rather different. ES can also be defined in more ecological terms, and in too many other ways to list here (Fisher et al., 2009). It is possible that the survey results would have been rather different with a different starting definition of ES – and therefore it should be considered that the very choice of definition encapsulates a certain perspective into the findings here.

Although SWOT analysis stands out for its simplicity and value in focusing attention on key issues, it entails limitations – for example unclear classification of items as strengths, weaknesses, opportunities or threats, or over-subjectivity in the generation of themes due to compiler bias (Pickton & Wright, 1998).

Nevertheless, the results of the SWOT analysis we conducted here allow assessing the relative importance of different themes under the four SWOT categories, from the perspective of a group of ES early career researchers and practitioners. The key utility in the research presented here is thus to review and capture, in a structured way, a variety of considerations relevant to the strategic development of the ES framework that are otherwise not collated within the literature. Another important aspect of conducting such a SWOT analysis is the process itself (Pickton & Wright, 1998). In this research, it provided a platform to exchange ideas and find agreement or otherwise among the YESS community, and contributed to building the community itself.

4.3 *Conclusion*

Critical analysis of the ES framework can already be found in literature, however, the innovative character of this research was that such analysis was systematically structured using a SWOT characterisation, allowing us to derive strategies for further development of the ES field. Another important feature of this research is that it reflects the views and perceptions of early career researchers and practitioners, who will help shape the ES field in the future. Our work emphasizes that the ES framework can be viewed not only as a way of improving decision-making, but also as a means for more widely interpreting and communicating the complexities of the interaction between humanity and nature. Further, it is suggested that the ES framework is only likely to truly find traction in implementation when more deeply merged with existing policies and incorporating existing tools. Interestingly, the ES framework appears in some senses contradictory – being valued by specialists as a simple means of communicating the importance of nature conservation, whilst also being potentially an oversimplification and characterised by ambiguous language, and this tension suggests its relevance as a bridge between research and practice. Provided sufficient funding and political will is maintained, e.g. through initiatives such as IPBES, the ES framework may yet provide a powerful means for facilitating interdisciplinary research, and for better incorporating sustainability into policy and practice.

Acknowledgements

All authors are members of the Young Ecosystem Service Specialists (YESS) group. We thank those members of YESS not named as co-authors who completed surveys, all YESS workshop participants at the 2013 Ecosystem Service Partnership conference in Bali, and the Ecosystem Service Partnership (ESP; www.es-partnership.org) for their support of YESS.

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