

1 Ecosystem Services: A bridge or barrier for UK marine stakeholders?

2 Abstract

3 Ecosystem services conceptualises the multiple interactions between ecosystems and the people
4 and communities benefitting from their direct or indirect use, aiming to provide stakeholders and
5 scientists with a common language. While some users appear to have adopted this language and
6 terminology, there are concerns that the complexities associated with the concept make it
7 inaccessible and, rather than providing stakeholders with a tool to explain complex relationships, the
8 language and terminology itself may disengage. Through surveying UK-based coastal and marine
9 stakeholders ($n=158$), this study examines stakeholders' perceptions of the concept of ecosystem
10 services and its role and usefulness within the marine and coastal science-policy-practice interface.
11 Overall, stakeholders provided favourable opinions, with findings similar across respondents with
12 the exception of industry; which used it less, was less confident with it and believed it to be less
13 important. The results provide an evidenced argument for the benefits of the ecosystem services
14 approach, including communication, supporting management and linking environment to humans.
15 The analysis also details the required advancements to ensure effective future use, including
16 improved terminology, pluralistic valuation and shared learning. Finally, the paper highlights
17 challenges and benefits relating to the term, creating links to ongoing discussions about effective
18 scientific communication for marine and coastal management.

19 **Keywords: environment, policy, governance, management, practitioners, coastal**

20 1. Introduction

21 The Ecosystem Services (ES) concept has been in use since the 1970's (Westman 1977, Costanza et
22 al., 1997, Daily 1997) but was formally defined and classified in 2005 by the Millennium Ecosystem
23 Assessment (MA 2005) as "the benefits people obtain from ecosystems. These include provisioning
24 services such as food and water; regulating services such as flood and disease control; cultural
25 services such as spiritual, recreational, and cultural benefits; and supporting services, such as
26 nutrient cycling, that maintain the conditions for life on Earth". Since the publication of the MA
27 (2005), interest in the ecosystem service concept has grown substantially and there are now a
28 multitude of definitions and classifications, for example: The Economics of Ecosystems and
29 Biodiversity classification (TEEB, de Groot et al., 2010b); the United Kingdom's National Ecosystem
30 Assessment classification (NEA 2011). Further classifications have been developed by the Crown
31 Estate (Saunders et al., 2010), Fisher et al., (2009), Atkins et al., (2011), Cognetti and Maltagliati
32 (2010), Beaumont et al., (2007), Balmford et al., (2011), as well as more recent contributions from
33 the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (Diaz
34 et al., 2018) (also see Gomez-Baggethun et al., 2010 for a historical summary). Accompanying this
35 has been an explosion of ES focused research across all areas of environmental, and more recently
36 economic and social, sciences (e.g. Beery et al., 2016; Willcock et al., 2016; Costanza et al., 2014;
37 Braat and de Groot, 2012).

38 The ES concept aims to provide a common language through which diverse audiences and users can
39 communicate about the natural world (Tallis et al., 2008; Steger et al, 2018). Over time, it has
40 evolved to reframe the human-nature relationship (Costanza et al, 2014), and has become
41 acknowledged as an effective management and policy tool (Beery et al., 2016; Willcock et al., 2016;
42 Dempsey and Robertson, 2012; De Groot et al, 2010; Norgaard, 2010; Tallis et al., 2008, Beaumont
43 et al., 2018), and as a concept through which the environment and societal wellbeing can be better
44 connected (Armsworth et al., 2007). Advantages of the application of the ecosystem service concept
45 have been found to include improved understanding of environmental benefits, improved

1 transparency of potential trade-offs under different management scenarios, and the enabling of
2 discussion and shared learning between stakeholders and with the wider academic community,
3 resulting in improved long-term relationships between these groups (Beaumont et al., 2018).

4 However, despite the perceived benefits of applying the ES concept within environmental
5 management, concerns have been raised. In fact, within the Intergovernmental Science-Policy
6 Platform on Biodiversity and Ecosystem Services (IPBES), the framework was perceived as so political
7 by some countries that a new shared terminology was introduced (Borie and Hulme 2015, Diaz et al.,
8 2018), sparking intense debate (see for example responses by Braat 2018 and Kenter 2018). To
9 tackle some of these challenges, there have been some recent Special Issues focusing on the
10 ecosystem services debate. Examples include a Special Issue of Ecosystem Services presents a series
11 of papers working towards the successful operationalisation of the ES concept (Van Dijk et al., 2018),
12 as well as a further Special Issue of the International Journal of Biodiversity Science, Ecosystem
13 Services & Management focused on the operationalisation of marine and coastal ecosystem services
14 (Rodrigues et al., 2018). A common theme throughout these publications is the recognition that,
15 although ES is a recognised concept within global environmental policy, challenges remain in its
16 application (Jax et al., 2018). First, although valuation is an optional rather than inherent aspect of
17 the ecosystem service concept, many recent interpretations have favoured economic valuation, with
18 a resultant key criticism that it instigates a migration towards market-led, economically driven
19 environmental policy (Kallis et al., 2013; Dempsey and Robertson, 2012). This is accompanied by a
20 growing body of research, which argues against the commodification of nature and the feasibility of
21 assigning a price or value to ecosystems (Kallis et al., 2013; Dempsey and Robertson, 2012,
22 Pendleton et al., 2016). A second concern arises from the deliberation as to a correct and shared
23 definition and classification of ES and a fundamental confusion arising from the vast array of
24 complex terminology (Beery et al., 2016; Thompson et al., 2016; Schroter et al., 2014; Dempsey and
25 Robertson, 2012; Braat and de Groot, 2012; de Groot et al., 2010; Norgaard, 2010, Metz et al.,
26 2010). A third and final concern is that the concept is overly simplistic and anthropocentric focused,
27 conflicting with global conservation and biodiversity goals, and lacking in necessary detail to deliver
28 benefit for both society and the environment (Schroter et al., 2014).

29 With a backdrop of a continually developing conversation around the contribution of nature to
30 society (Diaz et al., 2018), and owing to their often peripheral nature, coastal and marine
31 environments are particularly in need of careful management and a common language between
32 stakeholders. In addition, marine and coastal ecosystems are experiencing a growing level of
33 pressure on resources, and an accompanying unprecedented deterioration in ecosystem health,
34 biodiversity and functionality (Nursery-Bray et al., 2013; Barbier et al., 2011; UNEP, 2006;
35 UNEP/GPA, 2006; Worm et al., 2006; GESAMP, 2001; Turner, 2000). In response to this, marine and
36 coastal governance has shifted towards the ecosystem approach, which aims for integrated
37 management of land, water and living resources that promotes conservation and sustainable use in
38 an equitable way (Granek et al., 2010; CBD 2000; Turner, 2000). However, although there is a great
39 deal of marine and coastal science being undertaken, gaps remain between the science and its
40 inclusion in policy (Rivero and Villisante, 2016; Nursery-Bray et al., 2013). In principle, the ES concept
41 should provide support to bridge these gaps, but within the marine and coastal realm, similar
42 concerns as those posed above are being raised about the widespread acceptance and application of
43 the ES concept (Beaumont et al., 2018). Further to this, from a societal perspective, numerous
44 scholars have examined public understanding of ES in the context of a range of environments and
45 situations (e.g. Metz and Weigel, 2010), with others examining the link between ecosystem services
46 and successful delivery of policy (e.g. the EU's Blue Growth policies – see, for example, Lillebo et al.,
47 2017) . For the most part, these studies have highlighted gaps in public understanding of ES, and

1 indeed, a feeling that the use of terms deemed to be scientific jargon can prove challenging for
2 science communication (Beery et al., 2016; Thompson et al., 2016). While the majority of these
3 studies have focused on public perceptions of ES, recent studies suggest that a lack of understanding
4 and a feeling of redundancy associated with the term may exist within the environmental science
5 and practitioner community (Beery et al., 2016). Accompanying the adoption of the ecosystem
6 service concept as a bridge between academic disciplines and environmental management and
7 policy making, there has also been a growth in the number of barriers. Whether the concept is
8 sustainable will only be observed over time; decided by its ease of use and accompanying benefits,
9 but also whether it is seen as morally and ethically appropriate. As the world of marine and coastal
10 natural resource management negotiates its way between a myriad of management and valuation
11 approaches (e.g. ES, natural capital, natural accounting, marine spatial planning, marine protected
12 areas), this paper presents a timely interrogation of the views of marine and coastal stakeholders in
13 the United Kingdom, on the concept of ES. In a bid to obtain responses from marine and coastal
14 stakeholders from across the UK, an online questionnaire framed around four key themes was used
15 to undertake this task: i. Current use and experiences; ii. Factors that influence use and experience;
16 iii. Strengths and obstacles to use; and iv. Ways of improvement. Through analysis of these themes
17 using both quantitative and qualitative questions, the study provides a novel and unique insight into
18 stakeholders' use and experience of the ecosystem services concept, whether the concept is seen to
19 be beneficial, and if it succeeds in acting as a bridging and common language between the science-
20 policy-practice interface of marine and coastal management or if it is actually an unintended barrier.

21 **2. Methodology**

22 **2.1. Questionnaire Respondents**

23 To access UK marine and coastal stakeholders, the Communications and Management for
24 Sustainability (CMS) network was used. CMS boasts a membership of over 6000 individuals,
25 representing a range of marine and coastal stakeholders working within a number of different
26 disciplines and sectors. This includes academic researchers (within education & consultancy),
27 industry representatives (ports, fishing, shipping, defence, aquaculture, tourism to name just a few),
28 Government departments and organisations (e.g. Department for Food and Rural Affairs, the Marine
29 Management Organisation, Marine Scotland, the Environment Agency, Natural Resources Wales),
30 and Environmental Non-Government Organisations and charities (NGOs – e.g. World Wildlife
31 Foundation, Marine Conservation Society, Royal Society for the Protection of Birds). The network
32 was chosen as it would give the authors access to a representative group of marine and coastal
33 stakeholders within the UK with a view to comparing results between sector groups, research
34 disciplines, career stage, as well as country (Scotland, Wales, England and Northern Ireland). The
35 questionnaire was sent out to individuals registered with the CMS network on four occasions in
36 2017. The survey was opened 345 times, with 181 respondents completing the entire survey (52.5%
37 completion rate). The inclusion criteria were that respondents were over the age of 18 and identified
38 themselves as practitioners, researchers and/or decision makers who work across marine and
39 coastal disciplines and sectors within the UK. Consequently, 23 non-UK respondents were omitted,
40 resulting in a final sample of 158. As shown in Table 1, roughly half of the sample was male, the
41 majority were aged between 25 and 54, were based in England, and had a postgraduate qualification
42 or above. The majority of respondents were in full-time employment, had been working in this field
43 for over 10 years, and self-identified themselves as working within one of six sectors: education /
44 academic research, consultancy research, working within government & policy, and to a lesser
45 extent, non-government organisations (NGOs), industry and other (e.g. self-employment, journalism,
46 and in temporary work; see Table 1).

	N	%		N	%
Demographics			Work Related		
Gender			Employability Status		
Male	76	48.1	Employed full time	113	71.5
Female	75	47.5	Employed part time	23	14.6
Prefer not to say	7	4.4	Retired	4	2.5
Age Group			Volunteer	1	.6
18-24	10	6.3	Student	9	5.7
25-34	34	21.5	Other	7	4.4
35-44	50	31.6	Sector		
45-54	34	21.5	Education/Academic Research	42	26.6
55-64	18	11.4	Consultancy Research	26	16.5
65 or over	12	7.6	Govt & policy	41	25.9
Current residency			NGO	20	12.7
Scotland	27	17.1	Industry (mixed)	15	9.5
England	113	71.5	Other	14	8.9
Wales	16	10.1	Duration in field		
Northern Ireland	2	1.3	Under 1 Year	11	7.0
Education			Between 1 and 5 years	22	13.9
GCSE/ O Level or equivalent	1	0.6	Between 5 and 10 years	29	18.4
A Levels or equivalent	1	0.6	Between 10 and 20 years	50	31.6
Undergraduate degree	28	17.7	Over 20 years	44	27.8
Postgraduate Masters Qualification	63	39.9			
Postgraduate Doctoral Qualification	54	34.2			
Professional Qualification	11	7.0			

2 Table 1. The demographic and work profile of the final sample ($n = 158$)

3 **2.2 Procedure & Measures –**

4 The questionnaire was piloted on an expert group with significant experience working in the field of
5 marine and coastal ecosystem services research and management ($n = 11$), with minor changes to
6 the wording of questions made where necessary before undertaking the full study. CMS members
7 were invited to participate by following a link to an online questionnaire survey (using Qualtrics
8 software) between the months of June and September 2017.

9 Following a short introduction to the study, respondents completed a mix of open and closed
10 questions focusing on: (i) their understanding of the concept of ES, (ii) their use of the term within
11 marine and coastal management, (iii) their evaluation of ES, and (iv) socio-demographic information.

12 (i) *Understanding of ecosystem services* – To assess current understanding and perceptions about
13 the overall concept, an open-ended question was used to allow respondents to spontaneously
14 “describe the term ‘ecosystem services’” in their own words. Quantitative items were also used
15 where respondents rated how informed they felt about the term (from not at all informed [1] to
16 having a high expertise [5]) and their level of agreement to numerous statements (e.g. “overall I like
17 the terminology used in the ecosystem services approach” and “Ecosystem services are difficult to
18 understand” [negatively coded]). To increase the sensitivity and variance within responses, a 7 point

1 scale was used (strongly disagree [1] to strongly agree [7]) and a “don’t know” response was
2 included to reduce ambiguity for the neutral response option “neither agree nor disagree [4]”
3

4 (ii) *Use of ecosystem services* – To explore the frequency and application of ES in their work,
5 respondents were asked how often they apply the concept in their job and a qualitative item asked
6 how ES are used within their work. They were also asked to rate their level of agreement to a range
7 of statements that looked at their confidence in using the concept (e.g. “I feel confident about using
8 ecosystem services within my role / activities”), the importance of the concept in their line of work
9 (e.g. “The ecosystem service approach is important within my role / activities”), perceived
10 opportunities to apply it (e.g. “There are opportunities for using the Ecosystem Service Approach
11 within my role / activities”), and social support in using it (e.g. “Everyone I work with understands
12 what is meant by ecosystem services”). All statements were rated on the scale from strongly
13 disagree [1] to strongly agree [7] or don’t know.
14

15 (iii) *Evaluation of ecosystem services* – When reflecting on their experience of the ecosystem service
16 concept in their work, open questions were used to give respondents the opportunity to
17 qualitatively express their views on it. These questions focused on three key elements; notably, what
18 they saw as the “advantages of using ecosystem services”, “what barriers/challenges, if any, are
19 associated with the use of ecosystem services”, and “what improvements, if any, [they] could think
20 could be made to the use of the ecosystem services in [their] field”.
21

22 (iv) *Socio-demographic information* – The questionnaire concluded with a set of closed personal
23 questions to gather further information on this sample, such as gender, age group, country of origin,
24 and education and employment level.

25 **2.3 Data Analysis**

26 ***Quantitative Data Analysis***

27 For the quantitative questions, the overall trends are reported (means and standard deviations). To
28 test respondents’ agreement with statements, one-sample t-tests examined if the responses
29 statistically differed from the mid-point (i.e. neither agree nor disagree). Further analyses looked at
30 whether responses differed according to individual differences (e.g. demographics and work
31 experience) and how the different measures related to one another. For the individual differences, if
32 data was normally distributed, multiple analyses of variances (ANOVAs) were run, if the data did not
33 fulfil the criteria for parametric tests, non-parametric alternatives were used (i.e. Kruskal-Wallis). To
34 look at how the different responses related to one another, a Principal Components Analysis (PCA)
35 was applied to the responses from the sections ‘*Understanding of ES*’ and ‘*Use of ES*’ of the
36 questionnaire. PCAs emphasise variation and bring out strong patterns in a dataset. The scores for
37 the 1st and 2nd components from each PCA were plotted in a biplot for further interpretation. PCAs
38 were performed using the package *vegan* (Oksanen et al., 2016) in R (R Development Core Team,
39 2017).

40 ***Qualitative Data Analysis***

41 For all of the open response questions, a manual coding process to interrogate the data was used.
42 Thematic analysis was undertaken in a variety of ways. For the majority of these questions, a
43 bottom-up inductive coding was used where the qualitative data was reviewed to identify prominent
44 emergent categories in each question through a data reduction and thematic coding process, these
45 were then developed and revised after numerous reviews of the data to identify the dominant

1 themes and sub-themes (Braun and Clarke, 2006). Additional content analysis was applied to
 2 quantify the prominence of particular themes and sub-themes in our sample’s responses, whereby
 3 the number of mentions or quotes that aligned with each theme were collated. For one of the
 4 qualitative questions, a top-down a-priori coding process was also applied. One of the initial
 5 questions asked respondents to provide a definition of the term ‘ecosystem services’, of which we
 6 were interested in what respondents spontaneously said and how this compared with existing
 7 definitions. Respondents’ answers were consequently compared to an a-prior framework. This
 8 involved comparing their answers to a list of published ecosystem service definitions derived from
 9 both marine research and practical applications in aquatic management (See Table 1 in
 10 Supplementary Material). Key words from those ES definitions were identified, and then these key
 11 words were searched for within the respondents’ responses (see Table 2).

ES Categories	Contributories	Beneficiaries	Outcome
Regulating	Environment	Human	Benefits
Supporting	Environmental	People	Processes
Provisioning	Ecosystem	Society	Services
Cultural	Nature	Population	Goods
	Natural Resources	Humankind	Wellbeing
			Health
			Value

12 Table 2: Search protocol developed through review of key ecosystem services definitions.

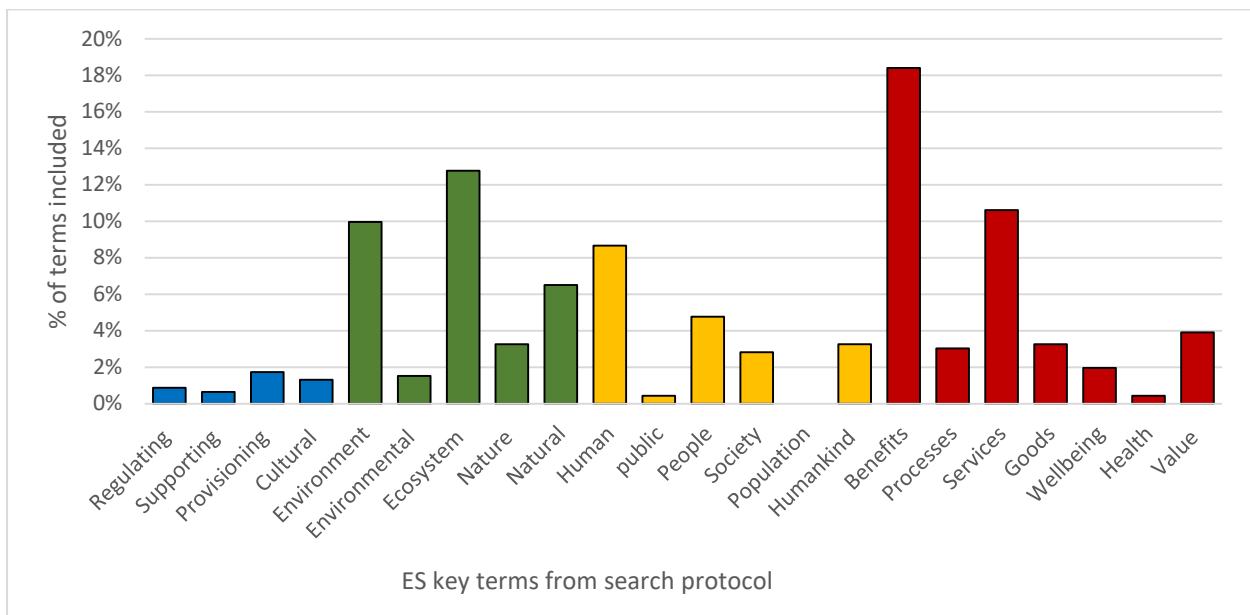
13 The qualitative data analysis provided additional insights into how respondents currently apply the
 14 concept of ES within the context of marine and coastal management in the UK, and their views on
 15 the challenges, benefits and opportunities for improving the use of the concept might be. These key
 16 themes are discussed in parallel to findings of the quantitative analysis, with quotes presented in
 17 italics to support the discussion where appropriate. Although analysis of qualitative data is
 18 inherently subjective, to check for inter-rater reliability two of the authors independently coded 20%
 19 of the data. Cohen’s kappa found satisfactory agreement between coders across the three
 20 qualitative data questions at an average of 67% (Landis and Koch, 1977).

21 **3. Results**

22 **3.1 Understanding of ecosystem services**

23 The definitions provided by respondents varied in the level of detail. Some were very brief and
 24 concise *“Flows of benefits from natural systems”* whereas some definitions included very specific
 25 information, presumably connected to the individual respondents’ experience, for example
 26 *“Recognising the benefits (and 'true' economic values) of natural environmental systems such as*
 27 *land, water, flora and fauna. Ecosystem services benefits are often ignored in traditional economic*
 28 *evaluations. An example would be the scrub/ buffer/ hedgerows around agricultural field that are the*
 29 *home to pollinating insects that are an essential part in maximising yields of grain and food stuffs. If*
 30 *you ploughed all the land that supports the pollinating insects, you might expect an increase in the*
 31 *amount of food produced, but if you destroy the habitat where the pollinators live then the yields will*
 32 *often dramatically decrease. Ecosystem services recognise the true benefits and economic values of*
 33 *the pollinators and their habitat is much greater than the extra land that would be released for*
 34 *agriculture. Similar benefits could be achieved for reduction in rainfall runoff and reduced risk by*
 35 *leaving buffer strips around fields that slow down water entering streams and rivers, thus reducing*
 36 *flooding downstream. These buffer strips act as an ecosystem service to people and property at risk*
 37 *of flooding further downstream a catchment”*.

1 Using the search protocol from Table 2, 95% of respondents used at least one of the key words in
 2 their definition (see Figure 1) – on average, the number of key terms used in respondent definitions
 3 was 3, although this varied from none to five. For the four groupings of search terms (see Table 2),
 4 4.5% of responses noted at least one of the ES categories, 34% emphasised contributors, 20%
 5 noted beneficiaries, with analysis showing the highest level of emphasis (41.5%) on outcome related
 6 terms. The terms most commonly used by respondents were ‘benefits’, ‘ecosystem’, ‘services’,
 7 ‘human’ and ‘environment’ (Figure 1.). Other words commonly used to define ES included ‘natural
 8 capital’, ‘economic value’ and ‘function’ – the inclusion of economic valuation language in
 9 respondents’ definitions, and the implications of this for the ongoing use of ES concept within
 10 marine and coastal management is addressed in later sections. Furthermore, it is interesting to note
 11 the dominance of ‘benefits’ as a key word within definitions, compared with the other ES terms of
 12 services and processes.



13
 14 Figure 1: Inclusion of ES terms in respondent definitions of ‘ecosystem services’.

15 Note. Bars in blue refer to the terms associated with ‘ES Categories’, green is ‘contributors’, yellow ‘beneficiaries’ and red
 16 ‘outcome’.

17 With regards to the level of understanding of ES, when asked to rate how informed they perceived
 18 themselves to be, respondents felt ‘moderately’ to ‘very informed’ about ES, on average ($M = 3.39$,
 19 $SD = 0.88$).

20 Overall, the sample statistically varied from the mid-point with regard to liking the term, and
 21 strongly agreed that it is a useful management tool and helps to assign meaningful value to marine
 22 resources. They also agreed that it aids communication, supports management plans, and generally
 23 like the terminology (see Table 3). The responses to the question “Ecosystem Services are difficult to
 24 understand” and “Ecosystem Services cover all aspects....” remained closer to the mid-point but had
 25 greater standard deviation indicating greater variation in the responses.

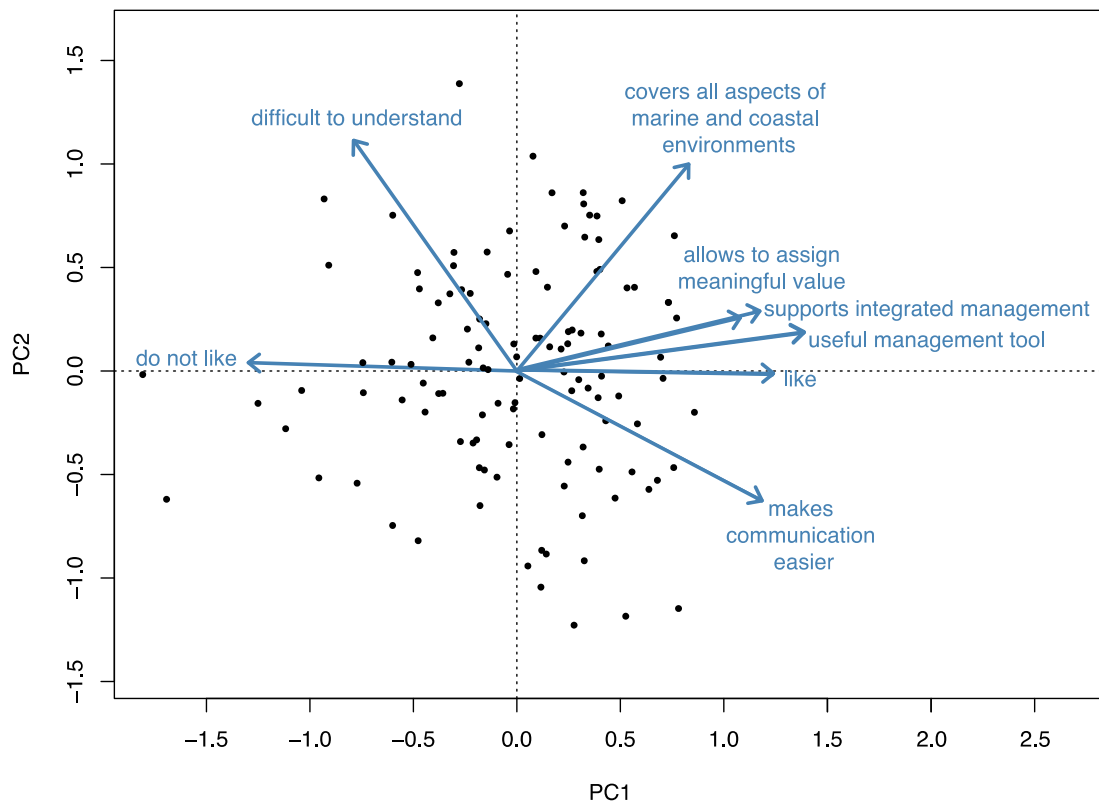
26

Statement	Mean	Standard Deviation
How informed do you feel about the term “ecosystem services”? ⁱ	3.39	0.88
a) Using ecosystem services makes communication easier and more effective. ⁱⁱ	4.64***	1.47
b) Ecosystem services are difficult to understand (-ive) ⁱⁱ	4.05	1.70
c) The ecosystem services approach is a useful management tool. ⁱⁱ	5.46***	1.33
d) Ecosystem services allow us to assign a meaningful value to marine and coastal resources ⁱⁱ	5.17***	1.52
e) The ecosystem services approach supports integrated management and plans of our coasts and seas. ⁱⁱ	4.64***	1.47
f) Ecosystem services cover all aspects of marine and coastal environments. ⁱⁱ	4.32	2.00
g) Overall, I do not like the concept of ecosystem services (-ive) ⁱⁱ	2.77***	1.68
h) Overall, I like the terminology used in the ecosystem services approach ⁱⁱ	4.46***	1.53

1 Note. Scale ⁱ ranged from not at all informed [1] to high expertise [5]; scale ⁱⁱ strongly disagree [1] to strongly agree [7].
2 “Don’t know” responses are not included in this analysis. (-ive) denotes negative wording of statement. N varies as some
3 respondents said “don’t know” to individual items, thus are not included in the analysis. *** denotes statistically different
4 to the mid-point (4) to a $p < 0.001$

5 Table 3. The average rating (and standard deviation) for each statement looking at perceptions
6 towards ecosystem services ($n = 149-158$).

7 PCA analysis found that the first axis of the PCA for respondents’ understanding of ES explained 45%
8 of the variance and was clearly an axis of ‘ES appeal’, as shown by the loadings of ‘overall I like the
9 terminology’ responses (overall dislikes in opposite direction, see Figure 2). The fact that ES supports
10 integrated management, is a useful management tool, allows to assign meaningful values and makes
11 communication easier also loaded PC1, and were strongly correlated to how much respondents liked
12 the ES framework. In contrast, the fact that the ES framework is difficult to understand and that it
13 covers many aspects did not influence the axis of ‘ES appeal’ (PC1) as much.



1
2 Figure 2. PCA biplot showing the scores of each respondent (black points) and the loadings of each
3 variable (blue arrows) on the 1st and 2nd principal components, in response to 'views about ES'.

4 *Note: The angles between arrows approximate to their correlations (smaller angles imply high correlations between*
5 *variables, and perpendicular arrows imply zero correlation). Points close together correspond to observations that have*
6 *similar scores on the PCA components.*

7 As shown in Figure 2, respondents who liked the ES concept (those on the right of the central line in
8 Figure 2) also thought it was useful as a management tool, that it allowed to assign a meaningful
9 value and that supported integrated management. Conversely, respondents on the left side of the
10 graph did not like the concept, did not think it was a useful management tool, did not find it allowed
11 to assign a meaningful value, and did not think it supported integrated management.

12 **3.2 Use of ecosystem services**

13 The majority of respondents (84.8%) have used this concept in their work, with 43.0% using it
14 occasionally, 33.5% using it frequently, and 8.2% of the sample using it on a daily basis. When
15 exploring respondents' experiences in using the concept in their work (see Table 4), they do not
16 believe that everyone understands ES. Overall, respondents agreed that there are opportunities to
17 use ES in their work, it is important within their role, and they understand how it can be used in
18 management plans. They also agree (but to a lesser extent) that they are confident in using ES and
19 communicating about ES, and that it helps to collaborate with other sectors. Demonstrating a
20 greater variability in responses, respondents did not necessarily agree that "My organisation / line
21 manager encourages me to use ecosystem services".

22
23

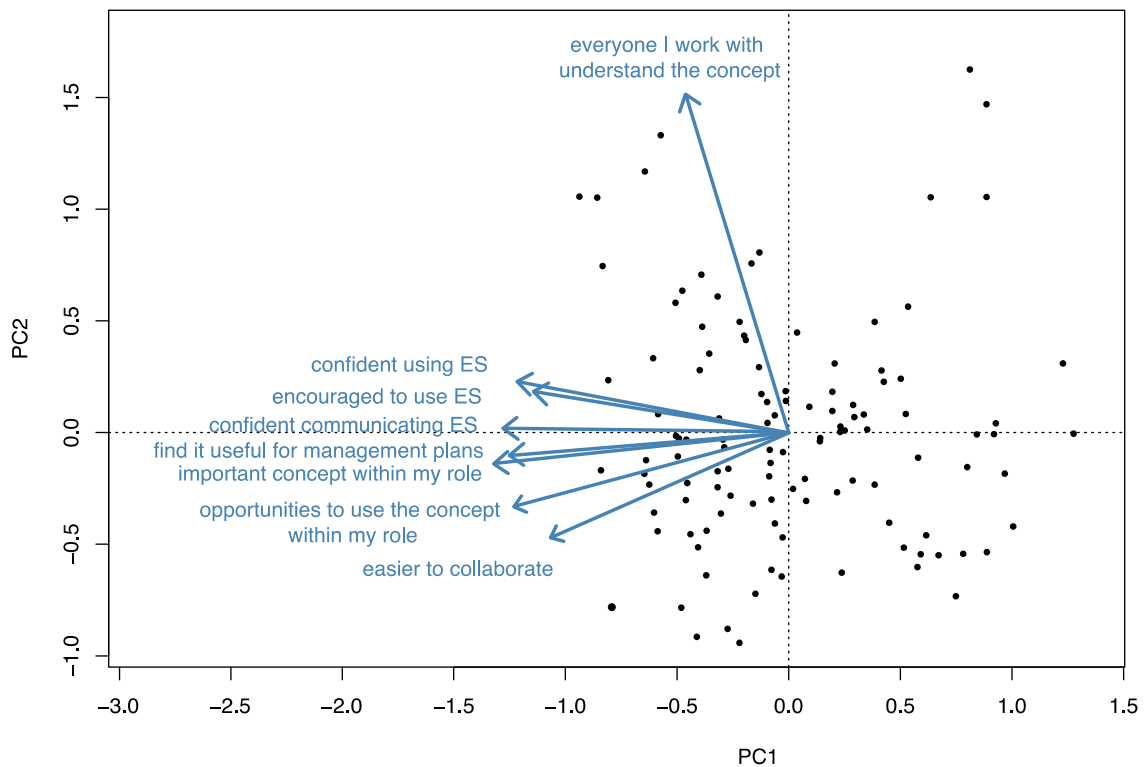
Statement	Mean	(Standard
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		Deviation)
a) I feel confident about using ecosystem services within my role / activities	5.15***	(1.60)
b) The ecosystem service approach is important within my role / activities	5.22***	(1.55)
c) There are opportunities for using the Ecosystem Service Approach within my role / activities	5.56***	(1.52)
d) I feel confident communicating about ecosystem services to colleagues and stakeholders	5.18***	(1.44)
e) I understand how ecosystem services can be used in management plans.	5.10***	(1.53)
f) Everyone I work with understands what is meant by ecosystem services	2.83***	(1.63)
g) My organisation / line manager encourages me to use ecosystem services	4.17	(1.97)
h) The concept of ecosystem services makes it easier to collaborate with different sectors.	4.64***	(1.58)

1 Table 4. The average rating (and standard deviation) for each statement looking at respondents' use
2 of ecosystem services in their work ($n = 145-157$).

3 *Note.* Scale ranged from strongly disagree [1] to strongly agree [7]. N varies as some respondents said "don't
4 know" to individual items, thus are not included in the analysis. *** denotes statistically different to the mid-
5 point (4) to a $p < .001$.

6 Further analysis on this set of questions was conducted to examine the relationship between the
7 ratings that individuals gave to the various questions. The first axis of the PCA for 'Use of ES'
8 explained 48% of the variance and was an axis of 'ES perceived usefulness'. PC1 was loaded with
9 responses to how confident respondents felt when using ES, how important this framework was
10 within their role, the opportunity of using ES, how encouraged they were to use this concept, or
11 whether the concept made it easier to collaborate with different sectors (Fig. 3). In contrast,
12 whether others understood the concept did not influence the 'perceived usefulness' of the ES
13 concept. Respondents on the right side of the Fig. 3 tended not to use the concept, didn't feel
14 confident communicating it, or felt that it wasn't an important concept within their role. In contrast,
15 respondents on the left side of the graph used the concept and were confident using it, among other
16 responses.



1
2 Fig. 3. PCA biplot showing the scores of each respondent (black points) and the loadings of each
3 variable (blue arrows) on the 1st and 2nd principal components, in response to 'using ES'.

4 *Note: The angles between arrows approximate to their correlations (smaller angles imply high correlations between*
5 *variables, and perpendicular arrows imply zero correlation). Points close together correspond to observations that have*
6 *similar scores on the PCA components.*

7 Relating to this, respondents were asked to qualitatively describe how they currently use the
8 concept of ES. Analysis of the data found there to be a myriad of ways in which UK marine and
9 coastal practitioners use the concept of ES, with the majority of respondents indicating that they
10 have current or previous experience in using the concept. Using a thematic analysis approach, a
11 number of themes relating to use were identified including: supporting sustainable management
12 and decision making, understanding and communicating the connections between different aspects
13 of the seas and coasts (including cultural and heritage components), education and research,
14 assessment of ES and natural resources, communication between stakeholders, improving
15 understanding of the benefits and importance associated with the marine and coastal environment,
16 and understanding and assigning value (both monetary and non-monetary) to resources, including
17 the application of natural capital/ accounting approaches to decision making. The multiple uses of
18 the ES concept were also neatly summarised by one respondent who stated that they had used the
19 concept in numerous ways – “1) education - providing lectures on the subject to both undergrad and
20 postgrad students; 2) with stakeholders as a method to stimulate discussion surrounding
21 management of MPAs [Marine Protected Areas]; 3) with MPA site managers by developing a matrix
22 approach; 3) as the basis of ecological valuation; 4) as the basis for economic valuation; 5) as the
23 basis for social valuation; 6) as the basis of peer-reviewed publications for the academic community”.

24 Comments on the application and use of the ES concept within marine and coastal management
25 highlighted its complexity, and potentially its limitations, as a concept with one respondent stating
26 that “ecosystem services give the appearance of quantifying importance but there are too many
27 possible future scenarios for us to be able to prioritise what is/will be the most important things to

1 *manage/protect*). Another respondent highlighted ongoing work to improve the accessibility of the
2 approach – “*I am working on projects that aim to make the ecosystem services approach applicable*
3 *and useful for marine management, planning and conservation.*”
4

5 It is worth noting that although the respondents were all individuals working within marine and
6 coastal management in some way, 13% of respondents indicated that they have never/ currently do
7 not use the concept of ES – one even stated that they are “*an ecological consultant and I cannot*
8 *recall an occasion when I have used the concept of Ecosystem Services*”. Furthermore, one
9 respondent commented that they had used the ES concept in the past, but this was before “*the term*
10 *natural capital was in common usage*”, perhaps indicating a natural evolution in terminology.

11 **3.3 Differences in perceptions towards the ES framework**

12 Secondary analyses were conducted to explore the relationship between respondents’
13 ‘understanding of the ES framework’ and ‘use of ES’ and respondents’ demographic and work
14 profile. When looking at individual differences, the most significant effects were sector and
15 experience of using ES in their work. Respondents across the six sector groups responded similarly
16 regarding their general perceptions of ES (see Table 5). However, there were significant differences
17 regarding how informed individuals felt about the concept ($p = 0.04$, see Table 5). Whilst
18 respondents from the industry sector self-categorised their knowledge as between ‘understanding
19 of the basics’ and ‘feeling moderately informed’, post-hoc analysis found that this was statistically
20 lower than those from other sectors, namely education/academic research ($p = 0.04$) and NGOs ($p =$
21 0.02). More statistical differences were found when further examining respondents’ use of the
22 concept (Table 5), with respondents from industry tending to give lower ratings. The largest effect
23 was found for the statement “My organisation / line manager encourages me to use ecosystem
24 services”: unlike the other sectors, respondents from industry overall disagreed with this statement,
25 giving it a statistically significantly lower rating to respondents from all other sectors ($ps < 0.03$). For
26 the other statements, there was a general agreement, with respondents within the industrial sector
27 feeling less confident in using the concept within their work (compared to education/academic
28 research and consultancy research, $ps = .04$); did not see it as important within their work compared
29 to others (education/academic research, consultancy research, government & policy, and NGOs, $ps <$
30 0.04), and perceived fewer opportunities to use the ecosystem service concept (e.g. than those
31 within consultancy research, NGOs, and government & policy, $ps < 0.01$).

32 In agreement with the results from the PCAs (Fig. 3), there were also linear main effects of how
33 often ES are used and how informed respondents felt about the concept on their ratings. With the
34 exception of the statement “Everyone I work with understands what is meant by ecosystem
35 services”, respondents who use ES in their work more regularly and felt more informed about the
36 concept gave more positive ratings and were more confident in using it ($ps < 0.02$). Using this
37 analytical approach, no demographic main effects were identified (e.g. gender, age, and education
38 level were not seen to have an overall main effect on respondents’ ratings, $ps > 0.06$).

Statement	Education/ Research (n = 37-42)	Consultancy Research (n = 21-26)	Govt & Policy (n = 38-41)	NGO (n = 19-20)	Industry (n = 13-15)	Other (n = 13-14)	Statistical difference
Perceptions of Ecosystem Services							
How informed do you feel about the term “ecosystem services”? ⁱ	3.50 (0.83)	3.50 (0.91)	3.34 (0.91)	3.65 (0.75)	2.73 (0.80)	3.36 (0.93)	$F(5,152) = 2.36, p = .04, \eta^2 = .07$
a) Using ecosystem services makes communication easier and more effective. ⁱⁱ	4.67 (1.51)	4.76 (1.56)	4.58 (1.41)	4.90 (1.52)	4.50 (1.29)	4.29 (1.59)	n.s.
b) Ecosystem services are difficult to understand (-ive) ⁱⁱ	3.81 (1.89)	3.88 (1.66)	4.39 (1.56)	4.40 (1.79)	4.29 (1.38)	3.36 (1.60)	n.s.
c) The ecosystem services approach is a useful management tool. ⁱⁱ	5.68 (1.21)	5.38 (1.79)	5.15 (1.31)	5.60 (0.82)	5.57 (0.94)	5.57 (1.60)	n.s.
d) Ecosystem services allow us to assign a meaningful value to marine and coastal resources ⁱⁱ	5.24 (1.51)	5.38 (1.65)	5.02 (1.39)	4.90 (1.29)	5.71 (1.38)	4.86 (2.11)	n.s.
e) The ecosystem services approach supports integrated management and plans of our coasts and seas. ⁱⁱ	4.67 (1.51)	4.76 (1.56)	4.58 (1.41)	4.90 (1.52)	4.50 (1.29)	4.29 (1.59)	n.s.
f) Ecosystem services cover all aspects of marine and coastal environments. ⁱⁱ	4.32 (2.16)	4.72 (2.01)	3.95 (1.80)	4.26 (1.97)	4.92 (1.66)	4.15 (2.41)	n.s.
g) Overall, I do not like the concept of ecosystem services (-ive) ⁱⁱ	2.70 (1.56)	2.69 (1.95)	2.80 (1.50)	2.60 (1.85)	2.79 (1.19)	3.21 (2.26)	n.s.
h) Overall, I like the terminology used in the ecosystem services approach ⁱⁱ	4.59 (1.50)	4.38 (1.84)	4.48 (1.48)	4.30 (1.49)	4.21 (1.31)	4.64 (1.65)	n.s.
Use of Ecosystem Services							
a) I feel confident about using ecosystem services within my role / activities	5.46 (1.47)	5.46 (1.24)	5.17 (1.72)	5.40 (1.31)	3.80 (1.78)	4.71 (1.77)	$\chi^2 = 12.89, df = 5, p = .02$
b) The ecosystem service approach is important within my role / activities	5.07 (1.49)	5.23 (1.77)	5.63 (1.43)	5.80 (1.01)	3.73 (1.28)	5.15 (1.72)	$\chi^2 = 21.49, df = 5, p = .001$
c) There are opportunities for using the Ecosystem Service Approach within my role / activities	5.40 (1.55)	5.96 (1.22)	5.85 (1.42)	5.95 (0.89)	4.00 (1.65)	5.50 (1.83)	$\chi^2 = 20.76, df = 5, p = .001$
d) I feel confident communicating about ecosystem services to colleagues and stakeholders	5.18 (1.39)	5.42 (1.42)	5.29 (1.57)	5.40 (0.75)	4.07 (1.49)	5.29 (1.64)	n.s.
e) I understand how ecosystem services can be used in management plans.	5.23 (1.40)	5.35 (1.65)	5.00 (1.70)	5.40 (1.27)	4.33 (1.45)	4.93 (1.49)	n.s.
f) Everyone I work with understands what is meant by ecosystem services	2.92 (1.64)	3.22 (1.57)	2.71 (1.69)	3.25 (1.74)	2.14 (1.10)	2.43 (1.65)	n.s.
g) My organisation / line manager encourages me to use ecosystem services	4.14 (1.78)	4.43 (1.86)	4.10 (1.96)	5.37 (1.64)	2.14 (1.41)	4.50 (2.18)	$\chi^2 = 22.55, df = 5, p < .001$
h) The concept of ecosystem services makes it easier to collaborate with different sectors.	4.54 (1.33)	4.22 (2.00)	5.10 (1.45)	4.75 (1.55)	4.13 (1.85)	4.71 (1.49)	n.s.

40 Note. Scale ⁱ ranged from not at all informed [1] to high expertise [5]; scale ⁱⁱ strongly disagree [1] to strongly agree [7]. “Don’t know” responses are not included in this analysis. (-ive) denotes negative wording of
 41 statement. N varies as some respondents said “don’t know” to individual items, thus are not included in the analysis.

42 Table 5. Comparing respondents according to their self-identified sectors on their average rating (and standard deviation) for each statement looking at perceptions and
 43 use of ecosystem services.

1 **3.4 Evaluation of ecosystem services**

2 In addition to identifying trends in understanding and use related to ES, three open questions were
3 posed to further evaluate the stakeholders' views, focusing on the perceived advantages, challenges
4 and potential opportunities for improvement. Open questions were used in this section to capture
5 as broad an input as possible, and because it was not possible to predetermine what these
6 responses might be.

7 8 **3.4.1. Advantages**

9 A vast majority of respondents shared positive experiences, with 92% providing a response to this
10 question. As explained above, thematic coding highlighted a range of advantages identified by
11 survey respondents (summarised in Table 2 in Supplementary Material). While these advantages
12 were described in varying ways, a dominant theme of communication and improving understanding
13 was identified as a key advantage of the concept of ES services. A total of 25% of responses (under
14 complementary thematic categories of common language and improved dialogue and
15 communication) emphasised that the ES concept acts as a way of supporting effective
16 communication and increasing understanding of the various components of marine and coastal
17 environments, providing a more integrated and holistic way of viewing *and* valuing a diverse set of
18 ecosystems, resources and user groups. There was a feeling that the ES concept provides "*common*
19 *ground*" and therefore a useful lens through which these complex socio-ecological interactions can
20 be simplified, engendering an increased level of understanding across diverse audiences.

21
22 In addition to providing a "*common language*" that supports communication, 10% of responses
23 indicated that the ES concept can be used to improve stakeholder and public understanding of the
24 value of these resources to society. Further to supporting communication between different sectors
25 and user groups, respondents indicated that the ES concept has been a useful tool through which
26 the various values (both monetary and non-monetary) associated with the marine environment can
27 be articulated in an accessible way. Monetary valuations were seen as being particularly useful in
28 the context of linking wider society, the economy and the environment. This aspect of ES valuation
29 was seen as having particular relevance for management and decision making was also identified,
30 with one respondent indicating that "*it can be useful for management plans that consider the*
31 *economic value of nature*". This was supported by another respondent who stated that "*People*
32 *realise that the monetary value [associated with the ES concept] provides a common currency for*
33 *discussion. If issues are not valued then they are excluded and not taken into account even though*
34 *they are very important*". There was a feeling from some that this quantification of marine and
35 coastal systems would be an ongoing trend within management and governance, with one
36 respondent suggesting that "*At the planning level, in [Environmental Impact Assessments],*
37 *ecosystem services will increasingly be quantified, and contribute to decisions to approve, and/or*
38 *attach planning conditions relating to ecosystem services*".

39
40 Finally, under the theme of communication, a further benefit of using the concept as a
41 communication tool leading to improved reputation of certain sectors and activities was suggested.
42 An example of this was given by one respondent who stated that "*using this term to describe the*
43 *more environmentally favourable forms of aquaculture helps with winning hearts and minds*".

44 45 **3.4.2. Barriers and Challenges**

46 While respondents highlighted a significant number of positive connotations associated with the
47 concept of ES, it was evident that there are a number of challenges facing the effective use of

1 concept within UK coastal and marine management, with 93% of respondents providing responses
2 to this question. The most commonly noted challenges and/or barriers were linked to the complexity
3 of the term (10%), the use of jargon/ inaccessible language associated with it (10%), and a lack of
4 both stakeholder and public understanding both around the concept and the science related to it
5 (19%).
6

7 Although the overarching view was that ES as a concept supports communication and dialogue
8 between different users, there was a recognition that challenges remain. One respondent summed
9 this up, by stating that the common language it provides is beneficial *“if we could all agree...”*
10 alluding to the ongoing debate surrounding the concept. There was an overarching view amongst
11 respondents that the concept remains complicated, complex, *“poorly understood”* and too full of
12 *“jargon”*. As shown in Table 3 in Supplementary Materials, respondents characterised the concept as
13 *“narrow”*, with a need for improved integration of heritage aspects within the language of ES
14 identified by one respondent, while another highlighted the challenges associated with the *“variety*
15 *of issues, and the varying approaches that [need to] be applied”*. Further comments were made by
16 4% of responses stressing not only the complexity of the concept, but also that of the marine and
17 coastal environment it is being applied to. There was a feeling that numerous gaps in knowledge and
18 understanding remain, posing a significant challenge to effectively embedding the ES concept within
19 marine and coastal management.
20

21 Given the ongoing conversation around the validity of attributing economic values to natural
22 resources, the theme of monetary valuation was examined through the analysis. Although, concerns
23 about monetary valuation have become part of the ES dialogue, this theme was only identified as a
24 concern and an ongoing challenge in 11% of responses, with one individual stating, *“There is often a*
25 *desire to reduce it down to a financial figure which I am not sure is possible or appropriate”*. This
26 concern was supported by another response who commented that they *“worry that if there's an*
27 *important ecosystem that needs protecting for its intrinsic environmental value but it doesn't have a*
28 *very strong economical case that these important sites will be overlooked”*. Within the broader
29 theme of monetary values, respondents highlighted the challenge of assigning monetary value to the
30 entire marine and coastal system, recognising that many ES and benefits are not marketable and
31 that monetary valuation is just one method of valuing nature and may not always be the most
32 appropriate method. With this in mind, there was a suggestion that the concept of ES *“must be used*
33 *as one tool in an arsenal rather than solo”* within marine and coastal management.
34

35 One respondent questioned the appropriateness of grounding policy development in the ecosystem
36 service concept, recognising gaps in current levels of knowledge and understanding of marine and
37 coastal ES, and directly questioning *“whether it is appropriate, helpful or meaningful to have marine*
38 *planning policies relating specifically to ecosystem services”*. There was a feeling derived from a small
39 group of responses (2%) that, perhaps, the ES concept should be better aligned with other initiatives
40 and policy drivers, for example *“[the] well-being of local communities; protecting MPA networks and*
41 *biodiversity; protecting/improving water quality etc. are more 'implementable', and should support*
42 *the provision of ecosystem services.”*
43

44 While interdisciplinarity and taking an integrated view of marine and coastal systems was seen as a
45 strength of the ES concept, concerns that this bringing together of these diverse sectors and
46 disciplines also posed a significant challenge to successfully applying the concept within marine and
47 coastal management in the UK were evident in 5% of responses. One respondent articulated a
48 concern that *“there are also still very strong sectoral barriers to working across disciplines in a*

1 *practical sense - these barriers can be financial (e.g. funding for particular work coming from one*
2 *area and therefore that being the focus of the work rather than a broader approach). The barriers*
3 *can also be political (government, regional and local) and at an individual level where people don't*
4 *want to engage. I also think that a focus on ecosystem services can be seen to (and can actually)*
5 *prevent progress in specific work areas, e.g. biodiversity protection".*

6
7 A further barrier identified within 19% of responses is that the concept remains complex and difficult
8 for different audiences to connect with, particularly the wider public. There were concerns
9 expressed that the intricacies of socio-ecological interactions between society and the UK seas and
10 coasts required more than an academic concept to improve public understanding, but that the
11 additional resources and time would be difficult to obtain, with one interviewee commenting that
12 *"Sometimes, 'the bigger picture' is too big and there is simply no way to tackle an issue on an*
13 *ecosystem wide level without significant additional resources. Furthermore, the term ecosystem*
14 *services does not engender much enthusiasm amongst the general public".*

15 16 3.4.3. Opportunities for Improvement

17
18 Recognising the dominance of ES as a fundamental concept within marine and coastal management,
19 this work sought to identify ways in which its application and use could be improved. Analysis of the
20 data found that 81% of respondents felt some form of improvement could be made to how the ES
21 concept is currently being used within UK marine and coastal management, with the dominant
22 themes discussed in the following sections (summarised in Table 6). Those with more than 10
23 mentions have been included in bold font; it is worth noting that the theme 'Improved stakeholder
24 and public understanding of the science and the application of the concept - including more research
25 and improved communication' has significantly higher counts than any other thematic category.
26 Other themes frequently mentioned by respondents included: the need for improved knowledge of
27 marine and coastal ecosystems; the need for standardisation across the ES concept; the need to
28 reduce jargon and improve communication supporting a common, user-friendly language; a desire
29 for improved guidance and provision of evidence of success through case studies; and, finally, a need
30 to consider a range of values, not just focusing on economic value and the Natural Capital approach.

Theme	Number of mentions	Evidence (quotes from respondent responses)
Improved stakeholder and public understanding of the science and the application of the concept - including more research and improved communication	47	<p><i>“Educate, educate, educate policy makers, politicians, local communities”</i></p> <p><i>“Lay person briefing sheets summarising the key ecosystem services would be of great value”</i></p> <p><i>“Better definition of ecosystem services for marine areas”</i></p> <p><i>“Further research to identify components of ecosystems which provide mental health and wellbeing benefits”</i></p> <p><i>“Great understanding and awareness of services that are apparent at a local scale”</i></p>
User Friendly language and better communication	20	<p><i>“Change the term for something more widely understandable - even the term ecosystem is a barrier to many...”</i></p> <p><i>“More/better communication of successes in integrating ecosystem services into decisions onto coastal management.”</i></p> <p><i>“Use of accessible and appropriate language according to the field.”</i></p>
Develop integrated valuation – taking all values into consideration, but including links to the Natural Capital approach.	14	<p><i>“A shift away from numerical values to a traffic light system: Green meaning things are better, Red meaning things are worse”</i></p>
Standardisation and development of common methods and tools	13	<p><i>“Standardisation of metrics, including valuation, and methods of assessment”</i></p>
Improved guidance for better application	12	<p><i>“More clarity on how knowledge of ecosystem services could be used in everyday management issues and casework. E.g. practical examples of how they've been used to implement a change in management.”</i></p>
Improved knowledge of marine and coastal ES	11	<p><i>“For the marine environment in particular, we are still a long way from understanding how the different components of the ecosystem inter-relate, making evaluation difficult. So more basic research to support the concept is needed in order to avoid trade-offs that lead to long-term environmental deterioration”</i></p> <p><i>“Better stakeholder understanding of the marine ecosystem.”</i></p>
Evidence of Success	11	<p><i>“Use of ecosystem services/the natural capital approach is still at a relatively early stage so although there is a lot of talk about it there still isn't much evidence of it influencing decision making at either a management or a policy level. Hopefully this may start to change with the Defra 25 year environment plan and the Pioneer areas which have been established to trial this approach”</i></p> <p><i>“Good applied case studies moving to real application”</i></p>
Use of best available and innovative science, data and methods.	6	<p><i>“Use the most up to date equipment to measure ecosystem effects...However crucially need to then use data and incorporate it into the data protocols system”</i></p>
Improved policy landscape to better support the ES concept	6	<p><i>“Introduce legal obligation to take ES into account in decision-making”</i></p> <p><i>“It is important to recognize the services provided by the environment when developing a policy framework for planning and development, this can then set the direction of travel down the line at the plan or project level to influence ecosystem service goals”</i></p>

Theme	Number of mentions	Evidence (quotes from respondent responses)
Improve inclusion to and understanding of culture and heritage.	5	<i>“Further delineation and refinement of the Cultural Ecosystem Services concept.”</i>
Better recognition of the assumptions that underpin ES	5	<i>[Need for] more intellectual input and genuine thought about network behaviour rather than tabulating well known connections and arguing about words and their meaning genuine efforts to understand how non-linear interconnections and networks behave, including human behaviour and economics”</i>
Need for funding	3	<i>“More financial resources would allow me to utilise ecosystem services on a wider scale and perhaps start to tackle some of the bigger issues. There needs to be more investment in government conservation bodies to lead this change, so that all conservation can be based around what's best for the ecosystem (and in turn the services we depend on) rather than a single site or species.”</i>
Recognition that the ES concept is part of a suite of management tools	3	<i>“To recognise that this is not the complete answer, it is just a tool which can help to make some comparative values clearer - there is a danger that the concept becomes the important thing and not the place”</i>

1 Table 6: Summary of suggested improvements for future application of the ES concept within UK
2 marine and coastal management.

3 **4. Discussion**

4

5 This paper provides insight into marine and coastal stakeholder perceptions and attitudes towards
6 ecosystem services (ES) and its role within UK marine and coastal management. Despite becoming
7 increasingly embedded within environmental decision-making and management, this study found
8 that while stakeholders indicated positive views towards the ES concept, questions, concerns and
9 scepticism remain. Indeed, respondents found a lot of room for improvement as shown by both the
10 volume and diversity of responses identified through the open questions. Many of these were linked
11 to the need for standard procedures to evaluate ES in marine and coastal settings, for clear (e.g.
12 simplified) terminology and classifications, pluralistic valuations, and the need for examples of
13 success stories using the concept within a marine and coastal context. While some of these are
14 already being addressed by both academia and practitioners (see e.g. Pascual et al., 2017), more
15 research in these areas is clearly required.

16 **Views and attitudes towards ES as a concept**

17 Analysis of the results from this study found that most respondents felt informed about ES, liked the
18 terminology, and found it a useful management tool, with some specifically welcoming it as a
19 mechanism through which values (both monetary and non-monetary) can be assigned to marine and
20 coastal ecosystems. We found that the more respondents used the concept, the more they liked it
21 (or vice versa), and the more they liked it, the more confident in using the concept they felt. Across
22 sectors, respondents from the industry sector felt less informed and encouraged to use the ES
23 framework. When asked to define ES, most respondents linked the concept with words such as
24 ‘environment’, ‘ecosystem’, ‘nature/natural’, ‘human’ and ‘benefits/services’, terms found in the
25 most commonly accepted definitions and frameworks of ES (MA, 2005, de Groot 2010b, NEA 2016).
26 This highlights that, overall, this particular sample of stakeholders had a very accurate idea of the

27 concept, liked the terminology and found it useful as a management tool, across the diverse
28 backgrounds of respondents.

29 With this in mind, it is possible that the ES concept and its application within marine and coastal
30 management should be reviewed, and definitions and approaches to assessment should evolve if
31 necessary, (as discussed by Fisher et al., 2009) to ensure applicability to a complex environmental
32 and governance landscape. As expected, respondents identified both advantages and challenges
33 associated with the use of the ES concept within marine and coastal management in the UK.
34 Synthesising all responses given throughout the questionnaire we propose that the main advantages
35 of the ES approach can be summarised in 5 key themes:

- 36 1) Supports the understanding of the multiple (plural) values of the environment;
- 37 2) Reduces complexity and provides a holistic view of the environment;
- 38 3) Provides a common language that improves communication between sectors, and increases
39 public understanding;
- 40 4) Links society to the environment; and
- 41 5) Supports management.

42 While numerous advantages were identified through this study, it remains clear that there are a
43 variety of challenges tied up with the application of the ES concept within contemporary marine and
44 coastal management. Bringing together the key findings from this study, we propose that these
45 challenges can be grouped into 5 main categories:

- 46 1) Problems of understanding and lack of specificity (unknowns);
- 47 2) Terminological problems (vagueness, openness);
- 48 3) Concerns linked to the commodification of nature and the dominance of economic
49 valuation;
- 50 4) Difficult application to a real-world context; and
- 51 5) Illustration of the need for increased support from the political landscape.

52 The benefits and challenges identified by respondents in this study are not necessarily unexpected,
53 and similar observations have been made by other authors, serving to highlight the complexity and
54 challenge associated with the ongoing ES debate. Indeed, it could be said that this itself illustrates
55 the complexity of societal interactions with the environmental world. Despite the range of
56 challenges and potential pit falls identified by respondents, the unique contribution of this work
57 remains in its assessment of the opportunities for future improvements.

58 ***Opportunities and Recommendations for Improvement***

59 Although other studies have examined perceptions towards the ES concept (Thompson et al., 2016),
60 this paper presents an evaluation not only of current views, thereby identifying trends in perceptions
61 whilst giving an insight as to why those views are held, but also of the challenges and potential
62 opportunities for improvement in the future. Analysis of the stakeholder responses generated 5 key
63 areas for improvement with regards to the application of the ES concept within marine and coastal
64 management:

- 65 • Need for standardisation and more guidance than currently available,
- 66 • Need for improved and clear terminology, including a simplification of classifications that does
67 not disengage the general public,
- 68 • Need for multilevel/multi-metric/pluralistic valuations, allowing greater connection to culture
69 and heritage,

- 70 • Need for a collection of success stories to be used as case studies,
- 71 • Improvements beyond ES (e.g. increased funding, increased scientific education for politicians
- 72 and policy makers).

73 Language, in a number of guises, was seen to be a key theme throughout the various aspects of this
74 research, both on the positive and negative side of the conversation. This discussion is one that has
75 been ongoing for some time, with numerous authors presenting different views and definitions
76 associated with the concept (see Fisher et al., 2009 for examples). A fundamental concern expressed
77 by stakeholders about the application of ES within marine and coastal management was a feeling
78 that the ES language and terminology is complex, inaccessible and hard for people to connect with.
79 Recent research has examined the influence that language and terminology can have on how a
80 concept is accepted or used (Raymond et al., 2013). Concerns about the semantic implications of
81 ecosystems providing services to people's wellbeing stem from the presentation of people and
82 nature as separate entities, with directional flows just from nature to people (Raymond 2017, Kenter
83 2018). Respondents referred to these issues, with the ES concept seen to 'disengage the general
84 public'. Concerns about the level of uncertainty and knowledge gaps relating to ES, and how the
85 concept can be applied, are not new (Wallace, 2007; Metz and Weigel, 2010; Dempsey and
86 Robertson, 2012; Schroter et al., 2014; Thompson et al., 2016; Potschin-Young et al., 2018), and,
87 evidently, this remains the case for marine and coastal management in the UK. Previous studies
88 argue that the dominance of the ES concept, and the economic valuation often associated with it,
89 can result in a diminished relationship between society and nature, rather than supporting strong
90 connections (Peterson et al., 2009; Schroter et al., 2014, Raymond et al., 2013; Diaz et al., 2018).
91 However, and interestingly, in many instances respondents found the same topic as both
92 advantageous and a disadvantage: e.g. vagueness-openness of the term, topics linked to making
93 communication easier between disciplines, offering a common ground, linking society to the
94 environment and providing a holistic view of the environment.

95 The areas for improvement detailed above are already being tackled by many groups, although this
96 is lacking a collective approach with moves towards improvement being steered by specific sub-
97 disciplines or sectors. For example, the Blue Carbon Initiative produced a manual (Howard et al.,
98 2014) 'with the goal of standardizing protocols for sampling methods, laboratory measurements,
99 and analysis of blue carbon stocks and fluxes'. The manual provides scientists and coastal managers
100 with 'a practical tool to produce robust blue carbon data'. This manual has turned into the current
101 gold standard for evaluation of global carbon stocks in marine ecosystems. Adopting a similar
102 approach to standardisation and the production of real-world examples to support implementation
103 for all ES and benefits, including those associated with culture and heritage, would make the ES
104 concept even more used and applicable to the real world. Another example of a trial to improve the
105 concept has been the recent presentation by the IPBES of the notion of 'Nature's Contributions to
106 People' (NCP) (Diaz et al., 2018). While the aim of developing this 'new' term was to come up with a
107 simpler more inclusive terminology that was accepted among different world views and disciplines
108 (Borie and Hulme 2015), the heated debate that has prompted (e.g. de Braat 2018), does not
109 envisage a resolution to this pending improvement. However, what has been praised from the IPBES
110 framework is the pluralistic valuation approach (one of the opportunities for improvement identified
111 in this study), which should be able to accommodate different world views by taking into account
112 not only economic values, but also social, ecological, cultural and indigenous and local knowledge
113 ones (See Pascual et al., 2015 for IPBES, but also Chan et al., 2012a, b). If the ES concept is to realise
114 its potential as a common tool that can be used by the multitude of actors involved in marine and
115 coastal management, more work is required to sufficiently embed these plural values within the
116 ongoing ES conversation and application.

117 **5. Concluding Comments and Recommendations**

118 Regardless of ongoing efforts to further embed the ES concept within marine and coastal
119 management, and despite the ever-growing literature base aimed at further developing the concept
120 and its application, the fact remains that there continue to be concerns as to how, and if, the ES can
121 be appropriately applied to the intricate and complex systems of the global seas and coasts. As
122 shown in this study, despite an overwhelmingly and, indeed, unexpectedly positive response from
123 UK marine and coastal stakeholders towards the ES concept, the perceived opportunities for
124 improvement are vast. With this in mind, the following sets out a series of recommendations:

- 125 • While support for the ES concept within the governance sphere is evident through its inclusion
126 in recent policy (e.g. UK's 25 Year Environment Plan (Defra, 2018)), there remains a call for
127 greater political support. We therefore recommend increased explicit consideration of ES
128 provided from specific marine and coastal environments within high level national legislation
129 and key policy drivers in the UK, as has been recently highlighted for Wales (McKinley et al.,
130 2018).
- 131 • For the ES concept to be successful, it must be recognised that there will be no 'one size fits all'
132 definition or approach that can be applied to all marine and coastal contexts across the UK.
133 However, for the benefits associated with culture and heritage to be appropriately recognised
134 within wider ES dialogue, a revised definition and perhaps, an interdisciplinary suite of
135 approaches and methodologies with the capacity to take account of pluralistic values and uses,
136 is recommended.
- 137 • Alongside a revised definition, it is suggested that users of the ES concept carefully consider
138 the audience and adopt appropriate language when communicating or discussing the ES
139 concept and how it might impact their use of the UK coast and sea. By taking account of the
140 heterogeneity of public audiences, and tailoring language fittingly should reduce the concerns
141 raised regarding complexity, jargon and technical language commonly associated with the ES
142 concept.
- 143 • While we found high levels of favourable attitudes towards the ES concept in a UK context, we
144 propose that such rates of stakeholder acceptance and use will not be achieved in other
145 countries of the world (Pagès and McKinley 2018) due to among other things, the influence of
146 differing world views across communities and user groups (Pascual et al., 2018, Borie and
147 Hulme 2015), as well as concerns about the application of monetary valuation to marine and
148 coastal management (Raymond et al., 2013). It is therefore recommended that the work
149 presented in this paper is reapplied internationally to explore this in more detail, with a view to
150 supporting global marine and coastal governance endeavours to develop, agree on, and
151 implement consistent approaches for marine and coastal management on a global scale.
- 152 • With a view to improving uptake, understanding and application of the ES concept within
153 marine and coastal management in the UK, the generation of success stories and best practice
154 examples of a multi-use/ value application of ES in an appropriate context is recommended.
155 Stakeholders could use these as evidence and support tools when developing Ecosystem based
156 management approaches.
- 157 • Crucially, we recommend that, as the conversation around societal interactions and
158 relationships with the natural environment continues to evolve (see, for example, the
159 emphasis on natural capital in the UK's recent 25 Year Environment Plan (REF)), the ES concept
160 should be considered one tool within a wider suite of options for marine and coastal
161 management.

162

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